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IT Architecture for Digital Integration: A Systematic Literature Review of Approaches, Challenges, and Solutions

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Abstract

The rapid development of technology has accelerated digitalization across various sectors, but implementing technology within complex ecosystems presents integration challenges, including data heterogeneity, technology fragmentation, legacy systems, limited interoperability, and misalignment between business requirements and technology implementation. This study explores the roles of IT architecture in supporting digital integration, the challenges encountered, and the architectural solutions proposed to address them. A Systematic Literature Review was conducted using the PRISMA framework across Scopus, ScienceDirect, IEEE Xplore, SpringerLink, and Google Scholar. From 506 retrieved articles, 17 studies published between 2021 and 2026 were selected for final synthesis. The findings show that IT architecture supports digital integration at both enterprise and system levels. At the enterprise level, it addresses fragmentation within digital ecosystems and supports digital transformation and data integration, while at the system level, it facilitates interoperability through the integration of emerging technologies such as the Internet of Things, blockchain, cloud computing, and Digital Twins. Enterprise architecture, particularly TOGAF, was the most frequently adopted architectural approach because it is a widely recognized industry standard. Integration challenges were categorized into five categories: data management and integration, infrastructure, strategic alignment, risk management, and standardization. Architectural solutions were categorized into five categories: application integration, data integration, architectural configuration, emerging technology integration, and governance and risk management. These findings provide an overview of how architectural approaches can address digital integration challenges across diverse technological and organizational contexts.

Keywords: Digital integration, digital transformation, enterprise architecture, information technology architecture, interoperability

1 Introduction

The increasing complexity of today's environment has driven a growing demand for technologies to deal with various real-world challenges. The emergence of new technologies has accelerated digital transformation across multiple sectors. However, when modern technologies are implemented at scale, managing the complexity of data flows and business workflows becomes increasingly challenging [1]. At the same time, the performance and reliability of technological systems are critical factors in ensuring that these technologies operate effectively and deliver their intended value [2]. This is because technology implementation not only involves advanced applications alone, but also encompasses data, business processes, infrastructure, and even organizational and cultural aspects [3], [4]. Furthermore, the increasing complexity of business processes, the rapid growth in data volume, and the diversity of data sources further complicate technology implementation [5], [6], [7]. Thus, the success of technology implementation largely depends on the ability to integrate these diverse components into an overarching digital ecosystem [8].

In practice, achieving digital integration remains a significant challenge. Rapid technological advancement often encourages organizations to implement new systems, resulting in heterogeneous and fragmented digital ecosystems characterized by numerous legacy systems [9]. Such conditions give rise to various issues, including information silos, data heterogeneity, limited interoperability, and data inconsistency [10], [11]. Moreover, integrating emerging technologies such as blockchain, the Internet of Things (IoT), cloud computing, and other digital technologies presents additional

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challenges due to differences in data formats and communication standards [12], [13], [14]. Insufficient digital integration hinders interoperability among systems and data, ultimately affecting organizational decision making, in which approximately 67% of management decisions are delayed because of poor data interoperability[5]. Therefore, digital integration has become a critical prerequisite for ensuring that technology implementation delivers its expected benefits.

To manage the complexity of digital integration, organizations require architectural approaches capable of defining information technology architectures from a holistic perspective while aligning technological capabilities with business objectives [15]. Architectural approaches also serve as proactive mechanisms for reducing the risk of information technology project failure [16]. Within the field of Information Systems and Information Technology literature, a variety of approaches have been proposed for designing information technology architectures. Enterprise architecture is among the most widely adopted approaches in both research and practice. Nevertheless, many studies have developed architectural solutions using research methodologies such as Design Science Research and Action Research, as well as various architectural frameworks tailored to different organizational contexts and research objectives.

Previous systematic literature reviews have discussed the implementation of architectural approaches across various topics and sectors, including Digital Transformation [17], [18], the Public Sector [9], AI and Digital Twins [19], [20], [21], Blockchain [22], [23], [24], E-Government [25], and Higher Education [26], [27]. Most of these reviews focused on enterprise architecture, while some discussed specific technology architectures integrated with other cutting-edge technologies. Other reviews have focused on the implementation of enterprise architecture using specific methodologies, such as TOGAF [14], or analyzed various enterprise architecture frameworks and methodologies [28].

However, the previous systematic literature reviews have not specifically examined architectural approaches for digital integration across different topics and sectors. This study aims to address this gap by analyzing the implementation challenges of digital integration, the architectural solutions proposed in the selected studies, architectural approaches employed, and emerging technology trends related to digital integration. The PRISMA methodology was selected to ensure a transparent, systematic, and reproducible literature synthesis [29]. Specifically, this study addresses the following research questions: (RQ1) What are the technological themes and trends discussed in the selected studies? (RQ2) What roles do architectural approaches or frameworks play in designing architectural blueprints to support digital integration? (RQ3) What challenges are encountered in achieving digital integration? (RQ4) What solutions have been proposed to address these digital integration challenges?

2 Literature Review

Based on IEEE technical standards, architecture is defined as the fundamental concepts or properties of a system in its environment, embodied in its elements, relationships, and the principles of its design and evolution [30]. Furthermore, an empirical study demonstrates that in real-world practice, architecture is interpreted through four primary roles: as a blueprint representing the structure of the system to be implemented, a language for facilitating communication and aligning perceptions among stakeholders, literature providing documentation and reference for future readers, and a decision serving as the foundation for technical and managerial decision-making [31].

The proliferation of IT across organizational functions can result in fragmented systems that are difficult to integrate and that do not adequately support business processes. Enterprise architecture provides an approach for establishing coherence among business processes and IT resources by representing their relationships and supporting decisions concerning data, applications, infrastructure, and organizational responsibilities [32]. From this perspective, EA can also be understood as an architectural means of addressing integration problems within an organization.

At the system level, architecture provides a structural abstraction of a system by defining its components, their properties, and the relationships among them [33]. This perspective becomes particularly important when multiple software components or systems need to operate together, as integration problems may arise from architectural incompatibilities between systems. A multiple case study of in-house software integration found that architectural compatibility is an important criterion when organizations determine how previously separate software systems should be integrated [34]. The study further demonstrated that integration decisions need to be considered early because

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architectural decisions can have significant consequences for subsequent implementation and evolution [34].

The role of architecture becomes increasingly important when integration involves heterogeneous systems developed independently using different technologies. Such systems may differ in their data formats, interfaces, communication mechanisms, and underlying assumptions, making interoperability difficult to achieve [35]. Architectural approaches can therefore operate at different levels of abstraction. At a lower level, architectural strategies such as messaging, adapters, REST, and microservices can address specific interoperability and integration requirements [35]. At a higher level, architectural descriptions can represent how system elements, relationships, and concerns are organized and coordinated.

3 Research Method

This study employs a Systematic Literature Review (SLR) methodology following the PRISMA guidelines. The literature review process was structured into four stages: identifying research questions, conducting literature search, qualifying the selected literatures, and synthesizing and analysing data. The PRISMA framework was specifically chosen for its capability to conduct transparent review process.

The initial stage of the study involved formulating the Research Questions (RQs) to ensure that the literature review remained focused on the objectives of the study. The research questions are as shown in the Table 1.

Table 1 Research question

ID	Research Questions
RQ1	What are the technological themes and trends discussed in the selected studies?
RQ2	What roles do architectural approaches or frameworks play in designing architectural blueprints to support digital integration?
RQ3	What challenges are encountered in achieving digital integration?
RQ4	What solutions have been proposed to address these digital integration challenges?

The initial literature search process was carried out on June 21, 2026. The databases used were ScienceDirect, IEEE Xplore, SpringerLink, and Google Scholar. The primary keywords used in the search process included:

"Enterprise Architecture Integration"
"Digital Integration"
"Architecture Integration"
"Enterprise Architecture Digital Transformation"

These keywords were combined using Boolean operators (AND and OR) to retrieve articles relevant to the research topic. An example of the search string used is as follows:

("Enterprise Architecture Integration" OR "Architecture Integration")
AND
("Digital Integration" OR "Enterprise Architecture Digital Transformation")

The articles retrieved from the search process were subsequently collected and documented for further screening and selection in accordance with the PRISMA 2020 guidelines, which involved three primary stages, namely identification process, screening process, and eligibility process. The article selection flow is illustrated in Figure 1.

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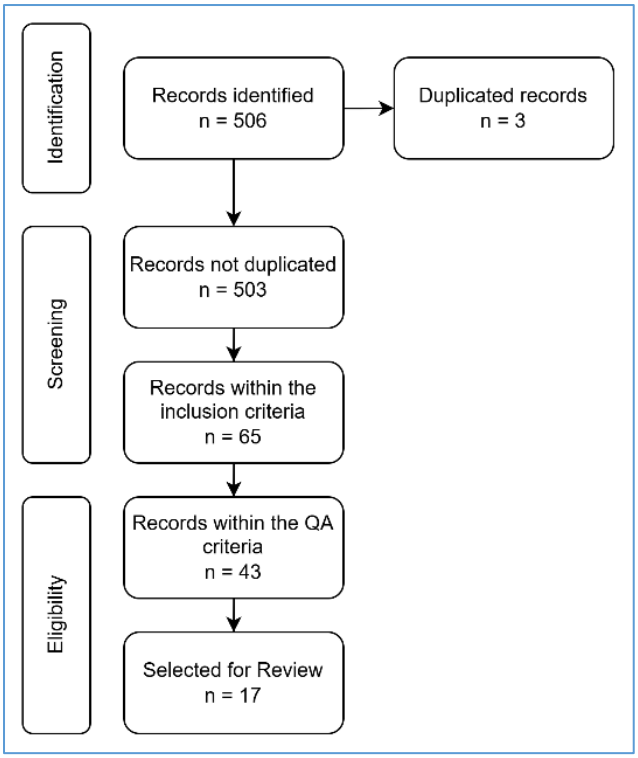


Figure 1 Article selection process flow

At the initial database search stage, a total of 506 articles were retrieved. Then, a total of 3 duplicate articles were removed, leaving 503 articles for the screening stage. The remaining articles were assessed based on the exclusion and inclusion criteria, as shown in Table 2. This aims to ensure that the selected articles are eligible to answer the research questions.

Table 2 Exclusion and inclusion criteria

Exclusion	Inclusion
Articles published before or after 2021–2026	Articles published within 2021–2026
Articles that do not discuss digital integration through IT Architecture or architectural approaches	Articles that discuss digital integration through IT Architecture or architectural approaches
Articles that do not discuss architecture in the context of Information Technology or Information Systems.	Articles that discuss architecture in the context of Information Technology or Information Systems
Non-peer-reviewed articles, book chapters, or whitepapers	Peer-review articles and conference proceedings

Furthermore, articles that met the criteria were evaluated through the Quality Assessment (QA) criteria, as described in Table 3. The further review and analysis involved papers that satisfied all the QA criteria.

Table 3 Quality assessment criteria

ID	Inclusion
QA1	Does the full-text of the study can be accessed?
QA2	Does the study clearly state its research objective or purpose?
QA3	Does the study clearly describe the digital integration context or problem?
QA4	Does the study clearly describe the architectural approach or framework used?
QA5	Does the study propose or evaluate solutions to address the identified integration challenges?

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4 Results and Analysis

The synthesis of the 17 selected studies shows a distribution of publications across the 2021–2026 period, as illustrated in Figure 2.



Figure 2 Distribution of publication

The distribution of publication years indicates an increase in research on integration architecture between 2023 and 2025. In 2026, only one publication was identified, which may be attributed to the limited number of articles publicly accessible at the time of the literature search. The following section discusses the findings from the selected literature based on the four main research questions (RQs) to provide a comprehensive understanding of the role of architectural approaches in supporting digital integration.

RQ 1. What are the technological themes and trends discussed in the selected studies?

The synthesized findings reveal a wide range of topics related to IT architecture and digital integration, as presented in Figure 3. Overall, the role of IT architecture in digital integration is categorized into two main types. First, IT architecture in an enterprise-level mainly focuses on digital transformation, which emerged as the most frequently discussed topic in this category. The literature shows the crucial role of integration architecture in supporting digital transformation and digitalization strategies by providing organizations with an overarching view of their business processes, data, applications, and IT infrastructure, as well as how they interconnect. This holistic perspective can help organizations to address fragmentation and heterogeneity in their digital ecosystem, enhancing its interoperability and integration. A study by Palade et al. also emphasize that successful digitalization requires a holistic, integrated, and strategic approach [36].

The second type is IT architecture in a system-level serves as a technical blueprint that supports the development of technological solutions. This includes the Internet of Things (IoT), Artificial Intelligence, Blockchain, and Digital Twin. In this context, IT architecture serves as a blueprint for defining and coordinating the relationships among different technological components, enabling their integration and supporting the development of the digital solutions. Figure 4 illustrates technology trends identified in the selected studies, showing that these cutting-edge technologies began to gain attention in 2023.

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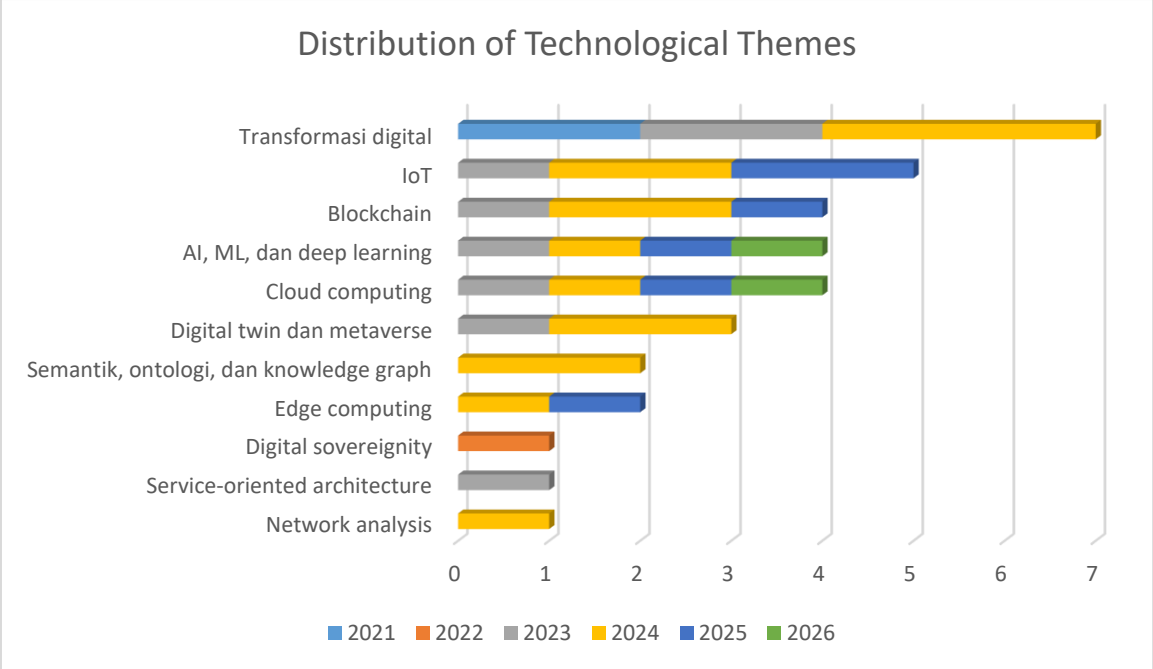


Figure 3 Distribution of technological themes

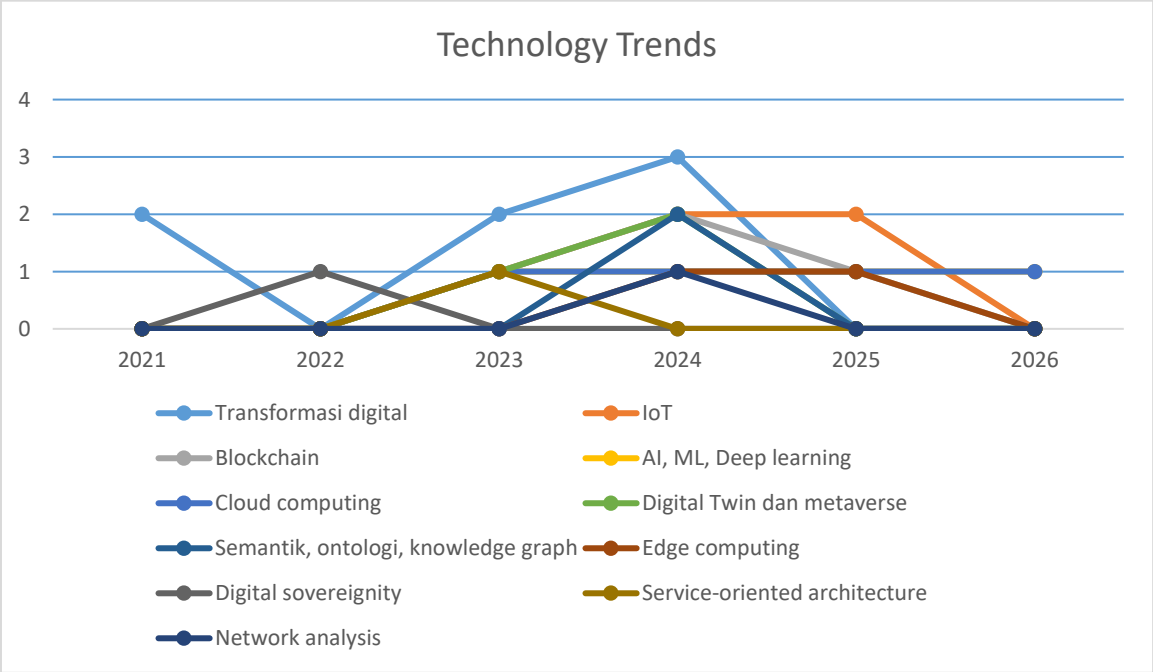


Figure 4 Technology trends

RQ 2. What roles do architectural approaches or frameworks play in designing architectural blueprints to support digital integration?

Overall, the 17 synthesized studies in Information Systems literature show that some architectural approaches are oriented toward different objectives in designing integration architecture. Among the reviewed literature, industry-based frameworks such as TOGAF Architecture Development Method (ADM), were the most frequently adopted. Meanwhile, other studies highlight the use of research-based frameworks, such as Design Science Research and Action Design Research. Several studies also employed more technical approaches, including the Layering Approach, Event-Driven, Holonic Systems Approach, and Service-Oriented Modelling Architecture. The various approaches and frameworks used to design digital integration architectures are summarized in Table 3.

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Table 3 Architectural approaches and their applications in digital integration

No.	Approach	Application	Sector/Domain	Papers
1	TOGAF ADM	Represents digital integration through business, data, application, and technology structures; aligns business objectives with the implemented information technology solutions.	Universities, manufacturing, insurance, blockchain, auditing institutions	[12], [13], [37], [38], [39], [40], [41]
2	Design Science Research	Develops validated solution artifacts to address integration-related problems.	International Data Spaces Association, blockchain, auditing institutions, manufacturing SMEs	[6], [10], [40], [42]
3	Layering Approach	Separates system components into distinct layers to simplify integration complexity.	Manufacturing, metaverse	[5], [43]
4	Action Design Research	Develops a digitalization framework tailored to the needs of manufacturing SMEs.	Manufacturing SMEs	[36]
5	Event-Driven	Guides the optimization of latency, data flows, and workflows in AI based decision intelligence systems.	Healthcare	[11]
6	System-Oriented Framework	Assesses the current organizational state and identifies relationships among organizational, data, and project information components.	Construction SMEs	[14]
7	Holonic Systems Approach	Guides architectural design by emphasizing modularity and adaptability.	Automotive	[7]
8	Service-Oriented Modelling Architecture	Develops a service-oriented architecture for enterprise systems.	Oil and gas	[44]

Most of the selected studies rely on TOGAF ADM to guide enterprises in their digital transformation initiatives [12], [13], [37], [38], [39], [40], [41]. As a widely recognized industry standard, the framework offers comprehensive guidelines and practical case studies for architectural design. The extensive adoption of TOGAF ADM indicates that enterprise architecture has become one of the primary foundations in the literature for designing digital integration architectures. However, several studies have explored alternatives to industry-oriented frameworks like TOGAF ADM, which may be perceived as relatively rigid [45].

Design Science Research (DSR), as a research-based approach, provides an alternative for designing digital integration architectures. As demonstrated in several studies, DSR enables the development of innovative artifacts specifically designed to address contextual [6], [10], [40], [42]. Through its iterative processes of demonstration, evaluation, and communication, DSR supports the refinement of architectural designs to ensure that the resulting artifacts address practical problems in real-world contexts [46] .

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Another research-based methodology adopted to develop a dedicated framework is Action Design Research (ADR) [36]. By adopting ADR, one study developed a three-dimensional framework consisting of architecture, capabilities, and governance to support digitalization in small and medium-sized manufacturing enterprises.

Nevertheless, several studies have combined two or more approaches or frameworks to address digital integration from complementary perspectives. For example, one study combined DSR as the scientific research methodology with TOGAF as the reference standard for architectural modeling [40]. The study further incorporated ITIL v4 best practices to standardize IT service management and COBIT 2019 as a governance layer to align IT service management with the institution's strategic objectives.

Another study combined enterprise architecture with a social network graph derived from the Project Management Body of Knowledge (PMBOK) [14]. This hybrid approach resulted in a System-Oriented Framework, a structured framework that not only facilitates the understanding of relationships among business, data, and application components within an organization, but also maps information associated with ongoing projects. This integrated perspective enables organizations to identify and determine digital solutions that best address their specific requirements.

In addition to research-based approaches, such as DSR and ADR, and socio-technical approaches, such as enterprise architecture, the selected studies also identified technical approaches and architectural principles that provide specific guidance for designing digital integration architectures. For example, the Layering Approach separates system components into multiple layers to reduce the complexity of technology integration [5], [43].

Event-Driven Architecture represents another technical approach. This distributed, cloud-native architectural mechanism was used to design a real-time analytics system for decision intelligence in the enterprise healthcare sector [11]. Similarly, the Holonic Systems Approach provides architectural design principles for developing complex systems with high levels of modularity and adaptability. These principles were used to guide architectural decisions during the development of a Digital Twin (DT) system [7].

Service-Oriented Modeling Architecture (SOMA), developed by IBM, provides a methodology for developing solutions based on Service-Oriented Architecture (SOA). The framework was used to guide the redesign of monolithic and isolated systems within an oil and gas company, supporting the transition toward a more service-oriented architecture [44].

RQ 3. What challenges are encountered in achieving digital integration?

Various practical challenges have motivated the architectural design objectives identified in Table 4.

Table 4 Digital integration challenges identified in the selected studies

No	Problem Group	Problems	Papers
1	Data Management and Integration	Data interoperability challenges	[6], [10], [13], [14], [37]
		Data heterogeneity	[5], [7], [11], [13], [37], [40], [44]
		Lack of data synchronization	[5], [11], [13], [41], [44]
		Information silos	[7], [10], [40], [42], [43]
2	Infrastructure, Technology, and Digital Ecosystem	Technology fragmentation	[5], [6], [10], [11], [13], [36], [37], [40], [41], [42], [44]
		Weak infrastructure	[11]

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		Infrastructure requirements	[43]
		Legacy systems	[5], [6], [10], [11], [12]
		Monolithic architecture	[44]
		Limited scalability	[12]
		High latency	[11], [41]
3	Strategic Alignment	Digital capability misalignment	[10], [39]
		Maturity gaps	[40], [43]
		Technology implementation misalignment	[11], [37], [38], [40]
		Failure to achieve expected ROI	[38]
		Vendor lock in	[6]
		Technology sustainability	[12]
4	Risk Management	Data security and privacy risks	[6], [10], [12], [39], [40], [43]
		Technology failure risks	[39], [43]
5	Standardization, Processes, and Transparency	Lack of standardization	[6], [10], [12], [14], [36], [37], [38], [40]
		Lack of visibility	[14]
		Lack of documentation	[5]
		Lack of traceability	[11], [36]
		Manual business processes	[41]
		Increasing complexity	[6], [7], [36], [39], [44]
		Process redundancy and duplication of business functions	[40], [44]

Overall, the most frequently reported challenges are related to data management and integration. Barriers to data integration can delay approximately 67% of management decisions [5]. Within this category, data heterogeneity is the most commonly reported challenge. Data heterogeneity hinders data analysis and integration with advanced technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and blockchain [5], [6]. Consequently, data heterogeneity becomes one of the factors that hinder data interoperability [13], [37].

Another frequently reported challenge concerns infrastructure, technology, and the digital ecosystem, particularly technology fragmentation. A poorly integrated enterprise ecosystem can lead to misunderstandings, communication ambiguity, and information silos across systems [42]. When systems operate independently, data exchange and information access across departments become constrained, potentially resulting in process duplication, operational inefficiencies, and human errors [37], [40], [41]. Therefore, integration challenges at the infrastructure, technology, and digital ecosystem level may also contribute to problems in other categories.

From a socio-technical perspective, strategic alignment represents another significant challenge for organizations, as intended plans often diverge from their actual implementation [11], [37], [38], [40]. This discrepancy can arise from gaps in understanding between business and IT stakeholders due to the absence of a shared consensus that integrates different perspectives. Such challenges may increase the risk of technology implementation failure [39], [43]. Consequently, architectural design can serve as a communication mechanism among stakeholders, facilitating the alignment of strategic objectives with operational technology implementation [47].

Challenges related to compliance, security, and risk management also represent important concerns in digital integration. The integration of multiple technologies may involve different access control mechanisms, potentially increasing risks to sensitive data and exposure to cyberattacks [6], [10], [12], [43]. In industry specific contexts, enterprise architecture implementation must also consider regulatory requirements, such as the European Commission's Solvency II framework, which

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addresses minimum capital requirements, governance, risk management, and transparency [39]. Furthermore, misalignment between business requirements and IT implementation may increase the risk of IT project failure [39], [43]. Therefore, digital integration architecture can provide standardization for operational procedures, technology integration, and governance, thereby helping mitigate risks related to compliance, security, and risk management [40].

Lack of standardization represents another challenge within the category of standardization, processes, and transparency. The absence of standardized procedures may also contribute to security and risk management issues. Within this category, increasing technological complexity is another challenge addressed through architectural design. By providing a holistic representation of the underlying system structure, architectural design can facilitate technical simplification and provide a reference framework for managing increasing technological complexity [7].

RQ 4. What solutions have been proposed to address these digital integration challenges?

The synthesized studies propose a range of architectural solutions to address the identified digital integration challenges. These solutions can be categorized into five dimensions, as shown in Table 5. While Figure Findings indicate that digital integration requires a combination of solutions across application, data, infrastructure, and governance layers.

Table 5 Architectural solutions for addressing digital integration challenges

No.	Solution Dimension	Architectural Solution	Papers
1	Application Integration	Use of APIs, standard web protocols, and application integration mechanisms	[6], [10], [11], [12], [13], [36], [37], [39], [40]
		Decomposition of services into independent modules using microservices	[5], [11]
2	Data Integration	Standardization of protocols, data structures, and data formats	[5], [6], [7], [10], [11], [37], [38], [39], [44]
		Use of ontological models and knowledge graphs for semantic data integration	[13], [14]
		Metadata creation and management	[10]
		Use of consortium blockchain at the data layer	[12]
3	Architectural Configuration	Centralized architecture	[7], [14], [36], [41], [44]
		Centralized network infrastructure	[38]
		Decentralized architecture	[6], [12], [13], [36], [43]
4	Emerging Technology Integration	Use of spatial computing and Digital Twin technologies to integrate virtual and physical environments	[7], [36], [43]
5	Governance and Risk Management	Centralized audit log management	[10], [11], [36], [39]
		Risk management governance	[10], [11], [36], [39]
		Data usage policies and digital sovereignty mechanisms	[10]

The most frequently proposed solution is the use of APIs, standard web protocols, and application integration mechanisms. These approaches facilitate communication and data exchange among heterogeneous applications without requiring complete replacement of existing systems [6]. This solution is particularly relevant to environments characterized by fragmented systems and legacy technologies. Moreover, API serves as the bridge between internal systems to external and data systems [10], [37].

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Data standardization represents another prominent solution identified in the literature. Several studies propose standardizing communication protocols, data structures, and data formats to establish a common structure across heterogeneous systems. This approach directly addresses data heterogeneity and interoperability challenges by reducing differences in how data are represented and exchanged. In addition to syntactic standardization, some studies propose semantic integration through ontological models and knowledge graphs [13], [14]. Ontologies provide a shared conceptual representation of data, while knowledge graphs can establish semantic relationships among information originating from different sources.

Several studies also propose restructuring applications and services to reduce integration complexity. The use of microservices, for example, decomposes applications into independent and loosely coupled modules [5], [11]. This architectural strategy can reduce the dependencies associated with monolithic systems and facilitate the integration, modification, and scaling of individual services. Metadata management is another proposed solution, particularly for improving the interpretation and management of distributed data [10].

The selected studies also propose different architectural topologies to address integration requirements. Centralized architectures are adopted in several studies to provide a common point for coordinating systems and data flow. Similarly, centralized network infrastructures can provide a controlled environment for coordinating information exchange [38]. In contrast, decentralized architectures are proposed in contexts where distributed control, autonomy, or reduced dependency on a central component is required, in which normally used for blockchain technology.

Emerging technologies are also incorporated into architectural solutions for specific integration requirements. Spatial computing and Digital Twin technologies are proposed to establish connections between physical and virtual environments. Consortium blockchain is similarly adopted at the data layer to support distributed data management and trusted information exchange among participating entities. These approaches demonstrate how emerging technologies can become architectural components rather than merely standalone technologies.

Finally, several studies emphasize governance as an important component of digital integration. Proposed mechanisms include risk management governance, centralized audit log management, and data usage policies. These mechanisms address integration challenges that cannot be resolved through technical architecture alone, particularly those involving security, compliance, accountability, and data sovereignty. Data usage policies and digital sovereignty mechanisms further establish rules governing how data are accessed, shared, and controlled across organizational boundaries.

5 Conclusion

The reviewed studies show that architecture provides different forms of support depending on the integration context. At the enterprise level, it is involved in a socio-technical context, helping establish coherence among business, data, applications, and technology, guiding digital transformation initiatives, and addressing fragmentation within digital ecosystems. At the system level, it serves as a technical blueprint for incorporating two or more emerging technologies, providing interoperability between them. The choice of architectural approach also varies according to the objectives and context of integration, ranging from established enterprise architecture frameworks to research-driven and technically oriented approaches. Across the literature, IT architecture helps address challenges categorized into data management and integration, infrastructure, strategic alignment, risk management, and standardization. These challenges are addressed through proposed architectural solutions such as application and data integration, architectural configuration, emerging technology integration, and governance. These findings suggest that digital integration can be achieved through architectural solutions that consider the interconnections between diverse components within an ecosystem, either at the enterprise level, which involves socio-technical settings, or at the system level, which incorporates data interoperability between different technologies. The synthesis therefore provides a basis for understanding how architectural approaches can be applied to address the complexity of digital integration across different contexts.

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References

[1] C. Chen, K. Zhao, J. Leng, C. Liu, J. Fan, and P. Zheng, "*Integrating Large Language Model and Digital Twins in the Context of Industry 5.0: Framework, Challenges and Opportunities*," *Robot. Comput. Integr. Manuf.*, Vol. 94, p. 102982, 2025, DOI: 10.1016/j.rcim.2025.102982.

[2] A. R. Akhatov, M. Sabharwal, F. M. Nazarov, and A. Rashidov, "*Application of Cryptographic Methods to Blockchain Technology to Increase Data Reliability*," in *2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)*, IEEE, Apr. 2022, pp. 642–647. DOI: 10.1109/ICACITE53722.2022.9823674.

[3] A. S. Divatia and J. Jagasia, "*Enterprise Architecture and Data Management for Digital Transformation - A Higher Education Institute (HEI) Case*," *Communications of the Association for Information Systems*, Vol. 57, No. 1, pp. 929–944, 2025, DOI: 10.17705/1CAIS.05740.

[4] D. Metris, N. Azis, B. Aji, S. A. Daulay, and S. F. Yanuari, "Digitalisasi dan Adaptasi Budaya Organisasi pada Sektor Bisnis Digital," *Al-KALAM : Jurnal Komunikasi, Bisnis dan Manajemen*, Vol. 13, No. 1, p. 142, 2026, DOI: 10.31602/al-kalam.v13i1.18231.

[5] S. Douimia, A. Bekrar, Y. El Hilali, and A. Ait El Cadi, "*Enterprise-Wide Data Integration for Smart Maintenance: A Scalable Architecture for Predictive Maintenance Applications at Toyota Manufacturing*," in *The 1st International Conference on Smart Management in Industrial and Logistics Engineering (SMILE 2025)*, Basel Switzerland: MDPI, Jul. 2025, pp. 46–60. DOI: 10.3390/engproc2025097046.

[6] B. Anthony Jnr, "*Enhancing Blockchain Interoperability and Intraoperability Capabilities in Collaborative Enterprise-a Standardized Architecture Perspective*," *Enterp. Inf. Syst.*, Vol. 18, No. 3, pp. 297–337, 2024, DOI: 10.1080/17517575.2023.2296647.

[7] R. Visser, A. H. Basson, and K. Kruger, "*An Architecture for the Integration of Product and Production Digital Twins in the Automotive Industry*," *Proceedings: MODELS 2024 - ACM/IEEE 27th International Conference on Model Driven Engineering Languages and Systems: Companion Proceedings*, pp. 431–441, 2024, DOI: 10.1145/3652620.3688257.

[8] D. Plekhanov, H. Franke, and T. H. Netland, "*Digital Transformation: A Review and Research Agenda*," *European Management Journal*, Vol. 41, No. 6, pp. 821–844, 2023, DOI: doi.org/10.1016/j.emj.2022.09.007.

[9] A. Ghaisani, D. Purnomo, D. I. Sensuse, S. Lusa, and N. Ramlan, "*Trends, Frameworks, and Reference Models in Public Sector Enterprise Architecture: A Systematic Review*," *Ranah Research : Journal of Multidisciplinary Research and Development*, Vol. 8, No. 4, pp. 2256–2268, 2026, DOI: 10.38035/rrj.v8i4.2105.

[10] D. R. Firdausy, P. De Alencar Silva, M. Van Sinderen, and M. E. Iacob, "*Towards a Reference Enterprise Architecture to Enforce Digital Sovereignty in International Data Spaces*," *Proceedings - 2022 IEEE 24th Conference on Business Informatics, CBI 2022*, Vol. 1, pp. 117–125, 2022, DOI: 10.1109/CBI54897.2022.00020.

[11] T. A. K. Manne, M. Jindal, S. S. Saini, A. M. Sivagnanam, G. Surianarayanan, and P. C. Jakku, "*Real-Time AI–Driven Decision Intelligence for Enterprise Healthcare Operations: Cloud-Native Architecture, Workflow Integration, and Measured Operational Outcomes*," *International Journal of Drug Delivery Technology*, Vol. 16, No. 12, pp. 1039–1051, 2026, DOI: 10.25258/ijddt.16.12s.115.

[12] T. Oak Kyaw Zaw *et al.*, "*A Systematic TOGAF-Driven Framework for Blockchain-based Food Traceability with Access Control Lists*," *HighTech and Innovation Journal*, Vol. 6, No. 2, pp. 461–475, Jun. 2025, DOI: 10.28991/HIJ-2025-06-02-07.

[13] N. Tousert, A.-D. Lipitakis, and X. S. Papageorgiou, "*A Multi-Layer Enterprise Architecture for Blockchain-Enabled Cereal Supply Chain Traceability and Decision Support*," *IFAC-PapersOnLine*, Vol. 59, No. 34, pp. 42–47, 2025, DOI: 10.1016/j.ifacol.2025.12.437.

[14] L. Zambrano, E. Atencio, C. Mariani, M. Mancini, and E. Atencio, "*An Enterprise Architecture Approach to Digital Transformation in Small and Medium-Sized Construction Companies*," in *Proceedings of the International Conference on Industrial Engineering and Operations Management*, Michigan, USA: IEOM Society International, Feb. 2024, pp. 1109–1121. DOI: 10.46254/AN14.20240278.

 ISSN:2302-8149
e-ISSN:2540-9719

[15] M. Möhring, B. Keller, R. Schmidt, K. Sandkuhl, and A. Zimmermann, "*Digitalization and Enterprise Architecture Management: A Perspective on Benefits and Challenges*," *SN Business & Economics*, Vol. 3, No. 2, p. 46, Jan. 2023, DOI: 10.1007/s43546-023-00426-3.

[16] M. Bernaert, G. Poels, M. Snoeck, and M. De Backer, "*Enterprise Architecture for Small and Medium-Sized Enterprises: A Starting Point for Bringing EA to SMEs, based on Adoption Models*," in *Information Systems for Small and Medium-Sized Enterprises*, Springer, Berlin, Heidelberg, 2014, pp. 67–96. DOI: 10.1007/978-3-642-38244-4_4.

[17] F. Grave, R. Van De Wetering, and R. J. Kusters, "*Enterprise Architecture Artifacts Facilitating the Strategy Planning Process for Digital Transformations: A Systematic Literature Review and Multiple Case Study*," *Iadis International Journal on Computer Science and Information Systems*, Vol. 16, No. 1, pp. 46–62, 2021, DOI: 10.33965/ijcsis_2021160104.

[18] T. S. Syamfithriani, Y. Wibisono, M. Munir, L. A. Wibowo, and A. Rahayu, "*Systematic Literature Review: The Role of Enterprise Architecture in Digital Transformation in the Era of the Fourth Industrial Revolution BT*," in *Proceedings of the 8th Global Conference on Business, Management, and Entrepreneurship (GCBME 2023)*, Atlantis Press, 2024, pp. 418–425. DOI: 10.2991/978-94-6463-443-3_55.

[19] S. M. M. Sajadieh and S. Do Noh, "*From Simulation to Autonomy: Reviews of the Integration of Artificial Intelligence and Digital Twins*," *International Journal of Precision Engineering and Manufacturing - Green Technology*, Vol. 12, No. 5, pp. 1597–1628, 2025, DOI: 10.1007/s40684-025-00750-z.

[20] V. Z. Mohale and I. C. Obagbuwa, "*A Systematic Review on the Integration of Explainable Artificial Intelligence in Intrusion Detection Systems to Enhancing Transparency and Interpretability in Cybersecurity*," 2025, *Frontiers Media*. DOI: 10.3389/frai.2025.1526221.

[21] D. B. Vuković, S. Dekpo-Adza, and S. Matović, "*AI Integration in Financial Services: A Systematic Review of Trends and Regulatory Challenges*," 2025, *Palgrave Macmillan*. DOI: 10.1057/s41599-025-04850-8.

[22] T. Surve, Dr. A. Kumar Tyagi, and B. F. Balogun, "*Blockchain for Smart Finance: A Review of Architectures, Integration Trends and Future Research Directions*," *Procedia Comput. SCI.*, Vol. 259, pp. 316–325, 2025, DOI: 10.1016/j.procs.2025.03.333.

[23] B. Bhushan, A. Khamparia, K. M. Sagayam, S. K. Sharma, M. A. Ahad, and N. C. Debnath, "*Blockchain for Smart Cities: A Review of Architectures, Integration Trends and Future Research Directions*," *Sustain. Cities Soc.*, Vol. 61, 2020, DOI: 10.1016/j.scs.2020.102360.

[24] S. I. Sion, K. Zhang, A. April, T. M. Lutete, and C. Bouchard, "*A Comprehensive Review of Multi-Chain Architecture for Blockchain Integration in Organizations*," in *Lecture Notes in Business Information Processing*, Vol. 527 LNBIP, 2024, pp. 5–24. DOI: 10.1007/978-3-031-70445-1_1.

[25] A. C. Puspitaningrum, "*Literature Review: Elements and Criteria Methodology of Enterprise Architecture for E-Government*," *Sistemasi*, Vol. 10, No. 1, p. 26, 2021, DOI: 10.32520/stmsi.v10i1.1027.

[26] Y. Tjong, S. U. R. O. T. O. Adi, R. Kosala, and H. Prabowo, "*Exploration on Enterprise Architecture Component for Higher Education Institution in Indonesia*," *ICIC Express Letters, Part B: Applications*, Vol. 10, No. 10, pp. 945–952, 2019, DOI: 10.24507/icicelb.10.10.945.

[27] Y. Soegoto, H. Prabowo, H. L. H. Spits Warnars, and A. Trisetyarso, "*Analysis of Enterprise Architecture Research Trends for Higher Education Institutions using Systematic Literature Review and Vos Viewer*," in *2023 International Conference on Informatics Engineering, Science & Technology (INCITEST)*, IEEE, Oct. 2023, pp. 1–5. DOI: 10.1109/INCITEST59455.2023.10396881.

[28] B. D. Rouhani, M. N. Mahrin, F. Nikpay, R. B. Ahmad, and P. Nikfard, "*A Systematic Literature Review on Enterprise Architecture Implementation Methodologies*," *Inf. Softw. Technol.*, Vol. 62, pp. 1–20, Jun. 2015, DOI: 10.1016/j.infsof.2015.01.012.

[29] A. Trifu, E. Smîdu, D. O. Badea, E. Bulboacă, and V. Haralambie, "*Applying the PRISMA Method for Obtaining Systematic Reviews of Occupational Safety Issues in Literature Search*," *MATEC Web Conf.*, Vol. 354, p. 52, 2022, DOI: 10.1051/matecconf/202235400052.

 ISSN:2302-8149
e-ISSN:2540-9719

[30] IEEE, "*IEEE Recommended Practice for Architectural Description of Software-Intensive Systems*," *IEEE Std*, Vol. 1471–2000, pp. 1–23, 2000, [Online]. Available: http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.102.9904

[31] K. Smolander, "*Four Metaphors of Architecture in Software Organizations: Finding Out the Meaning of Architecture in Practice*," in *ISESE 2002 - Proceedings, 2002 International Symposium on Empirical Software Engineering*, in ISESE '02. USA: IEEE Computer Society, 2002, pp. 211–221. DOI: 10.1109/ISESE.2002.1166942.

[32] S. Kotusev and S. Kurnia, "*The Theoretical basis of Enterprise Architecture: A Critical Review and Taxonomy of Relevant Theories*," *Journal of Information Technology*, Vol. 36, No. 3, pp. 275–315, 2021, DOI: 10.1177/0268396220977873.

[33] B. T. Hazen, R. V. Bradley, J. E. Bell, J. In, and T. A. Byrd, "*Enterprise Architecture: A Competence-based Approach to Achieving Agility and Firm Performance*," *Int. J. Prod. Econ.*, Vol. 193, pp. 566–577, Nov. 2017, DOI: 10.1016/j.ijpe.2017.08.022.

[34] R. Land and I. Crnkovic, "*Software Systems in-House Integration: Architecture, Process Practices, and Strategy Selection*," *Inf. Softw. Technol.*, Vol. 49, No. 5, pp. 419–444, May 2007, DOI: 10.1016/j.infsof.2006.07.002.

[35] P. H. D. Valle, V. R. Tonon, L. Garcés, S. O. Rezende, and E. Y. Nakagawa, "*TASIS: A Typology of Architectural Strategies for Interoperability in Software-Intensive Systems*," *Comput. Stand. Interfaces*, Vol. 91, p. 103874, Jan. 2025, DOI: 10.1016/j.csi.2024.103874.

[36] D. Palade, C. Møller, and A. K. Hansen, "*Enterprise Integration as a Driving Factor for Guiding Digitalization in a Manufacturing Small and Medium Enterprise*," *Complex Systems Informatics and Modeling Quarterly*, Vol. 2024, No. 39, pp. 48–64, 2024, DOI: 10.7250/csimq.2024-39.03.

[37] D. Hindarto, "*Supporting University Management System Digital Transformation with Enterprise Architecture*," *Jurnal JTIK (Jurnal Teknologi Informasi dan Komunikasi)*, Vol. 7, No. 4, pp. 696–706, 2023, DOI: 10.35870/jtik.v7i4.1830.

[38] M. H. Liao and C. T. Wang, "*Using Enterprise Architecture to Integrate Lean Manufacturing, Digitalization, and Sustainability: A Lean Enterprise Case Study in the Chemical Industry*," *Sustainability (Switzerland)*, Vol. 13, No. 9, pp. 4851–4877, 2021, DOI: 10.3390/su13094851.

[39] K. T. Prawira, D. Hindarto, and E. Indrajit, "*Application of Enterprise Architecture in Digital Transformation of Insurance Companies*," *SinkrOn*, Vol. 8, No. 2, pp. 856–865, 2023, DOI: 10.33395/sinkron.v8i2.12302.

[40] R. M. Villamil *et al.*, "*An Enterprise Architecture-Driven Service Integration Model for Enhancing Fiscal Oversight in Supreme Audit Institutions*," *Applied System Innovation*, Vol. 9, No. 1, pp. 16–40, 2025, DOI: 10.3390/asi9010016.

[41] B. Noranita, D. M. K. Nugraheni, M. I. Fitriyani, and Y. Nurhayati, "*Business Architecture and Information System Architecture Design in Savings and Payment unit Koperasi Pegawai Republik Indonesia (KPRI) Diponegoro University using TOGAF 9 Framework*," *J. Phys. Conf. Ser.*, Vol. 1943, No. 1, p. 012105, Jul. 2021, DOI: 10.1088/1742-6596/1943/1/012105.

[42] E. Atencio, M. Mancini, and G. Bustos, "*Enterprise Architecture Approach for Project-based Organizations Modeling, Design, and Analysis: An Ontology-Driven Tool Proposal*," *Alexandria Engineering Journal*, Vol. 98, No. 0, pp. 312–327, 2024, DOI: 10.1016/j.aej.2024.04.052.

[43] A. Nateghi and M. Mosharraf, "*Architecting the Future: A Model for Enterprise Integration in the Metaverse*," *Journal of Metaverse*, Vol. 3, No. 2, pp. 190–199, 2023, DOI: 10.57019/jmv.1355500.

[44] N. Legowo and A. Sumedi, "*Application and Data Integration based on Services Oriented Architecture in Enterprise*," *Emerging Science Journal*, Vol. 7, No. 2, pp. 455–468, 2023, DOI: 10.28991/ESJ-2023-07-02-011.

[45] S. Kotusev, "*TOGAF-based Enterprise Architecture Practice: An Exploratory Case Study*," *Communications of the Association for Information Systems*, Vol. 43, No. 1, pp. 321–359, 2018, DOI: 10.17705/1CAIS.04320.

[46] J. vom Brocke, A. Hevner, and A. Maedche, "*Introduction to Design Science Research*," 2020, pp. 1–13. DOI: 10.1007/978-3-030-46781-4_1.

 ISSN:2302-8149
e-ISSN:2540-9719

[47] S. Kotusev, S. Kurnia, and R. Dilnutt, "*Enterprise Architecture Artifacts as Boundary Objects: An Empirical Analysis*," *Inf. Softw. Technol.*, Vol. 155, No. February 2022, pp. 107108–107126, 2023, DOI: 10.1016/j.infsof.2022.107108.