

LEVERAGING TECHNOLOGY-DRIVEN INNOVATION THROUGH HUMAN RESOURCE CAPABILITIES TO ACHIEVE COMPETITIVE ADVANTAGE IN SERVICE INDUSTRIES

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Received : 25 December 2025

Accepted : 27 January 2026

Revised : 05 January 2026

Published : 15 February 2026

Abstract

The increasing adoption of digital technologies has transformed competition in service industries, where human resources play a central role in value creation. While technology-driven innovation is widely recognized as a strategic resource, its contribution to competitive advantage largely depends on the organization's human resource capabilities. This study examines how technology-driven innovation enhances competitive advantage through the development of service innovation, which reflects the effective utilization of human resource capabilities in service industries. Using a quantitative research design, data were collected from service-sector organizations and analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM). The measurement model was assessed for reliability and validity, while the structural model was evaluated using path coefficients, coefficient of determination (R^2), effect size (f^2), and mediation analysis. The findings indicate that technology-driven innovation has a significant positive effect on service innovation and competitive advantage. Service innovation also significantly influences competitive advantage and partially mediates the relationship between technology-driven innovation and competitive advantage. These results suggest that technological investments generate greater competitive value when they are leveraged through human resource capabilities that support innovative service delivery. This study contributes to the human resource management and strategic management literature by highlighting the role of human resource capabilities as a key mechanism for transforming technology-driven innovation into sustainable competitive advantage. Practically, the findings emphasize the importance of aligning digital transformation initiatives with human capital development in service industries.

Keywords: *technology-driven innovation; human resource capabilities; service innovation; competitive advantage; service industries; PLS-SEM*

1. Introduction

The development of digital technology has fundamentally changed the way service companies operate and compete (Shehadeh, et al., 2023). The service industry, which previously relied heavily on human interaction and manual processes, is now increasingly driven to adopt technology as a primary source of innovation and increased service value. Technologies such as digital platforms, artificial intelligence, big data analytics, and automation enable service companies to increase operational efficiency, improve service quality, and create more personalized customer experiences (Marei, 2023). In a context of increasingly fierce competition, a company's ability to build a competitive advantage is a key factor in business sustainability. Competitive advantage is determined not only by price or business scale, but also by a company's ability to strategically utilize technology to produce innovations that are difficult for competitors to imitate. Therefore, technology-driven innovation is seen as a crucial determinant in creating competitive advantage, particularly in the dynamic, service-based service sector (Abu-AlSondos et al., 2023). Although various studies have examined the relationship between innovation and company performance, research specifically examining the role of technology-driven innovation in competitive advantage in the service industry remains relatively limited, particularly in the context of developing countries (Moraga, 2026). Many service companies face challenges in effectively integrating technology into their business strategies, resulting in the benefits of technological innovation not being fully optimized.

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The rapid advancement of digital technologies has reshaped the competitive landscape of service industries. Unlike manufacturing sectors, service industries are highly people-intensive, making human resources a critical determinant of organizational performance and competitiveness. As a result, technology-driven innovation alone is insufficient to generate sustainable competitive advantage without being supported by adequate human resource capabilities. Previous studies have emphasized the strategic role of technology in improving efficiency and responsiveness. However, empirical evidence suggests that technological investments do not automatically lead to superior competitiveness. This phenomenon indicates that the effectiveness of technology-driven innovation depends on how well organizations leverage human resources to translate technological potential into innovative service outcomes. From a human resource management perspective, employees' competencies, adaptability, and innovative behavior are essential in enabling organizations to utilize technology effectively (Bachir et al., 2025). In service industries, innovation is often embedded in service delivery processes that are directly influenced by employee skills and interactions with customers. Therefore, understanding the role of human resource capabilities in linking technology-driven innovation and competitive advantage becomes increasingly important. Despite growing interest in digital transformation, limited empirical research has examined this relationship within service industries in emerging economies, particularly Indonesia. Accordingly, this study aims to investigate how technology-driven innovation contributes to competitive advantage through service innovation, viewed as an outcome of effective human resource capabilities.

2. Literature Review

Technology-driven innovation (TDI) refers to an organization's ability to adopt and leverage digital technology to strategically drive innovation in processes, systems, and business practices. In the service industry, technology serves not only as an operational tool but also as a strategic resource that enables efficiency, speed, and flexibility in service delivery (Wang et al., 2025). Recent literature emphasizes that technology's role is shifting from a supporting tool to an innovation driver. Digital technology enables service companies to redesign service processes, increase response times, and support data-driven decision-making (Shin et al., 2022). However, many studies also note the existence of a digital paradox, where high technology investment is not always accompanied by improved performance or competitiveness (Cao et al., 2023). Service innovation is not merely the outcome of technological adoption but is fundamentally shaped by employees' ability to utilize technology creatively in services design and delivery. Human resource capabilities determine how effectively organizations can translate technology-driven initiatives into innovative service processes, customer experiences, and value propositions. Employees with strong digital skills, learning orientation, and innovative behavior are more likely to experiment with new service methods, personalize customer interactions, and improve service quality through technology-enabled solutions.

Human resource capabilities refer to the collective competencies, knowledge, learning capacity, and adaptive behaviors of employees that enable organizations to respond effectively to technological and environmental changes. In service industries, these capabilities are particularly critical because value creation is largely driven by human interaction, problem-solving, and service customization rather than standardized production processes (Zhang et al., 2024). From the perspective of the resource-based view (RBV), human resource capabilities constitute a strategic asset that is valuable, rare, and difficult to imitate. When combined with technology-driven innovation, these capabilities form a complementary resource configuration that enhances service innovation. Technology provides the tools and infrastructure, while human resources supply the cognitive and behavioral capacity required to exploit these tools effectively. Furthermore, the dynamic capability perspective suggests that service innovation reflects an organization's ability to sense opportunities, seize technological potential, and reconfigure service processes.

Human resource capabilities play a central role in this dynamic process by enabling continuous learning, cross-functional collaboration, and adaptability in service delivery. Without sufficient human resource capabilities, technological investments may lead to operational improvements but fail to generate meaningful service innovation. In the context of service industries in emerging economies such as Indonesia, disparities in digital readiness and workforce skills further underscore the importance of human resource capabilities. Organizations that invest in employee development, digital literacy, and innovation-oriented human resource practices are better positioned to leverage technology-driven innovation into sustainable service innovation (Alper, 2024). Service innovation is defined as a service company's ability to develop new services or update existing ones to create added value for customers (Varzaru & Bocean, 2024). Service innovation encompasses changes in service design, delivery processes, levels of personalization, and the overall customer experience. Human resource capabilities reflect employees' collective skills, knowledge,

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learning ability, and adaptability that enable organizations to respond to technological and market changes (Francisco, 2024). Within service organizations, these capabilities play a crucial role in transforming technological inputs into service innovation. Service innovation thus represents the manifestation of human resource capabilities in designing and delivering value-added services. Unlike product innovation, service innovation is more complex because it involves human interaction, simultaneous production and consumption processes, and a high degree of heterogeneity. Therefore, the success of service innovation depends heavily on an organization's ability to integrate technology with an understanding of customer needs. From the perspective of dynamic capability theory, service innovation reflects a company's ability to dynamically reconfigure its resources and capabilities in response to environmental changes.

Technology acts as a trigger, but service innovation is the concrete manifestation of an organization's ability to transform capabilities into perceived value for customers. Empirical studies show that service companies capable of innovating in services tend to have higher levels of customer satisfaction, stronger loyalty, and a more competitive market position. Competitive advantage in the service industry refers to a company's ability to achieve a superior position compared to competitors by creating superior and sustainable service value. This advantage can be reflected in service quality, operational efficiency, customer loyalty, and market differentiation (Feliciano-Cestero, et al., 2023). In the service context, competitive advantage is often more difficult to maintain because it is easily imitated and heavily dependent on the customer experience. Therefore, service companies need to develop sources of competitive advantage that are dynamic, adaptive, and innovation-based. The literature confirms that sustainable competitive advantage is determined not only by the resources they possess, but also by the organization's ability to utilize and combine these resources innovatively (Obermayer, et al., 2022). Therefore, competitive advantage is understood as a strategic outcome of a continuous innovation process.

The relationship between technology-driven innovation and competitive advantage has been widely discussed in the literature, but the results are mixed. Some studies find a significant direct effect, while others indicate that the impact of technology on competitiveness is indirect. (Binsaeed et al., 2023; Criveanu, 2023). These differing findings indicate the existence of a mediating mechanism that explains how technology is converted into competitive advantage. In the context of the service industry, service innovation emerges as the most relevant mediator, as new technology will only provide strategic value when it is realized in the form of service innovations perceived by customers. Thus, service innovation is positioned as a conceptual bridge between technology-driven innovation and competitive advantage. This model aligns with the argument that effective digital transformation is not about how sophisticated the technology used, but rather about how innovative the services produced. Although research on technology and competitive advantage has progressed rapidly, several research gaps remain. First, many studies focus on the manufacturing sector, while the context of the service industry especially in developing countries is still relatively limited. Second, the role of service innovation as a mediator between technology-driven innovation and competitive advantage has not been widely tested empirically using the SEM approach. Therefore, this study contributes by testing a mediation model of service innovation in the relationship between technology-driven innovation and competitive advantage in the service industry in Indonesia. The proposed conceptual model is expected to enrich the service management literature and provide a deeper understanding of the mechanisms for creating competitive advantage in the era of digital transformation.

3. Research Method

3.1 Research Design and Approach

This study employs a quantitative approach (Ghanad, 2023) using a survey method to collect data from organizations operating in service industries. Respondents were managerial-level employees who possess adequate understanding of organizational innovation practices and human resource utilization. The measurement instruments were adapted from prior studies and assessed using a Likert scale. Data analysis was conducted using PLS-SEM, which is suitable for examining complex relationships and mediation effects in management and human resource research.

3.2 Research Location, Population, and Sample

The population of this study consists of **employees at the managerial and supervisory levels** working in service-sector organizations in Medan, Indonesia. These respondents were selected because they possess sufficient knowledge of organizational strategies, technology adoption, innovation practices, and the utilization of human resources in service delivery. The sample was drawn from the population using a **purposive sampling technique**, with the following criteria:

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1. Respondents are employed in organizations operating in service industries.
2. Respondents hold managerial or supervisory positions.
3. Respondents have direct involvement in or understanding of technology utilization, service innovation, and human resource management practices within their organizations.
4. Respondents have a minimum of one year of work experience in their current organization.

The number of respondents analyzed was 200, who were deemed to have met the minimum requirements for SEM-PLS analysis, both based on the rule of thumb (10 times the largest number of indicators) and an adequate level of statistical power.

3.3 Data Collection Techniques

Data were collected using a structured questionnaire survey designed to capture respondents' perceptions of technology-driven innovation, service innovation, and competitive advantage within service-sector organizations. The questionnaire was developed based on validated measurement scales from prior studies and adapted to the context of service industries in Indonesia. Prior to the main data collection, the questionnaire was reviewed to ensure clarity, relevance, and contextual appropriateness, particularly in relation to technology utilization and human resource practices in service organizations. A pilot test was conducted with a small group of respondents to assess item comprehensibility and refine wording where necessary. The final questionnaire was distributed to managerial and supervisory employees working in service industries. These respondents were selected because they are directly involved in decision-making processes related to technology adoption, service innovation, and the management of human resources. Data collection was conducted over a specified period using both online and offline distribution methods, depending on organizational accessibility and respondent availability. Participation in the survey was voluntary, and respondents were assured of the confidentiality and anonymity of their responses. No personally identifiable information was collected. To minimize common method bias, respondents were informed that there were no right or wrong answers and were encouraged to provide honest assessments based on their organizational experiences. After the data collection period, all returned questionnaires were screened for completeness and consistency. Incomplete or invalid responses were excluded from further analysis, resulting in 200 usable questionnaires for subsequent PLS-SEM analysis.

3.4 Variables and Operational Definitions

3.4.1 Technology-Driven Innovation

Technology-driven innovation is defined as a company's ability to adopt and utilize technology to generate innovative services and business processes. This variable is measured using several indicators, including:

- Level of digital technology adoption
- Technology-based service innovation
- Utilization of information systems in operational processes
- Company ability to leverage technology to create new value

Table 1. Indicator of Technology-Driven Innovation

Code	Indicator
TDI1	The level of adoption of digital technology in business processes
TDI2	Technology integration in corporate strategy
TDI3	Utilization of information systems to improve operational efficiency
TDI4	Technology capabilities in supporting decision making
TDI5	The company's ability to keep up with new technological developments

3.4.2 Service Innovation

Service innovation is a service company's ability to develop and update services through the application of technology and innovative approaches to create added value for customers. Measured variables:

- Development of new services
- Improved service quality
- Flexibility

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- Utilization of service innovations

Table 2. Indicator of Service Innovation

Code	Indicator
SI1	Development of new services based on customer needs
SI2	Improving service quality through innovation
SI3	Flexibility and personalization of services
SI4	The company's speed in introducing new services
SI5	Leveraging service innovation to enhance customer experience

3.4.3. Competitive Advantage

Competitive advantage is defined as a company's ability to achieve superior value over competitors through superior, difficult-to-imitate offerings. This variable is measured through the following indicators:

- Service quality
- Operational efficiency
- Customer satisfaction and loyalty
- Superior market position compared to competitors

Table 3. Indicator of Competitive Advantage

Code	Indicator
CA1	Superior service quality compared to competitors
CA2	Better operational efficiency than competitors
CA3	Customer satisfaction and loyalty levels
CA4	Market position advantage
CA5	Sustainable competitive ability

3.5 Data Analysis Techniques

Data analysis was conducted using Structural Equation Modeling – Partial Least Squares (SEM-PLS) with the aid of SmartPLS software. The SEM-PLS method was chosen because it can simultaneously test relationships between constructs and is suitable for research with non-normal data distributions and medium sample sizes.

The analysis was conducted in two main stages:

a. Measurement Model Evaluation (Outer Model)

This evaluation aims to test the validity and reliability of the research instrument, including:

- Convergent validity, measured by factor loading values (>0.7) and Average Variance Extracted (AVE >0.5).
- Discriminant validity, tested using the Fornell–Larcker criteria and cross-loading values.
- Reliability, measured by Cronbach's Alpha and Composite Reliability (>0.7).

b. Structural Model Evaluation (Inner Model)

The structural model evaluation is conducted to test the research hypothesis by considering:

- Path coefficient values to determine the direction and strength of the relationship between variables.
- t-statistic and p-value values to test the significance of the influence of independent variables on the dependent variable.
- R-square values to measure the ability of independent variables to explain variation in the dependent variable.

3.6 Hypothesis Test

The use of digital technology enables service companies to develop new services, increase process flexibility, and create more innovative customer experiences. Technology plays a key role as an enabler in driving service innovation, especially in the service industry, which relies heavily on the quality of interactions and speed of service.

H1: Technology-driven innovation has a positive and significant effect on service innovation.

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Service innovation enables service companies to create differentiation, increase customer satisfaction, and strengthen market loyalty. Continuous service innovation is a crucial factor in building a competitive advantage that is difficult for competitors to imitate.

H2: Service innovation has a positive and significant effect on competitive advantage.

Beyond service innovation, technology can also directly improve operational efficiency and service quality, ultimately strengthening a service company's competitive position.

H3: Technology-driven innovation has a positive and significant effect on competitive advantage.

Based on the Resource-Based View and the service innovation literature, technology-driven innovation creates competitive advantage more effectively when translated into service innovation. Thus, service innovation plays a key role in bridging the relationship between technology and competitive advantage.

H4: Service innovation mediates the effect of technology-driven innovation on competitive advantage.

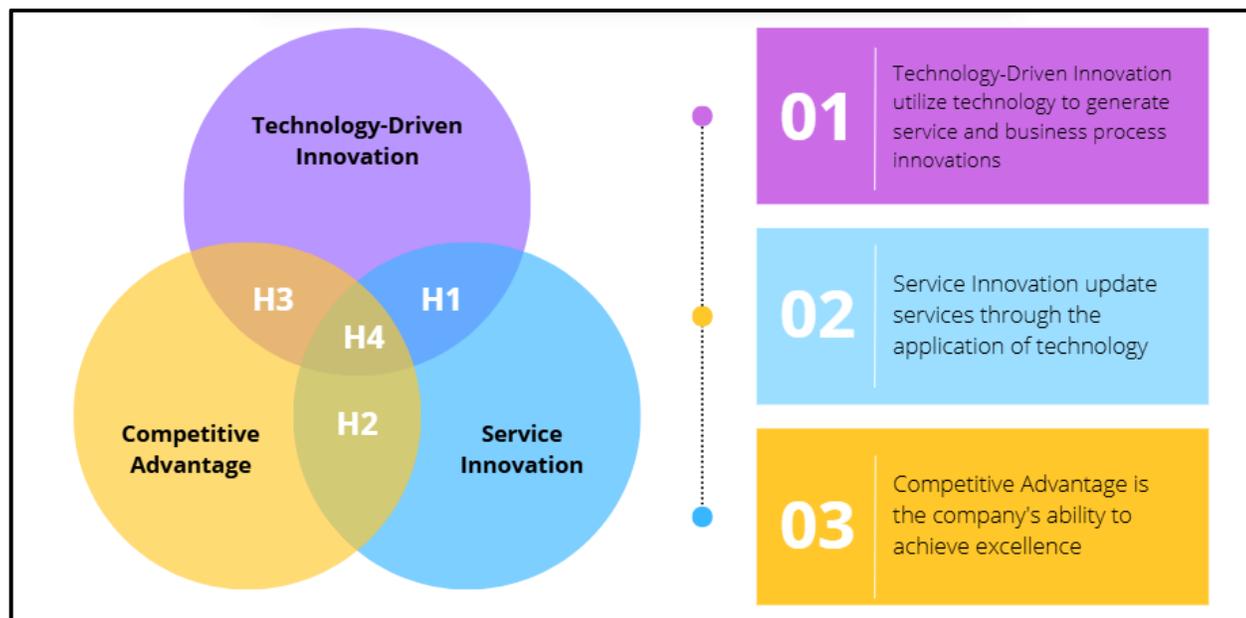


Figure 1. Research Diagram Model

4. Research Result

4.1 Measurement Model

Evaluation of the measurement model was conducted to test convergent validity, discriminant validity, and construct reliability using SEM-PLS.

Convergent Validity

Criteria:

- Outer loading $\geq 0,70$
- AVE $\geq 0,50$

The results show that all indicators meet the convergent validity criteria.

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Table 4. Outer Loading Indicator

Variabel	Indicator	Loading
Technology-Driven Innovation	TDI1	0,78
	TDI2	0,81
	TDI3	0,83
	TDI4	0,79
	TDI5	0,76
Service Innovation	SI1	0,82
	SI2	0,85
	SI3	0,80
	SI4	0,78
	SI5	0,84
Competitive Advantage	CA1	0,81
	CA2	0,79
	CA3	0,84
	CA4	0,82
	CA5	0,80

No indicators were eliminated, indicating the instrument is stable.

Construct Reliability

Criteria:

- Composite Reliability (CR) $\geq 0,70$
- Cronbach’s Alpha $\geq 0,70$

Table 5. Reliability and AVE

Variabel	Cronbach’s Alpha	CR	AVE
Technology-Driven Innovation	0,86	0,90	0,65
Service Innovation	0,88	0,91	0,68
Competitive Advantage	0,87	0,91	0,66

All constructs are reliable and convergently valid.

4.2 Structural Model

Coefficient of Determination (R²)

The R² value shows the explanatory power of the independent variable on the dependent variable.

Table 6. R² Value

Endogen Variable	R ²	Interpretation
Service Innovation	0,52	Moderate
Competitive Advantage	0,64	Moderate–strong

The model is able to explain 64% of the variation in competitive advantage, a very reasonable figure for service management research.

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4.3 Path Analysis

Hypothesis testing was conducted using bootstrapping with a significance level of 5%.

Table 7. Coefficient Path Test Result

Hipotesis	Relation	Coefisien	t-statistic	p-value	Decision
H1	TDI → SI	0,72	9,84	0,000	Accepted
H2	SI → CA	0,49	5,67	0,000	Accepted
H3	TDI → CA	0,31	3,92	0,000	Accepted

4.4 Mediation Effect Test

Mediation testing was conducted by looking at the indirect influence of Technology-Driven Innovation on Competitive Advantage through Service Innovation.

Table 8. Mediation Test

Mediation Path	Indirect Effect	t-statistic	p-value	Conclusion
TDI → SI → CA	0,35	4,88	0,000	Mediasi parsial

Service Innovation has been shown to be a partial mediator, meaning that technology has a direct influence on competitive advantage, but its impact becomes stronger when translated into service innovation.

4.5 Summary of Key Findings

The results demonstrate that technology-driven innovation significantly enhances service innovation, indicating that technological initiatives strengthen employees' ability to develop and deliver innovative services. Furthermore, service innovation significantly improves competitive advantage, highlighting the role of human resource capabilities in translating innovation into strategic outcomes. The mediation analysis confirms that service innovation partially mediates the relationship between technology-driven innovation and competitive advantage. This suggests that while technology directly contributes to competitiveness, its impact becomes more substantial when supported by human resource capabilities that enable innovative service delivery.

Discussion

The findings underscore the importance of human resource capabilities in leveraging technology-driven innovation within service industries. Consistent with dynamic capability theory, the results suggest that technology alone does not guarantee competitive advantage; instead, it must be complemented by employees' skills, learning capacity, and innovative behavior. In the Indonesian service context, where digital adoption is rapidly increasing, organizations often prioritize technological investment without sufficient attention to human capital development. This study demonstrates that service innovation—enabled by human resource capabilities serves as the critical mechanism that transforms technology into competitive advantage. These findings extend the human resource management literature by emphasizing the strategic role of HR in digital transformation initiatives. Human resources should not be viewed merely as support functions but as central actors in driving innovation and competitiveness.

Implications

From a managerial perspective, the results highlight the necessity of aligning technology-driven innovation with human resource development. Managers should focus on enhancing employee competencies through continuous training, digital skill development, and empowerment to maximize the benefits of technological innovation. Human resource managers are encouraged to integrate innovation-oriented competencies into recruitment, training, and performance management systems. Policymakers may also support service industries by promoting workforce upskilling programs that complement national digital transformation agendas.

Conclusion

This study concludes that technology-driven innovation contributes to competitive advantage in service industries primarily through service innovation, which reflects the effective utilization of human resource capabilities.

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While technology plays a vital role, sustainable competitive advantage is achieved when organizations leverage their human resources to transform technological potential into innovative service outcomes. The findings reinforce the importance of adopting a human resource-centered approach to digital transformation, particularly in service industries within emerging economies. This study is subject to several limitations. First, the cross-sectional design limits the ability to capture dynamic changes in human resource capabilities over time. Second, the analysis focuses on service industries in general rather than specific sectors. Future research may incorporate longitudinal designs, sector-specific analysis, or additional human resource variables such as employee engagement or innovative work behavior to further enrich understanding of technology-driven innovation and competitive advantage.

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