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Supporting Adaptive Service Innovation through Digital Twin Integration: A Framework for the Systemic Evolution of Service Design Methods

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Abstract
The increasing complexity of digitally transformed service ecosystems has challenged the effectiveness of conventional Service Design Methods (SDMs). Existing SDMs are frequently characterised by methodological fragmentation, limited adaptability, weak lifecycle integration, and insufficient responsiveness to dynamic stakeholder interactions. While Digital Twin (DT) technology has gained significant attention in manufacturing and engineering contexts, its potential contribution to service design evolution remains underexplored. This study investigates how DT integration can support the systemic evolution of SDMs within contemporary service ecosystems. Adopting a Design Science Research approach, the study develops a conceptual framework that combines methodological structuring through the MO Mapping Framework, evolutionary trend analysis, and DT-enabled adaptive mechanisms. Findings indicate that DT capabilities—including real-time monitoring, predictive analytics, continuous feedback integration, and ecosystem coordination—can significantly enhance the adaptability and responsiveness of service design practices. The proposed framework demonstrates how DT technologies can facilitate continuous methodological refinement and intelligent service innovation across complex socio-technical environments. The study contributes to service management literature by extending DT applications beyond operational optimisation and introducing a novel perspective on adaptive service methodology evolution. Practical implications are provided for organisations seeking to strengthen digital transformation initiatives and improve service innovation capabilities through data-driven and ecosystem-oriented approaches.

Keywords: Digital Twin, Service Design Methods, Service Innovation, Digital Transformation, Service Ecosystems

Introduction

The rapid advancement of digital technologies has fundamentally transformed contemporary service environments, giving rise to increasingly complex service ecosystems characterised by interconnected stakeholders, real-time data exchange, intelligent systems, and continuously evolving customer expectations. Unlike traditional service settings, modern organisations operate within digitally enabled ecosystems where service value is co-created through dynamic interactions among customers, service providers, technological infrastructures, and institutional actors. This transformation has significantly increased the complexity of service management, requiring organisations to continuously adapt their service strategies, coordinate multiple stakeholders, and respond rapidly to changing environmental conditions (Marvi et al., 2026).

Service Design (SD) has consequently become an essential strategic approach for improving service quality, enhancing organisational performance, and facilitating value co-creation across diverse stakeholder networks. Over the past two decades, SD has evolved from a process-oriented discipline focusing primarily on customer touchpoints and service encounters into a broader ecosystem-oriented approach that incorporates organisational capabilities, technological infrastructures, and collaborative stakeholder engagement (da Fontoura Vieira et al., 2025). This evolution reflects the growing recognition that service innovation no longer occurs within isolated organisational processes but emerges through interactions within interconnected socio-technical ecosystems.

Despite these developments, a critical problem remains unresolved. Existing Service Design Methods (SDMs) have largely been developed as standalone methodologies for specific design contexts, resulting in fragmented structures, inconsistent methodological foundations, and limited interoperability across service environments (Klaassen et al., 2026). Most SDMs continue to follow static, sequential, and project-based procedures that are insufficiently responsive to the rapidly changing conditions created by digital transformation, increasing stakeholder diversity, and continuous ecosystem evolution (Chavarnakul et al., 2025). Consequently, organisations frequently encounter difficulties in integrating real-time operational information into service design processes, coordinating multiple stakeholders, and continuously refining service methodologies throughout the service lifecycle. These limitations reduce organisational adaptability, delay innovation, and constrain the development of resilient and data-driven service ecosystems.

The emergence of digital transformation has further intensified these challenges by fundamentally changing how services are designed, delivered, and managed. Technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), Big Data Analytics, Cloud Computing, and Cyber-Physical Systems (CPS) have enabled organisations to continuously collect, analyse, and utilise real-time operational data for intelligent decision-making (Mourtzis & Angelopoulos, 2024). These technologies support predictive analysis, intelligent automation, and continuous performance monitoring, thereby creating opportunities for more adaptive, personalised, and resilient service systems. However, while digital technologies have evolved rapidly, the methodological foundations of service design have progressed at a considerably slower pace. As a result, a growing disconnect has emerged between technological capabilities and the adaptive capacity of existing service design methodologies, limiting organisations' ability to fully exploit digital transformation initiatives (Chavarnakul et al., 2025).

Among the emerging technologies supporting digital transformation, Digital Twin (DT) has attracted considerable attention because of its capability to establish dynamic virtual representations of physical, organisational, and service systems through continuous data integration, simulation, predictive analytics, and feedback mechanisms (Tabet et al., 2026). Initially developed for manufacturing and engineering applications, DT technology has demonstrated substantial value in predictive maintenance, operational optimisation, lifecycle management, and intelligent decision support (Mohanraj & Balaji, 2026). More recently, DT applications have expanded into healthcare, smart cities, logistics, and service management, illustrating its growing potential to support increasingly complex socio-technical systems (Sacoto-Cabrera et al., 2025). This emerging phenomenon suggests that DT possesses capabilities extending well beyond operational optimisation and may provide new opportunities for transforming service design methodologies into adaptive and continuously evolving systems.

Although previous studies have acknowledged the importance of digital transformation in service management, existing research remains fragmented across several streams. Research on Service Design has primarily focused on customer experience enhancement, service processes, and design tools, while providing limited attention to the long-term evolution of service methodologies. Meanwhile, Digital Twin research has predominantly concentrated on technological implementation, manufacturing optimisation, predictive maintenance, and operational efficiency (Jain et al., 2025). Comparatively few studies have examined how DT capabilities can facilitate continuous methodological refinement, stakeholder coordination, ecosystem responsiveness, and adaptive service innovation. Furthermore, existing studies rarely integrate Service Design, Digital Twin technology, and service ecosystem perspectives into a unified conceptual framework capable of supporting continuous methodological evolution. This represents a significant theoretical and practical research gap, particularly as organisations increasingly require adaptive service methodologies capable of responding to rapidly changing digital environments.

Given these limitations, there is a compelling need to investigate how Digital Twin technology can support the systemic evolution of Service Design Methods within digitally enabled service ecosystems. Addressing this issue is important not only for advancing theoretical understanding of adaptive service innovation but also for providing organisations with practical approaches to improve methodological flexibility, ecosystem coordination, and data-driven decision-making. Accordingly, this study examines how Digital Twin integration can facilitate the continuous evolution of SDMs by combining the perspectives of Service-Dominant Logic (Marvi et al., 2026), Service Ecosystem Theory (Marvi et al., 2026), and Task–Technology Fit Theory (Goodhue & Thompson, 1995). Building upon these theoretical foundations, the study develops a structured framework that explains how DT capabilities can enhance methodological adaptability, stakeholder integration, and continuous service innovation across complex service ecosystems.

This study makes several important contributions to the literature. First, it extends the theoretical application of Digital Twin technology beyond its traditional focus on manufacturing and operational optimisation by positioning DT as an enabling mechanism for the continuous evolution of Service Design Methods. Second, it develops an integrated conceptual framework that systematically connects Digital Twin capabilities, service ecosystem theory, and adaptive service design, thereby addressing an important gap in existing service innovation research. Third, the study introduces the Method–Objective (MO) Mapping Framework as a structured mechanism for analysing and organising Service Design Methods according to their objectives and functional characteristics. Finally, the proposed framework provides practical guidance for organisations seeking to strengthen digital transformation initiatives through adaptive, data-driven, ecosystem-oriented, and continuously evolving service design practices.

The remainder of this paper is organised as follows. The next section reviews the literature on Service Design evolution, Service Ecosystem Theory, Digital Transformation, and Digital Twin technology, followed by the identification of the research gap and conceptual positioning. The subsequent sections present the research methodology, conceptual framework, findings, discussion, theoretical and managerial implications, and conclusions.

Literature Review

SD and the Evolution of Service Design Methods

SD has emerged as a multidisciplinary field that focuses on the planning, development, and improvement of services through a user-centred and stakeholder-oriented approach. Initially, service design primarily concentrated on enhancing customer experiences and optimising service delivery processes. However, the increasing complexity of service systems has expanded the scope of SD beyond operational improvements toward ecosystem-level coordination and innovation (da Fontoura Vieira et al., 2025).

Early service design approaches were largely process-oriented and focused on individual service encounters, touchpoints, and customer journeys. These methods provided organisations with structured mechanisms for analysing and improving service interactions. Nevertheless, such approaches often treated services as isolated organisational activities and failed to account for the broader socio-technical environments in which services operate (Rao et al., 2025). As a result, traditional service design methods frequently lacked the adaptability required to respond to rapidly changing service conditions.

The emergence of human-centred design significantly transformed the field by emphasising stakeholder participation, co-creation, and experiential value. Human-centred approaches recognised customers as active participants in service development rather than passive recipients of service outcomes (Schmager et al., 2025). Although this perspective improved stakeholder engagement and service innovation, it remained largely focused on individual users and specific service contexts, providing limited support for managing increasingly interconnected service ecosystems.

More recently, service design has evolved toward systemic and ecosystem-oriented perspectives. Contemporary service systems involve complex interactions among organisations, users, technologies, communities, and institutional actors operating within dynamic environments (Marvi et al., 2026). Consequently, scholars have argued that service design methodologies must move beyond isolated tools and techniques toward integrated frameworks capable of supporting continuous adaptation and ecosystem coordination (Klaassen et al., 2026).

Despite this evolution, existing SDMs remain fragmented and highly context-dependent. Numerous methods have been developed independently across disciplines, resulting in overlapping functionalities, inconsistent structures, and limited interoperability (Chavarnakul et al., 2025). Furthermore, many SDMs continue to rely on static procedural logic that restricts their ability to accommodate emerging technological capabilities and dynamic service environments. This methodological fragmentation highlights the need for more systematic and adaptive approaches capable of supporting the continuous evolution of service design practices.

Service Ecosystems and Value Co-Creation

The increasing complexity of contemporary services has led researchers to conceptualise service environments as ecosystems rather than isolated organisational systems. This perspective is strongly influenced by Service-Dominant Logic (S-D Logic), which proposes that service constitutes the fundamental basis of exchange and that value is co-created through interactions among multiple actors (Marvi et al., 2026).

According to S-D Logic, value is not embedded within products or services but emerges through collaborative resource integration among organisations, customers, communities, and technological systems. This perspective challenges traditional provider-centric views and emphasises the importance of stakeholder interactions in creating meaningful service outcomes (Jain et al., 2025). As a result, service innovation increasingly depends on the ability of organisations to facilitate collaboration and coordinate resources across complex networks.

Building upon S-D Logic, Service Ecosystem Theory conceptualises services as dynamic configurations of interconnected actors, technologies, resources, and institutional arrangements (Marvi et al., 2026). Within service ecosystems, value creation occurs through continuous interactions among stakeholders operating at multiple levels. These ecosystems are characterised by interdependence, adaptability, and ongoing transformation.

A key characteristic of service ecosystems is their dynamic nature. Changes in customer behaviour, technological infrastructure, organisational strategies, or regulatory environments can significantly influence ecosystem performance and service outcomes (Rao et al., 2025). Consequently, organisations must continuously monitor and adapt to evolving conditions to maintain service effectiveness and competitiveness.

The ecosystem perspective has important implications for service design. Traditional design methods that focus primarily on customer interactions are often insufficient for addressing broader ecosystem challenges such as stakeholder coordination, technological integration, and institutional complexity. Therefore, scholars increasingly advocate for adaptive service design approaches that support ecosystem-level learning, coordination, and evolution (Heinonen, 2025).

Digital Transformation in Service Systems

Digital transformation has become one of the most significant drivers of organisational change in contemporary service industries. Defined as the integration of digital technologies into organisational processes, business models, and customer interactions, digital transformation fundamentally reshapes how services are designed, delivered, and managed (Adama & Okeke, 2024).

The adoption of technologies such as AI, IoT, Big Data Analytics, Cloud Computing, and CPS has enabled organisations to collect and analyse vast amounts of real-time information (Mourtzis & Angelopoulos, 2024). These technologies facilitate improved decision-making, enhanced operational efficiency, and more personalised customer experiences.

One of the most important consequences of digital transformation is the shift from static service delivery models toward dynamic and adaptive service ecosystems. Organisations increasingly rely on continuous data flows to monitor service performance, predict customer needs, and respond proactively to environmental changes (Schmager et al., 2025). This transition has significantly increased the complexity of service management and highlighted the need for more responsive design methodologies.

Despite these technological advancements, many organisations continue to rely on conventional service design approaches that were developed before the emergence of digitally enabled ecosystems. Such approaches often struggle to accommodate real-time data integration, predictive decision-making, and continuous service adaptation (Chavarnakul et al., 2025). Consequently, a gap exists between the capabilities offered by emerging digital technologies and the methodologies used to design and manage services.
This gap has prompted growing interest in exploring how advanced digital technologies can support adaptive service innovation and methodological evolution.

Digital Twin Technology

DT technology has emerged as one of the most promising innovations associated with Industry 4.0 and digital transformation initiatives. A Digital Twin can be defined as a dynamic digital representation of a physical, organisational, or service system that continuously interacts with its real-world counterpart through real-time data exchange, simulation, and feedback mechanisms (Mohanraj & Balaji, 2026).

The concept originated in manufacturing and engineering domains, where DTs were primarily used for predictive maintenance, operational optimisation, and lifecycle management of physical assets (Panyaram, 2024). By integrating sensor data, simulation models, and analytical capabilities, DTs enable organisations to monitor system performance, anticipate potential issues, and optimise operational outcomes.

Recent developments have expanded DT applications beyond manufacturing into sectors such as healthcare, transportation, smart cities, education, and service management (Tabet et al., 2026). These emerging applications demonstrate that DT technology possesses capabilities extending beyond physical asset management.

Several core capabilities make DT particularly relevant for service innovation. First, DT enables real-time monitoring of service processes and stakeholder interactions. Second, simulation capabilities allow organisations to evaluate alternative scenarios before implementation. Third, predictive analytics supports proactive decision-making and risk management. Finally, continuous feedback integration facilitates organisational learning and adaptive improvement (Sacoto-Cabrera et al., 2025).

Despite these advantages, current DT research remains heavily focused on operational optimisation and technical implementation. Limited attention has been given to how DT may support the evolution of service methodologies themselves. Consequently, there remains a significant opportunity to investigate DT as an enabler of adaptive service design and methodological innovation.

Theoretical Foundations

S-D Logic

S-D Logic provides the primary theoretical lens for understanding value creation within service ecosystems. The theory emphasises service exchange, resource integration, and value co-creation among multiple stakeholders (Marvi et al., 2026). In the context of this study, S-D Logic supports the conceptualisation of service design as an evolving ecosystem activity rather than a series of isolated design interventions.

Service Ecosystem Theory

Service Ecosystem Theory extends S-D Logic by emphasising the interconnected and adaptive nature of service environments (Marvi et al., 2026). The theory highlights how organisations, users, technologies, and institutional actors collectively influence service outcomes. This perspective provides a foundation for understanding why service design methodologies require continuous adaptation within dynamic ecosystems.

Task–Technology Fit Theory

Task–Technology Fit (TTF) theory argues that technology contributes to performance improvements when its capabilities align with task requirements (Goodhue & Thompson, 1995). Within this study, TTF provides a useful framework for examining how Digital Twin functionalities support the adaptability, integration, and responsiveness required by contemporary service design activities.

Research Gap and Conceptual Positioning

The literature reveals several important gaps. First, existing studies on service design predominantly focus on operational tools and customer experience improvement while providing limited attention to the long-term evolution of service methodologies. Second, current DT research remains concentrated on technical optimisation and manufacturing applications, with insufficient exploration of methodological and organisational implications. Third, limited studies have examined how DT capabilities can facilitate adaptive service design within complex service ecosystems.

Furthermore, existing research lacks an integrated framework that systematically connects service design evolution, digital transformation, and Digital Twin capabilities. Consequently, there remains a need for a conceptual model capable of explaining how DT technology can

support continuous methodological refinement, stakeholder coordination, and adaptive service innovation.
Addressing these gaps forms the foundation of the present study and provides the rationale for developing a DT-supported framework for the systemic evolution of Service Design Methods.

Methodology
This study adopted a qualitative research approach grounded in the Design Science Research (DSR) paradigm to investigate how DT technology can support the systemic evolution of SDMs. DSR was selected because it facilitates the development and evaluation of artefacts designed to address complex real-world problems while contributing to both theory and practice (Tuunanen et al., 2024).

The research was conducted in three sequential phases. The first phase involved a Systematic Literature Review (SLR) to identify and synthesise existing SDMs, Digital Twin applications, and service ecosystem concepts. Findings from the review informed the development of the Method–Objective (MO) Mapping Framework, which was used to systematically classify and analyse SDMs based on their structural characteristics and intended objectives.

The second phase focused on identifying evolutionary trends, methodological challenges, and structural limitations within SDMs. A qualitative analytical approach incorporating Zettelkasten-based knowledge organisation was employed to facilitate thematic synthesis and pattern identification across the reviewed literature.

The third phase involved the development and validation of DT-supported service evolution mechanisms. Semi-structured interviews were conducted with experts from service design, digital transformation, and information systems domains. Purposive sampling was employed to select participants with relevant academic and professional expertise. The interview data were analysed using thematic analysis to identify key themes, validate the proposed framework, and refine the DT-enabled mechanisms.

To ensure research rigour, credibility was enhanced through expert validation, iterative data analysis, and methodological triangulation. These procedures strengthened the trustworthiness and reliability of the findings while supporting the development of a robust framework for adaptive service design evolution in digitally enabled service ecosystems.

Results and Discussion
Structuring Service Design Methods through the MO Mapping Framework
The first objective of this study was to systematically organise and analyse SDMs using the proposed MO Mapping Framework. The analysis revealed that existing SDMs are highly fragmented, with methods frequently developed in isolation and applied within specific contexts. This fragmentation creates difficulties in method selection, integration, and adaptation across different service environments.

The MO Mapping Framework classified SDMs according to their primary objectives and functional roles within the service design process. The results indicate that most methods are concentrated in customer understanding and service exploration activities, while relatively fewer methods support ecosystem coordination and continuous service evolution.

Table 1
Classification of Service Design Methods Using the MO Mapping Framework

Method Category	Primary Objective	Examples of Methods	Contribution to Service Design
Exploration Methods	Understanding user needs	Interviews, Personas, Ethnography	Customer insights
Mapping Methods	Visualising service systems	Customer Journey Map, Service Blueprint	Service analysis
Co-Creation Methods	Stakeholder participation	Workshops, Co-design Sessions	Value co-creation
Prototyping Methods	Testing service concepts	Storyboarding, Pilot Testing	Service validation
Evolution Methods	Continuous adaptation	DT-enabled monitoring and feedback	Service evolution

The findings demonstrate that traditional SDMs primarily support discrete stages of service development rather than continuous ecosystem adaptation. This result supports previous studies suggesting that service design practices remain largely project-oriented and insufficiently equipped for dynamic digital environments (Klaassen et al., 2026). Consequently, a structured analytical framework such as the MO Mapping Framework can improve methodological transparency, consistency, and scalability across service innovation initiatives.

Evolutionary Trends and Challenges in Service Design

The second objective examined evolutionary trends and structural challenges affecting contemporary SDMs. The analysis identified four major trends shaping service design evolution: increasing ecosystem complexity, digital transformation, data-driven decision-making, and continuous stakeholder engagement.

Simultaneously, several challenges continue to constrain methodological evolution.

Table 2
Major Trends and Challenges Affecting Service Design Evolution

Evolutionary Trend	Description	Associated Challenge
Ecosystem Orientation	Growing interdependence among actors	Coordination complexity
Digital Transformation	Increased technology integration	Methodological adaptability
Data-Driven Services	Real-time information utilisation	Data integration capability
Continuous Innovation	Ongoing service improvement	Lifecycle management

The results suggest that contemporary service ecosystems require methodologies capable of adapting to changing stakeholder needs and technological conditions. Existing methods often struggle to integrate real-time data and maintain responsiveness across service lifecycles. Similar observations have been reported in recent service ecosystem research, which highlights the limitations of static design approaches in digitally enabled environments (Marvi et al., 2026).

Furthermore, the analysis revealed four recurring structural limitations affecting SDMs.

Table 3

Key Limitations of Existing Service Design Methods

Limitation	Description	Impact on Service Innovation
Fragmentation	Independent method development	Limited interoperability
Static Structures	Fixed procedural processes	Reduced adaptability
Weak Ecosystem Integration	Limited stakeholder coordination	Poor systemic responsiveness
Lack of Evolution Mechanisms	Absence of continuous refinement	Reduced long-term effectiveness

These findings indicate that methodological evolution remains an underdeveloped area within service design research. While considerable attention has been devoted to customer experience improvement, less emphasis has been placed on how service methodologies themselves can evolve in response to changing ecosystem conditions.

Digital Twin-Supported Service Design Evolution Mechanisms

The third objective focused on identifying how DT capabilities can support the systemic evolution of SDMs. Expert interview findings demonstrated strong consensus regarding the potential of DT technologies to enhance adaptability, responsiveness, and ecosystem coordination within service design processes.

Four key DT-enabled mechanisms emerged from the thematic analysis.

Table 4

Digital Twin-Supported Service Design Evolution Mechanisms

DT Capability	Service Design Function	Expected Outcome
Real-Time Monitoring	Continuous observation of service performance	Improved responsiveness
Predictive Analytics	Forecasting service conditions and needs	Proactive decision-making
Dynamic Feedback Integration	Continuous stakeholder feedback collection	Service improvement
Simulation and Scenario Testing	Evaluation of alternative solutions	Reduced implementation risk

The findings indicate that DT technologies can support service design beyond operational optimisation. Through real-time monitoring and predictive analysis, organisations can continuously evaluate service performance and identify emerging challenges before they affect service quality. Similarly, feedback integration mechanisms enable service methodologies to evolve based on actual stakeholder interactions rather than periodic evaluations.

These findings extend existing DT literature, which has traditionally focused on manufacturing and engineering applications (Panyaram, 2024; Tabet et al., 2026). The results suggest that DT possesses significant potential as an enabler of adaptive service innovation and methodological evolution.

Proposed Framework for Adaptive Service Innovation

Integrating the findings from the three research phases resulted in the development of a DT-supported Service Design Evolution Framework. The framework positions Digital Twin as a central enabling layer connecting service methodologies, ecosystem stakeholders, and continuous feedback processes.

Table 5
Components of the Proposed DT-Supported Service Design Evolution Framework

Framework Layer	**Components**	**Primary Function**
Service Design Layer	SDMs, tools, design activities	Service development
Digital Twin Layer	Monitoring, simulation, analytics	Data-driven adaptation
Ecosystem Layer	Stakeholders, organisations, technologies	Value co-creation
Evolution Layer	Feedback loops, learning mechanisms	Continuous improvement

The framework demonstrates how DT capabilities can transform conventional service design approaches into adaptive systems capable of continuous refinement. This aligns with Service-Dominant Logic, which emphasises value co-creation and dynamic resource integration (Marvi et al., 2026), as well as Service Ecosystem Theory, which views services as evolving networks of interconnected actors (Marvi et al., 2026).

Overall, the findings indicate that DT integration can serve as a strategic mechanism for supporting adaptive service innovation, ecosystem responsiveness, and the long-term evolution of service design methodologies. By enabling real-time monitoring, predictive decision-making, and continuous learning, DT technologies provide organisations with new opportunities to improve service performance and strengthen digital transformation initiatives.

Conclusion

The increasing complexity of contemporary service ecosystems, driven by digital transformation, interconnected stakeholders, and evolving customer expectations, has created significant challenges for conventional SDMs. While service design has progressed from process-oriented approaches toward more systemic and ecosystem-oriented perspectives, many existing methodologies remain fragmented, static, and insufficiently responsive to rapidly changing service environments. In response to these challenges, this study examined how DT technology can support the systemic evolution of SDMs and facilitate adaptive service innovation within digitally enabled service ecosystems.

The findings revealed that existing SDMs are characterised by methodological fragmentation, limited ecosystem integration, weak lifecycle responsiveness, and a lack of continuous evolution mechanisms. To address these limitations, the study developed the MO Mapping Framework, which provides a structured approach for organising and analysing service design methods according to their objectives and functional characteristics. The framework contributes to improving methodological transparency, comparability, and analytical consistency across diverse service design practices.

Furthermore, the study identified several major trends influencing the evolution of service design, including increasing ecosystem complexity, digital transformation, data-driven decision-making, and continuous innovation requirements. These trends highlight the growing need for adaptive methodologies capable of responding to dynamic service conditions and evolving stakeholder expectations. The findings also demonstrated that Digital Twin capabilities, particularly real-time monitoring, predictive analytics, dynamic feedback integration, and simulation-based evaluation, offer significant potential for supporting continuous methodological refinement and ecosystem responsiveness.

The proposed DT-supported Service Design Evolution Framework represents the primary contribution of this study. By integrating service design methodologies, Digital Twin technologies, and service ecosystem perspectives, the framework provides a conceptual foundation for enabling continuous adaptation, stakeholder coordination, and data-driven service innovation. The framework extends the application of DT beyond its traditional focus on operational optimisation and positions it as a strategic enabler of methodological evolution within service systems.

From a theoretical perspective, this study contributes to the growing body of knowledge on service innovation by integrating Service-Dominant Logic, Service Ecosystem Theory, and Task–Technology Fit theory into a unified framework for understanding adaptive service design. The research advances existing literature by conceptualising SDMs as evolving socio-technical systems rather than static design tools and by demonstrating how DT technologies can facilitate continuous methodological development.

From a practical perspective, the findings provide valuable insights for organisations seeking to strengthen digital transformation initiatives and improve service innovation capabilities. The proposed framework offers managers and practitioners a structured approach for leveraging DT technologies to enhance service responsiveness, ecosystem coordination, and long-term organisational adaptability.

Despite its contributions, this study has several limitations. The research adopted a qualitative and conceptual approach, with validation primarily based on expert perspectives rather than large-scale empirical implementation. Consequently, the findings should be interpreted as an initial framework for understanding DT-supported service design evolution. Future research should conduct quantitative assessments, longitudinal studies, and sector-specific implementations to evaluate the operational effectiveness of the proposed framework across different service industries. Further investigation may also explore the integration of emerging technologies such as Artificial Intelligence, machine learning, and advanced analytics within DT-enabled service ecosystems.

In conclusion, this study demonstrates that Digital Twin technology possesses considerable potential to support the systemic evolution of Service Design Methods and to facilitate adaptive service innovation within complex service ecosystems. As organisations continue to navigate increasingly dynamic and digitally connected environments, DT-enabled service design approaches may provide a promising pathway towards more intelligent, resilient, and continuously evolving service systems.

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