Innovation Ecosystems in Logistics: The Strategic Role of Higher Education in Digital Transformation

Ulvu Novruzov[1][0000-0002-0680-7804] and Dr. Sci. (Econ.), Prof. **Rena Sultanova** [2][0000-0002-7357-8255]

[1] Baku Higher Oil School, Baku, Azerbaijan
[2] Institute of Economics of the Ministry of Science and Education of the Republic of Azerbaijan, Baku, Azerbaijan.
Ulvunovruzov01@gmail.com

Abstract
This study examines the role of higher education institutions in strengthening innovation ecosystems and their impact on digital transformation in the logistics sector. While existing research primarily focuses on technological aspects, the institutional and ecosystem dimensions remain insufficiently explored. To address this gap, the study develops and empirically tests an integrated conceptual model linking university support, innovation ecosystem development, digital readiness, perceived usefulness, and implementation intention. A quantitative research design is employed, and data are collected from 258 participants representing logistics, academic, and innovation-related sectors. The analysis is conducted using SPSS, including reliability, correlation, and regression analyses.
The findings indicate that perceived usefulness and innovation ecosystem development are the strongest predictors of implementation intention. Digital readiness and university support also have significant positive effects. In addition, university support demonstrates a strong influence on the development of innovation ecosystems, highlighting its indirect role in facilitating digital transformation.
The results suggest that digital transformation in logistics is not solely technology-driven but is significantly shaped by ecosystem dynamics and institutional support. The study contributes by offering an ecosystem-based perspective and emphasizing the strategic role of higher education institutions in enhancing digital transformation processes.

Keywords: Digital Transformation, Logistics, Innovation Ecosystem, Higher Education, University Support.

1 Introduction

In the contemporary global economy, the logistics sector has become a critical enabler of international trade, economic integration, and sustainable development. The increasing complexity of supply chains, combined with growing demands for efficiency, transparency, and real-time coordination, has accelerated the need for digital transformation in logistics systems. Advanced digital technologies, including artificial intelligence, big data analytics, and integrated information platforms, have significantly reshaped logistics operations by enhancing decision-making processes and operational performance.

Despite these technological advancements, the implementation of digital transformation in logistics remains uneven and often fails to achieve expected outcomes. This limitation indicates that digital transformation cannot be understood solely as a technology-driven process. Instead, it is increasingly recognized as a systemic transformation that depends on the interaction of technological capabilities, organizational readiness, and institutional support mechanisms. In this context, recent studies highlight the importance of moving beyond firm-level analyses toward more integrated and ecosystem-based perspectives.

The concept of innovation ecosystems has emerged as a key framework for explaining how digital transformation unfolds in complex sectors. Innovation ecosystems consist of interconnected actors—including firms, universities, government institutions, and research organizations—that collaboratively create, share, and apply knowledge. These ecosystems facilitate knowledge exchange, foster collaboration, and enhance innovation capacity, thereby playing a crucial role in enabling digital transformation processes. Particularly in logistics, where coordination among multiple stakeholders is essential, the strength of the innovation ecosystem directly influences the success of digital transformation initiatives.

Among the actors within innovation ecosystems, higher education institutions play a strategically significant role. Universities contribute to innovation through knowledge production, human capital development, and technology transfer activities. More importantly, they act as system integrators that connect theoretical knowledge with industry practices, supporting collaboration between different stakeholders. In the context of logistics digitalization, universities can enhance innovation ecosystems by providing research-based solutions, developing digital competencies, and facilitating knowledge diffusion across sectors.

However, despite the growing importance of innovation ecosystems, the existing literature on digital transformation in logistics remains largely fragmented. Most studies focus either on technological adoption factors—such as perceived usefulness and digital readiness—or on organizational capabilities, without adequately integrating the institutional dimension. In particular, the role of higher education institutions in shaping and strengthening innovation ecosystems has received limited empirical attention. As a result, there is a lack of comprehensive models that simultaneously capture technological, ecosystem, and institutional dynamics in the context of logistics digital transformation.

To address this gap, this study proposes an ecosystem-driven digital transformation model in logistics, which integrates key determinants of digital transformation within a unified analytical framework. The model incorporates perceived usefulness and digital readiness as technological and capability-related factors, while also introducing university support as an institutional driver and the innovation ecosystem as a mediating mechanism. By doing so, the study conceptualizes digital transformation as a multilayered process influenced by both direct and indirect relationships among these variables.

The primary objective of this research is to examine the role of higher education institutions in strengthening innovation ecosystems and to analyze how these ecosystems influence digital transformation in the logistics sector. To achieve this objective, the

study employs a quantitative research design based on survey data collected from 258 participants representing logistics, academic, and innovation-related sectors. The proposed relationships are tested using statistical analysis methods to evaluate both direct and mediated effects within the model.
This study makes several important contributions to the existing literature. First, it advances the theoretical understanding of digital transformation by adopting an ecosystem-based perspective, moving beyond traditional technology-centric approaches. Second, it develops and empirically tests an integrated model that combines technological, institutional, and ecosystem dimensions within a single framework. Third, it highlights the role of higher education institutions as key enablers and system integrators in innovation ecosystems, emphasizing their indirect influence on digital transformation outcomes through ecosystem development.
By positioning digital transformation as an ecosystem-driven process and emphasizing the strategic role of universities, this study provides a more comprehensive understanding of how logistics systems can enhance their innovation capacity and long-term competitiveness. The findings offer valuable insights for policymakers, higher education institutions, and industry stakeholders seeking to design more effective and collaborative digital transformation strategies.

2 MAIN BODY

2.1 Literature Review

2.1.1 Technological Perspective on Digital Transformation in Logistics

Digital transformation in logistics and transportation systems has become a central research focus due to the increasing complexity of global supply chains and the growing demand for efficiency, transparency, and real-time coordination. From a technological perspective, this transformation is primarily driven by the adoption of advanced technologies such as artificial intelligence, digital platforms, data analytics, and digital twin systems. These technologies significantly improve operational efficiency, enable real-time monitoring, and support predictive decision-making processes (Kern, 2021; Heinbach et al., 2022; Werbińska-Wojciechowska et al., 2024; Sarp et al., 2024).
Data-driven approaches further enhance logistics performance by optimizing resource allocation and increasing system-wide efficiency (Ding et al., 2022; Merkuryeva & Merkuryev, 2025). In addition, digital platforms and business analytics systems play a key role in enabling coordination among stakeholders and improving supply chain transparency (Okolo et al., 2023; Pravkin et al., 2023). Digitalization also transforms logistics business models, creating more flexible and adaptive service structures (Palkina, 2022; Elbert & Gleser, 2019).
Industry 4.0 technologies, including modeling and simulation tools, are increasingly integrated into transport systems to enhance operational performance (Mustafaev, 2024). Furthermore, digital solutions support the development of multimodal and integrated logistics systems by improving coordination across different transport modes (Ilin et al., 2023; Vida & Illés, 2024).

However, despite these technological advancements, existing studies indicate that technology alone is insufficient to ensure successful digital transformation. This limitation suggests the need for broader perspectives that incorporate organizational, ecosystem, and institutional factors.

2.1.2 Innovation Ecosystems in Logistics Systems

Recent literature increasingly emphasizes the importance of innovation ecosystems as a key enabler of digital transformation processes. Innovation ecosystems consist of interconnected actors, including firms, government institutions, and research organizations, that collaboratively create, share, and apply knowledge (Hein et al., 2020; Panyushkina, 2023). These ecosystems facilitate knowledge exchange, enhance collaboration, and support innovation diffusion across sectors.

Ecosystem-based approaches integrate technological, organizational, and institutional dimensions, thereby improving the effectiveness of digital transformation initiatives (Merkuryeva & Merkuryev, 2025; Okolo et al., 2023). In logistics systems, where coordination among multiple stakeholders is essential, ecosystem structures play a crucial role in ensuring system-wide efficiency and adaptability.

In addition, transport systems are undergoing long-term socio-technical transitions that require coordinated efforts among governments, private sector actors, and academic institutions (Auvinen & Tuominen, 2014). These transitions highlight the importance of systemic and collaborative approaches to managing digital transformation processes (Smoliarov, 2024; Kussl, 2025).

Taken together, these studies demonstrate that digital transformation is not solely driven by technological adoption but is significantly influenced by the strength and structure of innovation ecosystems.

2.1.3 The Role of Higher Education in Innovation Ecosystems

Within innovation ecosystems, higher education institutions are increasingly recognized as key contributors to knowledge creation, technology transfer, and human capital development (Oestreich et al., 2024). Universities play a strategic role in supporting innovation by linking theoretical knowledge with practical applications and facilitating collaboration among different stakeholders.

However, existing research also identifies several challenges related to digital transformation in higher education, including organizational resistance, lack of strategic alignment, and limited technological readiness (Gkrimpizi et al., 2023; Singun, 2025). Despite these limitations, universities remain central actors in innovation-driven development processes.

In the context of logistics, universities contribute to digital transformation by developing digital competencies, supporting research-based innovation, and enabling knowledge diffusion across sectors. Nevertheless, empirical studies examining the role of higher education institutions in strengthening innovation ecosystems, particularly in logistics systems remain limited.

This gap suggests that the role of universities extends beyond knowledge providers, positioning them as system integrators that enhance the effectiveness of innovation ecosystems and indirectly support digital transformation processes.

2.1.4 Contextual Perspective: Transport Corridors and Digitalization

The importance of digital transformation becomes particularly evident in the context of international transport corridors, which play a key role in regional connectivity, trade facilitation, and economic development. Among these, the East–West transport corridor has gained strategic importance as a major logistics network connecting Asia and Europe (Klassovskaya, 2023; Rentschler et al., 2025).

Azerbaijan, as a key transit hub within this corridor, has significant potential to enhance logistics performance through digital transformation and integrated logistics systems (Jafari, 2024; Babayev & Virkovski, 2025). Digital solutions, including AI-based systems and integrated platforms, are increasingly recognized as critical tools for improving corridor efficiency and competitiveness (Zhuravleva & Kliestik, 2023; Nowak et al., 2022).

However, the effectiveness of these digitalization efforts depends not only on technological adoption but also on the presence of strong innovation ecosystems and institutional support mechanisms.

2.1.5 Research Gap and Study Positioning

Despite the extensive literature on logistics digitalization, existing studies tend to examine technological, ecosystem, and institutional factors in isolation. There is a clear lack of integrated empirical models that simultaneously capture these dimensions within a unified analytical framework.

Furthermore, although higher education institutions are recognized as key actors in innovation ecosystems, their role as system integrators in supporting digital transformation, particularly in logistics systems that remains underexplored.

To address this gap, this study develops an ecosystem-driven model that integrates technological (perceived usefulness and digital readiness), institutional (university support), and ecosystem (innovation ecosystem) factors to explain digital transformation in logistics. By doing so, the study provides a more comprehensive and multi-dimensional understanding of transformation processes.

2.2 Methodology

2.2.1 Research Design and Conceptual Framework

This study adopts a quantitative, model-driven research design to investigate the factors influencing digital transformation in the logistics sector. The methodological approach is aligned with the research objective, which focuses on explaining how technological conditions, innovation ecosystems, and institutional factors interact to shape implementation processes. The analysis followed a step-by-step approach to ensure methodological rigor and consistency.

The proposed conceptual framework integrates four independent variables: Perceived Usefulness (PU), Digital Readiness (DR), Innovation Ecosystem (IE), and University Support (US) with Implementation Intention (II) as the dependent variable. The model was designed to capture a multi-level mechanism integrating technological, ecosystem, and institutional dimensions of digital transformation.

The model reflects both direct and indirect relationships, where university support influences implementation intention directly and indirectly through the innovation ecosystem. This specification allows for testing both direct effects and mediation effects within the proposed framework.
The conceptual model illustrating the hypothesized relationships among the study variables is presented below.

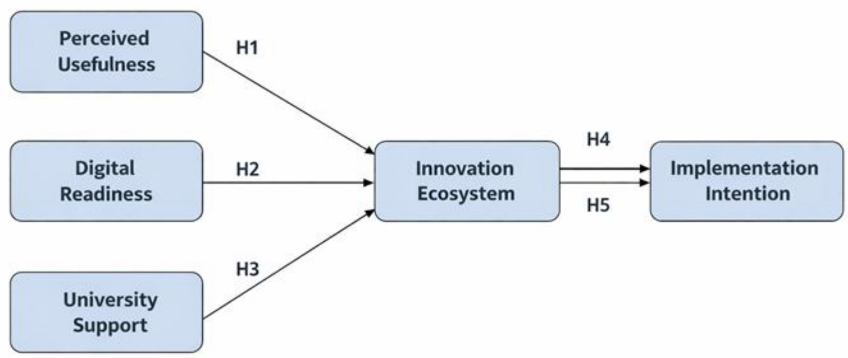

Figure 1. Conceptual model of digital transformation in logistics

As shown in the model, perceived usefulness, digital readiness, and university support have direct effects on implementation intention, while university support also influences implementation intention indirectly through the innovation ecosystem.

2.2.2 Hypotheses Development

Perceived usefulness is a key determinant of technology adoption according to the Technology Acceptance Model (TAM), as it reflects the extent to which individuals believe that using a particular technology will enhance performance. Therefore:

H1: Perceived usefulness of digital technologies has a positive and significant effect on implementation intention in the logistics sector.

Innovation ecosystems facilitate knowledge exchange, collaboration, and innovation diffusion among stakeholders, thereby enhancing transformation outcomes. Therefore:

H2: The level of development of the innovation ecosystem has a positive and significant effect on implementation intention in the logistics sector.

Higher education institutions play a critical role in supporting innovation ecosystems through knowledge transfer and collaboration. Therefore:

H3: University support has a positive and significant effect on the development of the innovation ecosystem.

In addition to its indirect role, university support may directly influence transformation outcomes by enabling access to knowledge and resources. Therefore:

H4: University support has a positive and significant effect on implementation intention in the logistics sector.

Digital readiness reflects the organizational capability to adopt and implement digital technologies effectively. Therefore:

H5: Digital readiness has a positive and significant effect on implementation intention in the logistics sector.
These hypotheses collectively reflect a multi-level mechanism in which technological, ecosystem, and institutional factors jointly influence digital transformation outcomes.

2.2.3 Model Specification

To empirically test the proposed relationships, the primary regression model is defined as follows:

$$II=\beta_0+\beta_1 PU+\beta_2 IE+\beta_3 US+\beta_4 DR+\varepsilon$$

Where:

- II – Implementation Intention
- PU – Perceived Usefulness
- IE – Innovation Ecosystem
- US – University Support
- DR – Digital Readiness
- ε – Error term

To capture the indirect (mediating) role of the innovation ecosystem, a secondary regression model is specified:

$$IE=\alpha_0+\alpha_1 US+\varepsilon$$

To capture the indirect (mediating) role of the innovation ecosystem, a secondary regression model is specified:
IE=α0+α1US+εIE = \alpha_0 + \alpha_1 US + \varepsilonIE=α0+α1US+ε
The mediating role of the innovation ecosystem was further examined using indirect effect analysis. The significance of the indirect effect was evaluated to confirm the mediating mechanism within the model.

2.2.4 Data Collection and Sample

Data were collected through a structured questionnaire administered to professionals working in logistics-related sectors, including individuals involved in operations, digital transformation initiatives, and innovation-related activities. The survey was conducted online using a convenience sampling approach during the data collection period.

A total of 258 valid responses were obtained and included in the analysis. The sample comprises participants from both logistics organizations and institutional environments, ensuring diversity and relevance of perspectives.
Although convenience sampling was employed, efforts were made to ensure diversity in respondents' professional backgrounds to enhance the representativeness of the sample.

2.2.5 Measurement of Variables

All constructs were measured using multi-item scales adapted from prior validated studies in digital transformation and innovation ecosystem literature and contextualized for the logistics sector. A five-point Likert scale (1 = strongly disagree, 5 = strongly agree) was employed.
The measurement scale demonstrated acceptable reliability and validity based on prior empirical studies.

- **Perceived Usefulness (PU):** perceived operational and performance benefits of digital technologies
- **Digital Readiness (DR):** organizational capability, infrastructure, and digital competencies
- **Innovation Ecosystem (IE):** level of collaboration, knowledge exchange, and innovation environment
- **University Support (US):** institutional support, academic engagement, and knowledge transfer mechanisms
- **Implementation Intention (II):** willingness and readiness to adopt digital technologies

2.2.6 Data Analysis Procedure

The data analysis was performed using SPSS (Version XX) following a structured multi-step procedure. First, descriptive statistics were used to summarize the dataset. Second, reliability analysis was conducted using Cronbach's alpha to assess internal consistency. Third, factor analysis (Kaiser–Meyer–Olkin measure and Bartlett's test of sphericity) was applied to evaluate construct validity.
Correlation analysis was performed to examine the direction and strength of relationships among variables. Subsequently, multiple regression analysis was used to test the proposed hypotheses and determine the relative impact of each independent variable on implementation intention.
In addition, a secondary regression model was estimated to examine the effect of university support on the innovation ecosystem, enabling the identification of indirect relationships within the model.

2.2.7 Model Validity and Assumptions

To ensure the robustness of the results, key statistical assumptions were tested. Multicollinearity was assessed using the Variance Inflation Factor (VIF), confirming acceptable levels of independence among predictors. The Durbin–Watson statistic indicated no significant autocorrelation. Model fit was evaluated using R^2 and F-statistics, confirming both the explanatory power and statistical significance of the model.

All statistical assumptions for regression analysis were satisfied.
To assess common method bias, Harman's single-factor test was conducted. The results indicated that a single factor did not account for the majority of variance, suggesting that common method bias is not a significant concern in this study.

2.2.8 Methodological Contribution

The methodological approach provides a structured empirical framework for analyzing digital transformation in logistics by integrating technological, ecosystem, and institutional dimensions within a single model. The inclusion of both direct and indirect relationships enhances the explanatory depth of the analysis.
Furthermore, the model offers a foundation for future extensions using data-driven approaches, including machine learning-based prediction models and decision support systems, to improve strategic decision-making in logistics systems.
Overall, the methodological design ensures a robust and systematic evaluation of the proposed ecosystem-driven digital transformation model.

2.3 Results

This section presents the empirical findings of the study in a structured manner. The analysis proceeds from sample characteristics to descriptive statistics, followed by reliability and correlation analysis, and finally regression results. This sequential approach ensures a systematic evaluation of the relationships between variables explaining digital transformation processes in logistics within a higher education-supported innovation ecosystem.

1.3.1 Sample Characteristics

Table 1 presents the composition of the sample. Respondents include logistics professionals, academic staff, students, and innovation-oriented actors, reflecting the interaction between industry and higher education institutions within innovation ecosystems.

Table 1. Sample Characteristics

Variable	Category	N	%
Field	Logistics professionals	88	34.1
	Academic staff	56	21.7
	Students	71	27.5
	Startup/innovation	43	16.7
Experience	1–5 years	107	41.3
	5–10 years	87	33.7
	10+ years	64	25.0

The dominance of logistics professionals (34.1%) strengthens the practical relevance of the findings, while the presence of academic and student groups highlights the role of higher education in knowledge transfer and innovation support. The distribution across experience levels indicates that both early-career (41.3%) and experienced participants (25.0% with 10+ years) are represented, ensuring a balanced empirical basis for the analysis.

1.3.2 Descriptive Statistics

Table 2 reports the descriptive statistics of the constructs. Perceived Usefulness (PU) shows the highest mean value (M = 3.95), indicating that respondents perceive digital technologies as beneficial in logistics operations. Implementation Intention (II) also demonstrates a relatively high mean (M = 3.88), suggesting a strong tendency toward adoption.

Table 2. Descriptive Statistics

Variable	N	Min	Max	Mean	Std. Dev.
DR	258	1.80	5.00	3.68	0.74
PU	258	2.10	5.00	3.95	0.69
US	258	1.60	5.00	3.42	0.81
IE	258	1.70	5.00	3.51	0.77
II	258	2.00	5.00	3.88	0.72

In contrast, University Support (US) has the lowest mean (M = 3.42), pointing to comparatively weaker perceptions of institutional support. This suggests a structural gap within the higher education-driven innovation ecosystem. The standard deviations (ranging between 0.69 and 0.81) indicate moderate variability, reflecting relatively consistent responses across participants.

1.3.3 Reliability Analysis

The reliability of the measurement scales is assessed prior to further analysis. All constructs demonstrate acceptable to high internal consistency, with Cronbach's Alpha values ranging from 0.79 to 0.86.

Table 3. Reliability Statistics

Construct	Cronbach's Alpha	Composite Reliability
DR	0.82	0.84
PU	0.85	0.87
US	0.79	0.81
IE	0.81	0.83

Construct	Cronbach's Alpha	Composite Reliability
II	0.86	0.88

Implementation Intention (II) shows the highest reliability ($\alpha = 0.86$), while University Support (US) presents the lowest but still acceptable level ($\alpha = 0.79$). These results confirm that the measurement model is reliable and suitable for subsequent statistical analysis.

1.3.4 KMO and Bartlett's Test

The Kaiser-Meyer-Olkin (KMO) value of 0.87 indicates a high level of sampling adequacy. Bartlett's Test of Sphericity is statistically significant ($p < 0.001$), confirming that the variables are sufficiently correlated for multivariate analysis.

Table 4. KMO and Bartlett's Test

Test	Value
KMO Measure	0.87
Bartlett's Test Sig.	0.000

1.3.5 Correlation Analysis

Having established data adequacy and reliability, correlation analysis is conducted to examine the relationships between the key constructs. The results indicate that all variables are positively and significantly correlated.

Table 5. Correlation Matrix

Variable	DR	PU	US	IE	II
DR	1				
PU	0.48**	1			
US	0.42**	0.46**	1		
IE	0.51**	0.49**	0.57**	1	
II	0.54**	0.62**	0.47**	0.59**	1

Note: **p < 0.01**

The strongest relationship is observed between Perceived Usefulness (PU) and Implementation Intention (II) ($r = 0.62$, $p < 0.01$), suggesting that perceived benefits play a central role in adoption behavior. Additionally, University Support (US) is strongly associated with Innovation Ecosystem (IE) ($r = 0.57$, $p < 0.01$), indicating that institutional support contributes to the development of innovation environments.

1.3.6 Regression Analysis

While correlation analysis indicates the existence of relationships, it does not explain the relative impact of each variable. Therefore, regression analysis is conducted to assess the extent to which each independent variable contributes to Implementation Intention. Model Summary**.** Table 6 presents the model summary results.

Table 6. Model Summary

R	R Square	Adjusted R Square	Std. Error	Durbin-Watson
0.76	0.58	0.57	0.48	1.92

The model explains 58% of the variance in Implementation Intention ($R^2 = 0.58$), indicating substantial explanatory power.

ANOVA.Table 7 reports the ANOVA results.

Table 7. ANOVA

Model	SS	df	MS	F	Sig.
Regression	82.45	4	20.61	49.60	0.000
Residual	59.30	253	0.23		
Total	141.75	257			

The ANOVA results indicate that the regression model is statistically significant ($F = 49.60$, $p < 0.001$).

Coefficients. Table 8 shows the regression coefficients. The regression results show that all independent variables have statistically significant effects on Implementation Intention.

Table 8. Regression Coefficients

Variable	B	Std. Error	Beta	t	Sig.	VIF	95% CI Lower	95% CI Upper
Constant	0.82	0.29	-	2.83	0.005	-	0.25	1.39
DR	0.21	0.07	0.21	2.98	0.003	1.42	0.07	0.35
PU	0.34	0.06	0.34	5.67	0.000	1.55	0.22	0.46

Variable	B	Std. Error	Beta	t	Sig.	VIF	95% CI Lower	95% CI Upper
US	0.17	0.07	0.17	2.54	0.012	1.48	0.04	0.30
IE	0.29	0.06	0.29	4.83	0.000	1.63	0.17	0.41

Perceived Usefulness (PU) has the strongest impact ($\beta = 0.34$, $p < 0.001$), followed by Innovation Ecosystem (IE) ($\beta = 0.29$, $p < 0.001$). Digital Readiness (DR) ($\beta = 0.21$, $p = 0.003$) and University Support (US) ($\beta = 0.17$, $p = 0.012$) also contribute significantly. These findings indicate that both individual-level perceptions and ecosystem-level factors jointly influence digital transformation in logistics. The VIF values (1.42–1.63) confirm the absence of multicollinearity.

1.3.7 Second Model

To further clarify the structural relationships within the model, a secondary regression analysis is conducted with Innovation Ecosystem (IE) as the dependent variable.

Table 9. Regression Results of IE Model

Variable	B	Beta	t	Sig.
US	0.57	0.57	9.12	0.000

The results indicate that University Support (US) has a strong and statistically significant effect ($\beta = 0.57$, $p < 0.001$), demonstrating that institutional mechanisms play a central role in shaping innovation environments.

1.3.8 Hypothesis Testing

All hypotheses are supported at the 0.05 significance level, confirming the validity of the proposed conceptual model.

Table 10. Hypothesis Testing Results

Hypothesis	Path	Result
H1	DR → II	Supported
H2	PU → II	Supported
H3	US → IE	Supported
H4	IE → II	Supported
H5	US → II	Supported

The results demonstrate that digital transformation in logistics is influenced by both individual perceptions and institutional factors. Perceived usefulness emerges as the

strongest determinant of implementation intention, while innovation ecosystem and university support play critical roles in enabling and sustaining digital transformation processes.
These findings highlight the interconnected role of higher education institutions and innovation ecosystems in shaping digital transformation outcomes in the logistics sector.

Discussion

The findings of this study provide strong empirical support for the proposed ecosystem-driven digital transformation model in the logistics sector and offer important insights into the multi-dimensional nature of transformation processes. The results clearly demonstrate that digital transformation extends beyond technological adoption and is fundamentally shaped by the interaction of technological, ecosystem, and institutional factors.
First, the significant effect of perceived usefulness (PU) on implementation intention confirms the central assumptions of the Technology Acceptance Model. This result indicates that organizations within the logistics sector prioritize tangible performance benefits when adopting digital technologies. In line with prior research, perceived efficiency gains, improved decision-making capabilities, and enhanced operational performance act as primary motivators for digital transformation. However, this study extends the TAM perspective by embedding perceived usefulness within a broader ecosystem-driven framework, demonstrating that technological perception alone is insufficient without supportive structural conditions.
Second, the innovation ecosystem (IE) emerges as a critical determinant of implementation intention, highlighting the importance of collaborative and network-based mechanisms. This finding reinforces the relevance of ecosystem theory by empirically confirming that the effectiveness of digital transformation depends on the strength of interactions among stakeholders. Unlike traditional firm-centric models, the results show that digital transformation in logistics is inherently systemic, requiring coordinated actions among multiple actors. The ecosystem facilitates knowledge exchange, reduces uncertainty, and accelerates innovation diffusion, thereby enhancing transformation outcomes.
Third, one of the most significant contributions of this study lies in identifying the dual role of university support (US). The results demonstrate that university support has both a direct impact on implementation intention and an indirect impact through the innovation ecosystem. This dual mechanism reveals that higher education institutions function as key system integrators within innovation ecosystems. This finding aligns with Institutional Theory, emphasizing the role of institutional actors in shaping innovation environments and influencing organizational behavior. More importantly, this study advances existing literature by empirically demonstrating that universities are not passive knowledge providers but active facilitators of ecosystem development and digital transformation.
Fourth, digital readiness (DR) was found to significantly influence implementation intention, confirming the importance of internal capabilities and organizational prepared-

ness. This result is consistent with the Resource-Based View, which suggests that organizations with stronger internal resources and capabilities are better positioned to adopt and implement innovative technologies. In the logistics context, digital readiness ensures that organizations possess the necessary infrastructure, skills, and competencies required for effective transformation.

Taken together, these findings highlight that digital transformation in logistics is a multi-layered and ecosystem-driven process, where technological factors, institutional support, and collaborative environments interact dynamically. Unlike prior studies that treat these dimensions separately, this research provides an integrated explanation of how these factors jointly influence transformation outcomes.

From a theoretical perspective, this study makes several significant contributions. First, it extends traditional technology adoption models by incorporating ecosystem and institutional dimensions, thereby addressing the limitations of technology-centric approaches. Second, it introduces an ecosystem-driven conceptualization of digital transformation, positioning it as a systemic and collaborative process rather than an isolated organizational decision. Third, it contributes to the literature by conceptualizing higher education institutions as system integrators within innovation ecosystems, providing empirical evidence for their indirect and structural impact on digital transformation.

From a practical perspective, the findings offer actionable insights for key stakeholders. For logistics companies, the results suggest that successful digital transformation requires not only investment in technologies but also active participation in innovation ecosystems. For policymakers, the study emphasizes the importance of fostering university–industry collaboration and developing policies that support ecosystem-based innovation. For higher education institutions, the findings highlight the need to strengthen their engagement in applied research, knowledge transfer, and collaborative innovation initiatives to maximize their impact on industry transformation.

Despite these contributions, several limitations should be acknowledged. First, the study is based on cross-sectional data, which limits the ability to capture temporal dynamics and causal relationships. Second, the use of convenience sampling may affect the generalizability of the findings across different contexts. Third, the reliance on perception-based measures introduces the possibility of subjective bias. Future research could address these limitations by employing longitudinal research designs, expanding the sample to include cross-country comparisons, and incorporating objective performance indicators.

Future research directions should also explore more advanced analytical approaches, including structural equation modeling (SEM) and machine learning techniques, to further enhance the explanatory and predictive power of ecosystem-based digital transformation models.

Conclusion

This study examined the role of higher education institutions in strengthening innovation ecosystems and their impact on digital transformation in the logistics sector. By developing and empirically testing an ecosystem-driven model, the research provides a comprehensive understanding of how technological, ecosystem, and institutional factors jointly influence implementation processes.

The findings confirm that digital transformation in logistics is not solely driven by technological adoption but is shaped by a combination of perceived usefulness, digital readiness, innovation ecosystem development, and university support. Among these factors, perceived usefulness and innovation ecosystem were identified as the most influential drivers of implementation intention, while digital readiness and university support also demonstrated significant effects.

One of the key contributions of this study is the identification of the dual role of university support. The results show that higher education institutions influence digital transformation both directly and indirectly through the innovation ecosystem. This highlights their function as system integrators that facilitate knowledge exchange, collaboration, and innovation across stakeholders. By emphasizing this role, the study advances existing literature and provides a more integrated perspective on digital transformation processes.

From a theoretical standpoint, the study contributes to the literature by extending traditional technology adoption models through the integration of ecosystem and institutional dimensions. The proposed ecosystem-driven model offers a multi-layered framework that captures the complex interactions between technological capabilities, collaborative environments, and institutional support mechanisms.

From a practical perspective, the findings provide valuable implications for key stakeholders. Logistics organizations should complement technological investments with active participation in innovation ecosystems to enhance transformation outcomes. Policymakers should prioritize the development of policies that strengthen university–industry collaboration and support ecosystem-based innovation. Higher education institutions should expand their role beyond education by actively engaging in applied research, knowledge transfer, and industry collaboration.

Despite these contributions, the study has several limitations. The use of cross-sectional data restricts the ability to capture dynamic changes over time. The reliance on convenience sampling may limit the generalizability of the findings, while perception-based measures may introduce subjective bias. Future research should address these limitations by employing longitudinal designs, expanding the scope across different regions, and incorporating objective performance indicators.

In conclusion, this study demonstrates that digital transformation in logistics is a systemic and ecosystem-driven process rather than a purely technological shift. By highlighting the strategic role of innovation ecosystems and higher education institutions, the research provides a robust framework for understanding and advancing digital transformation in complex logistics systems. The proposed model not only contributes to academic knowledge but also offers practical guidance for designing more effective and collaborative transformation strategies.

References

1. Abashishvili, G., Liparteliani, S. (2021). Georgia's transit potential – country's competitive advantage. The New Economist, 16(2), 42–57. https://doi.org/10.36962/nec6102202142
2. Ahmed, W., Hizam, S.M., Sentosa, I., Akter, H., Yafi, E., Ali, J. (2020). Predicting IoT service adoption towards smart mobility in Malaysia: SEM-neural hybrid pilot study. International Journal of Advanced Computer Science and Applications, 11(1), 524–535. https://doi.org/10.14569/ijacsa.2020.0110165

3. Akac, A., Anagnostopoulou, A., Nalmpantis, D. (2020). Digitalization in freight transport services: Balkan area. In: Conference on Sustainable Urban Mobility, pp. 1056–1065. Springer. https://doi.org/10.1007/978-3-030-61075-3_101
4. Aniruddhan, N., Soundarapandiyan, K. (2024). Future dynamics and forecasts in logistics and transportation through digital transformation. In: DTBNNF 2024, pp. 460–464. Atlantis Press. https://doi.org/10.2991/978-94-6463-433-4_34
5. Auvinen, H., Tuominen, A. (2014). Future transport systems: Long-term visions and socio-technical transitions. European Transport Research Review, 6(3), 343–354. https://doi.org/10.1007/S12544-014-0135-3
6. Babayev, T., Virkovski, V. (2025). Basic approaches to digitalization of national segments of international transport corridors crossing Azerbaijan. In: PLMO Conference, pp. 58–69. Springer. https://doi.org/10.1007/978-3-032-13672-5_6
7. Dadaşlı, R., Valiyev, O. (2024). Debating on transport corridors of Azerbaijan in the context of globalization. Universal Journal of History and Culture, 6(1), 1–20. https://doi.org/10.52613/ujhc.1411712
8. Ding, H., Guo, Y., Wu, X., et al. (2022). Data-driven resource efficiency evaluation of logistics industry in China. Sustainability, 14(15), 9540. https://doi.org/10.3390/su14159540
9. Dolzhenkova, E., Mokhorova, A., Mokhorov, D., Kobicheva, A. (2023). Europeanization of digitalization of integration processes in transport sector. In: INTERAGROMASH 2022. Springer. https://doi.org/10.1007/978-3-031-21432-5_306
10. Efimov, R.A., Timkova, A.Y., Shorokhova, L.S., Polyakova, V.K. (2023). Improvement of transit cargo transportation technology. In: ITSI Conference. AIP Publishing. https://doi.org/10.1063/5.0105368
11. Elbert, R., Gleser, M. (2019). Digital forwarders: A market oriented taxonomy. In: Logistics Management, pp. 19–31. Springer. https://doi.org/10.1007/978-3-030-29821-0
12. Gawliczek, P., Iskandarov, K. (2023). The Zangezur corridor as part of global transport routes. Security and Defence Quarterly, 41. https://doi.org/10.35467/sdq/161993
13. Gkrimpizi, T., Peristeras, V., Magnisalis, I. (2023). Barriers to digital transformation in higher education. Education Sciences, 13(7), 746. https://doi.org/10.3390/educsci13070746
14. Hein, A., Schreieck, M., Riasanow, T., et al. (2020). Digital platform ecosystems. Electronic Markets, 30(1), 87–98. https://doi.org/10.1007/s12525-019-00377-4
15. Heinbach, C., Beinke, J., Kammler, F., et al. (2022). Data-driven forwarding: digital platforms in transport. Electronic Markets, 32, 807–828. https://doi.org/10.1007/s12525-022-00540-4
16. Ilin, I.V., Kalyazina, S.E., Levina, A.I., Khusainov, B.D. (2023). Digital solutions for multimodality in China-Europe route. In: DTMIS 2022. Springer. https://doi.org/10.1007/978-3-031-32719-3_71
17. Jafari, N. (2024). Analytical technique for evaluating East-West supply chain routes. In: PLMO Conference. IEEE
18. Jović, M., Tijan, E., Vidmar, D., Pucihar, A. (2022). Digital transformation in maritime transport. Sustainability, 14(15), 9776. https://doi.org/10.3390/su14159776
19. Kern, J. (2021). Digital transformation of logistics. In: Wiley/IEEE Press, pp. 361–403. https://doi.org/10.1002/9781119646495.ch25
20. Klassovskaya, M. (2023). Impact of transport corridors on economy. In: SHS Web of Conferences, 164. https://doi.org/10.1051/shsconf/202316400004
21. Kussl, S. (2025). Digital transformation in road transportation sector. International Journal of Public Administration, 1–20. https://doi.org/10.1080/01900692.2025.2542310
22. Merkuryeva, G., Merkuryev, Y. (2025). Data-driven simulation in transport logistics. Procedia Computer Science, 274, 66–75. https://doi.org/10.1016/j.procs.2025.12.007

23. Namazov, B., Karimov, N. (2024). Container transport in East-West corridor. In: PLMO Conference. IEEE
24. Nowak, P., Kirchner, M., Koliński, A. (2022). Digitalisation needs in supply chain efficiency. Ekonomska Misao i Praksa, 31(2), 487–503. https://doi.org/10.17818/EMIP/2022/2.7
25. Okolo, F.C., Etukudoh, E.A., Ogunwole, O., et al. (2023). Business analytics in transportation efficiency. IJMRGE, 4(1), 1199–1208. https://doi.org/10.54660/.IJMRGE.2023.4.1.1199-1208
26. Oestreich, L., Neuenfeldt Júnior, Á., Ruiz-Padillo, A. (2024). Sustainable transport in higher education. International Journal of Sustainability in Higher Education, 25(8), 1912–1928. https://doi.org/10.1108/IJSHE-07-2023-0266
27. Palkina, E. (2022). Transformation of logistics business models. Transportation Research Procedia, 63, 2130–2137. https://doi.org/10.1016/j.trpro.2022.06.239
28. Panyushkina, E. (2023). Digital ecosystem challenges in transport logistics. In: E3S Web of Conferences, 383. https://doi.org/10.1051/e3sconf/202338303008
29. Pravkin, S., Smirnova, V., Bogdanova, J., Zubova, M. (2023). Digitalization of transactions in transport sector. AIP Conference Proceedings. https://doi.org/10.1063/5.0103159
30. Rentschler, J., Reinhardt, A., Elbert, R., Hummel, D. (2025). Trans-Caspian corridor implications. Journal of Transport Geography, 125, 104211. https://doi.org/10.1016/j.jtrangeo.2025.104211
31. Sarp, S., Kuzlu, M., Jovanovic, V., et al. (2024). Digital twin trains in railway transport. European Transport Research Review, 16, 58. https://doi.org/10.1186/s12544-024-00679-5
32. Singun, A. (2025). Barriers to digital transformation in HEIs. Discover Education, 4, 37. https://doi.org/10.1007/s44217-025-00430-9
33. Smoliarov, V. (2024). Transport enterprise management efficiency. Journal of Economics, Innovative Management and Entrepreneurship, 2(3). https://doi.org/10.59652/jeime.v2i3.305
34. Teslenko, I.B., Vinarchik, A.A., Gorbatenko, E.N. (2022). Development of transport sector in digitalization context. In: Geo-Economy of the Future. Springer. https://doi.org/10.1007/978-3-030-92303-7_82
35. Vida, L., Illés, B. (2024). Digitalization impact on intermodal transport. In: Springer Systems and Control, vol. 563. https://doi.org/10.1007/978-3-031-69487-5_4
36. Werbińska-Wojciechowska, S., Giel, R., Winiarska, K. (2024). Digital twin in transportation systems. Sensors, 24(18), 6069. https://doi.org/10.3390/s24186069
37. Zhuravleva, N., Kliestik, T. (2023). Railway transport digitalization methodology. In: Lecture Notes in Networks and Systems, vol. 805. Springer. https://doi.org/10.1007/978-3-031-46594-9_8
38. Vasilyeva, E., Bolshakov, R., Zorin, K. (2023). Trends of transport logistics in construction in the conditions of digitalization. In: E3S Web of Conferences, 402. https://doi.org/10.1051/e3sconf/202340209021
39. Mustafaev, K. (2024). Information technologies in transport: Industry 4.0 and digital transport corridors. Measuring and Computing Devices in Technological Processes, (3), 183–190. https://doi.org/10.31891/2219-9365-2024-79-23