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# Digital transformation of tourist information centres in Slovakia

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**Abstract**

**Purpose** – Digital transformation, a key trend in the global tourism environment, is becoming increasingly accessible and urgent for smaller players, including tourist information centres (TICs), due to technological advances and the development of smart infrastructure. The aim of this study is to examine the level of digitalisation of TICs in Slovakia and to identify typologically distinct groups based on their approaches to implementing digital technologies, the services they provide, the perceived benefits, and the planned innovations in digital transformation. **Methodology** – The research sample consisted of 52 TICs. Primary data were collected between April and June 2025 through in-person visits and an online questionnaire survey. Hierarchical cluster analysis using Ward's method was applied to identify groups of TICs with similar characteristics in terms of digital technology implementation and service provision. **Findings** – The analysis revealed three clusters: 17 digitally advanced "leaders", 25 moderately digitised "followers", and 10 minimally digitised "laggards". These results indicate considerable heterogeneity in digital maturity levels among TICs and differences in their adoption of digital solutions. **Implications** – The findings highlight the need for targeted support for less digitally developed centres and provide practical insights for designing effective digital transformation strategies in tourism.

**Keywords:** digitalisation, digital transformation, hierarchical cluster analysis, tourist information centres
**JEL classification**: L83, L89, Z32

# Digitalna transformacija turističkih informativnih centara u Slovačkoj

**Sažetak**

**Svrha** – Digitalna transformacija, kao ključni trend u globalnom turističkom okruženju, postaje sve dostupnija i urgentnija za manje aktere, uključujući turističke informativne centre (TIC), usled tehnološkog napretka i razvoja pametne infrastrukture. Cilj ove studije je da ispita nivo digitalizacije TIC-ova u Slovačkoj i da identifikuje tipološki različite grupe na osnovu njihovog pristupa implementaciji digitalnih tehnologija, pruženih usluga, percipiranih koristi i planiranih inovacija u procesu digitalne transformacije. **Metodologija** –

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Istraživački uzorak činila su 52 TIC-a. Primarni podaci prikupljeni su u periodu od aprila do juna 2025. godine putem ličnih poseta i online anketnog upitnika. Hijerarhijska klaster analiza primenom Ward-ove metode korišćena je za identifikaciju grupa TIC-ova sa sličnim karakteristikama u pogledu implementacije digitalnih tehnologija i pružanja usluga. **Rezultati** – Analiza je identifikovala tri klastera: 17 digitalno naprednih „lidera", 25 umereno digitalizovanih „sledbenika" i 10 minimalno digitalizovanih „zaostalih". Ovi rezultati ukazuju na značajnu heterogenost u nivou digitalne zrelosti TIC-ova i razlike u usvajanju digitalnih rešenja. **Implikacije** – Rezultati ukazuju na potrebu ciljane podrške manje digitalno razvijenim centrima i pružaju praktične smernice za oblikovanje efikasnih strategija digitalne transformacije u turizmu.

**Ključne reči:** digitalizacija, digitalna transformacija, hijerarhijska klaster analiza, turistički informativni centri
**JEL klasifikacija:** L83, L89, Z32

## 1. Introduction

Current developments towards a more sustainable, digital, and data-driven society are significantly transforming the tourism sector. Digitalisation has become a key development priority at both European and national levels, enabling more efficient destination management, improved services, and new forms of visitor interaction. In an environment of growing competition and changing visitor behaviour, digital solutions are essential for providing value-added services.

The integration of digital technologies such as mobile applications, online booking systems, smart maps, destination digital twins, and predictive analytics is reshaping how destinations communicate with visitors, increasing operational efficiency and supporting sustainable tourism through resource optimisation. These technologies form the basis of smart tourism and enhance the attractiveness of destinations and the visitor experience (Galvão et al., 2024; Zhou & Zhang, 2025).

Tourist information centres (TICs) play an important role as intermediaries between destinations and visitors. Their traditional function was based primarily on personal contact, but they are gradually transforming into modern information hubs through digital channels and tools. Their ability to adapt to digital trends is therefore becoming an important indicator of readiness to face current challenges. Examining the level of digitalisation of TICs in Slovakia is thus justified, as it allows us to identify centres that require targeted support.

At the national level in Slovakia, digital transformation is framed by strategic documents. The Slovak Digital Transformation Strategy 2030 (MIRRI SR, 2019) emphasises the need to develop smart infrastructure and increase digital skills. It is complemented by the Action Plan for Smart Industry in the Slovak Republic (MH SR, 2018) and the National Strategy for Digital Skills in the Slovak Republic (MŠVVaŠ SR, 2020).

The aim of this study is to examine the level of digitalisation of TICs in Slovakia and to identify typologically distinct groups based on their approaches to implementing digital technologies, the services they provide, the perceived benefits, and the planned innovations in digital transformation.

This study contributes to the current body of knowledge. First, it extends research on digital transformation in tourism by focusing on TICs, which have received relatively limited attention in existing literature. Second, by applying hierarchical cluster analysis, the study identifies distinct profiles of digital maturity among TICs. Third, the study contributes to

explaining differences in the adoption of digital technologies among TICs through a theoretical lens.

From a practical perspective, the findings provide insights for policymakers and tourism managers to support digital infrastructure, employee training, and the implementation of innovations.

## 2. Theoretical background

In recent years, Information and Communication Technologies have radically transformed tourism and hospitality, creating new competitive environments and customer experiences (Calvaresi et al., 2021). This digitisation, framed by Industry 4.0 technologies, has led to the emergence of "smart tourism", a research area focused on tourist experiences and destination management (Rodrigues et al., 2022; Topsakal et al., 2021). Smart features, interoperability, and data-exchange platforms can automate and simplify business and customer activities (Leung, 2019).

These changes also affect the traditional TIC, which is increasingly expected to adopt digital solutions that improve services and visitor interactions (Rodrigues et al., 2022). Technologies such as Artificial Intelligence (AI), Big Data, and the Internet of Things (IoT) support more efficient, informative, and interactive personalised tourist information services (Kalia et al., 2022). As Pfaff et al. (2023) note, digital transformation should not merely provide visitor information but help develop "smarter tourism" (Aliyah et al., 2023) through real-time data and personalised recommendations. Beták et al. (2023) add that technologically proficient customers increasingly use digital tools when choosing services, destinations, or products.

The integration of technologies and digital media goes beyond information dissemination. It aims to build a digital ecosystem in TICs that can respond to visitors' needs (Мустафаева et al., 2020). Although the benefits of digital technologies are clear, tourism has adopted digital transformation more slowly than other sectors and still faces barriers and uncertainty (Rodrigues et al., 2022). Comprehensive strategies are therefore needed to address these barriers and help tourism benefit from digital technologies (Chon & Hao, 2024). Key barriers include high infrastructure costs, workforce upskilling, and concerns about data privacy and security. It is thus important to assess current digitalisation practices and how regional and national frameworks can strengthen the competitiveness of regional tourism products (Barashok et al., 2021).

Given the complexity of tourism digitalisation, these processes should be analysed through an appropriate theoretical framework. This study therefore draws on the Technology–Organization–Environment (TOE) framework, developed by Tornatzky and Fleischer (1990) to explain organisational technology adoption. The framework has been widely applied in research on technology adoption and digital transformation, including in tourism (e.g., Martín Lucas et al., 2024; Nikopoulou et al., 2023).

The TOE framework identifies three key dimensions influencing the adoption of digital technologies. The technological dimension refers to the availability and characteristics of technologies relevant to the organisation. The organisational dimension encompasses internal characteristics such as resources, competencies, and managerial support. The environmental dimension reflects external conditions, including competitive pressure, regulatory environment, and the broader development of the digital ecosystem (Tornatzky & Fleischer, 1990).

In the context of TICs, the TOE framework requires specific consideration because TICs differ from typical profit-oriented organisations. Their functioning is often shaped by public funding, destination management structures, and regional tourism development. Therefore, the technological, organisational, and environmental dimensions should be interpreted in relation to the public-service and destination-support roles of TICs. This perspective helps explain the factors shaping digital transformation in TICs, especially the role of digital technologies.

From the technological dimension of the TOE framework, digital twins represent a relevant digital innovation in tourism and an advanced tool for analysing and managing tourist destinations. Real-time data allow a digital twin to reflect the current state of a physical process. Supported by technologies such as the Internet of Things (IoT), cloud computing, machine learning, application programming interfaces (APIs), and augmented and virtual reality, digital twins enhance process analysis and visualisation (Sani, 2022).

The concept of Digital Twins (DT) has emerged as a prominent digital trend. This technology links physical and digital environments. It helps people understand how assets perform, predict their behaviour, and improve operations and services. Since it encompasses the entire asset life cycle, it requires regular updates to remain accurate (Hartmann & Van der Auweraer, 2020). According to Abayadeera and Ganegonda (2024), multiple scholars have proposed distinct interpretations of DT technology, leading to several revisions of its definition.

Glaessgen and Stargel (2012) define a Digital Twin as a detailed, dynamic digital version of a physical system or asset. Using models, sensor data, and historical information, it reflects the condition, behaviour, and performance of its real-world counterpart. As new data become available, the virtual version updates in real time, supporting monitoring, prediction, and decision-making throughout the system's lifecycle. Based on the literature review, Trauer (2020) identifies three core characteristics of DT: 1) A Digital Twin is a dynamic virtual replica of a physical object or system; 2) The data flows bidirectionally and automatically between the physical system and the Digital Twin; 3) The Twin contains data from each phase of the entire product life cycle and is associated with each one of them.

Accordingly, the author of the review (Trauer et al., 2020, p. 761) establishes the following definition: "*A Digital Twin is a virtual dynamic representation of a physical system, which is connected to it over the entire lifecycle for bidirectional data exchange*."

Based on Jones et al. (2019), the benefits of Digital Twins include: 1) enhanced understanding of design concepts; 2) improved early-stage decision-making; 3) reduced uncertainty and risk; 4) accelerated iteration and innovation; 5) improved communication and collaboration; and 6) lifecycle orientation.

Considering the tasks and responsibilities of TICs, the following specific benefits of Digital Twins can be outlined:

1. Enhanced understanding of visitor behaviour – Deeper insights into how visitors move, interact, and use TIC services.
2. Improved decision-making for TIC services – Evidence-based evaluation of new layouts, services, and facilities.
3. Reduced uncertainty in visitor flow and operations – Simulations of peak times and emergencies for better preparedness.
4. Accelerated innovation in visitor experience – Faster testing of new ideas, such as augmented reality tours or interactive kiosks.
5. Improved communication with stakeholders – A shared digital platform for collaboration with tourism boards, city planners, and local businesses.

6. Lifecycle perspective for sustainable tourism – Forecasting long-term impacts on resources, energy use, and visitor flows.

According to Florido-Benítez (2024), digital twin (DT) technology can support public participation in innovative urban planning models. Its scalability and predictive functions can improve organisational management and inform managerial and governmental decision-making. With the rise of overtourism, monitoring and predicting tourist behaviour is increasingly important for effective mitigation measures. Digital Twins can generate insights into complex tourism behaviour and help decision makers develop more informed action plans (Sampaio, 2025).

As noted above, Digital Twins offer several possibilities for the tourism sector. However, implementing this technology may be difficult for smaller TICs with limited financial or human resources. Challenges include technology costs, data security, and employee training. The quality and completeness of input data, which are necessary for DTs to function and make predictions, are also key issues when deciding whether to establish and use Digital Twins.

## 3. Materials and methods

The aim of this study is to examine the level of digitalisation of TICs in Slovakia and to identify typologically distinct groups based on their approaches to implementing digital technologies, the services they provide, the perceived benefits, and the planned innovations in digital transformation.

Primary data were collected using a structured questionnaire administered both in person and online between April and June 2025. A total of 109 TICs registered in the Slovakia Travel database were contacted, of which 52 responded (47.7%).

Hierarchical cluster analysis using Ward's method and Euclidean distance was applied to identify homogeneous groups of TICs. This method groups observations based on similarity and minimises within-cluster variance (Everitt et al., 2011; Hair et al., 2019).

The input variables included indicators related to the services provided, the digital technologies implemented, the perceived benefits of digitalisation, and planned innovations. The selection of variables was guided by the research objectives and the questionnaire structure, with the aim of capturing the main aspects of digitalisation in TICs, including internal processes and visitor responses.

To ensure theoretical consistency, the selected variables were structured according to the TOE framework. The technological dimension included variables related to the implementation and planned use of digital technologies (e.g., digital maps, chatbots, online booking systems, and mobile applications). The organisational dimension was captured through variables reflecting internal capacities, such as employee training, the availability of qualified personnel, and human resources-related barriers. The environmental dimension reflected external factors, particularly visitor demand, feedback on digital services, and perceived trends in digital technologies (e.g., AI, AR/VR, and data security), representing broader developments in the tourism environment. This structuring of variables enabled the interpretation of cluster results within a theoretically grounded TOE framework.

Euclidean distance was used as the metric, as it is appropriate for interval data. The results were visualised using a dendrogram in SPSS, and a three-cluster solution was selected based on a marked increase in linkage distance, indicating the most appropriate cluster structure.

To examine relationships between the implementation of digital technologies and the perceived benefits of digitalisation, the chi-square test of independence was used.

Descriptive statistics were used to identify the main trends in the responses, providing an overview of the most frequently reported services, technologies implemented, perceived benefits, and challenges of digitalisation in TICs.

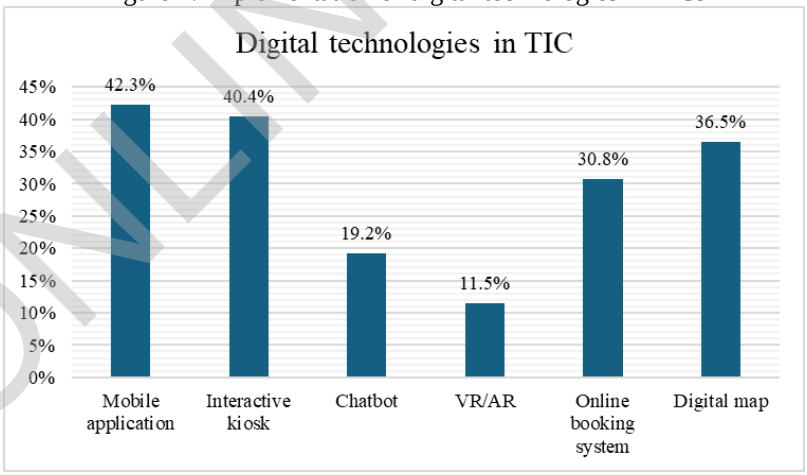
## 4. Results and discussion

The analysis is based on data from 52 TICs: 44 traditional TICs in resort destinations, 7 city information centres, and 1 visitor centre, typically located near a transport hub.

TICs in Slovakia primarily provide essential informational services. All surveyed centres (n=52) offer information about tourist attractions, events, and activities. A significant number also engage in commercial activities, such as selling souvenirs and regional products (n=45; 86.5%) and tickets for events, attractions, or public transport (n=39; 75.0%). However, digital services such as mobile applications and online booking systems are available in just over half of the centres (n=28; 53.8%), suggesting moderate adoption of digital tools. Guide services are the least commonly offered, available at only 13.5% of TICs (n=7). Overall, the results indicate that TICs mainly focus on traditional information provision and retail activities, while more specialised services and digital tools are less widely implemented.

The findings indicate that TICs in Slovakia are gradually implementing digital services, but the level of digitalisation remains uneven. As Figure 1 shows, basic tools dominate, while more advanced technologies are less widespread. This suggests that TICs still mainly fulfil their traditional informational role, with limited use of digital technologies for personalisation.

Figure 1: Implementation of digital technologies in TICs




Source: Authors' research

Regarding the evaluation of digital technology implementation, TICs generally perceive the process positively; however, outcomes remain only partially successful. Table 1 shows that many centres report operational improvements while highlighting challenges in infrastructure, adaptation, and user engagement. A notable share of TICs has not yet

implemented digital technologies but plans to do so, indicating further development potential and the need for targeted support.

Table 1: Evaluation of the implementation of digital technologies in TICs

| Evaluation | Abs. | Rel. |
|---|---|---|
| Very successful | 1.0 | 1.9 |
| Successful, but some aspects still need improvement | 21.0 | 40.4 |
| Moderately successful, we still face many challenges | 16.0 | 30.8 |
| Unsuccessful, technologies were not adequately accepted | 1.0 | 1.9 |
| Technologies have not been implemented, but are planned | 11.0 | 21.2 |
| Technologies have not been implemented and are not planned | 2.0 | 3.8 |
| Total | 52.0 | 100.0 |

Source: Authors' research

In terms of perceived impacts, TICs primarily associate digital technologies with improved operational efficiency and information accessibility, suggesting that digitalisation reinforces their core informational function.

Digital technologies contribute to more efficient operations, for example, by reducing waiting times and facilitating service delivery. As shown in Table 2, improved access to information is the most frequently perceived benefit, while personalised recommendations and immersive experiences are less common, likely due to the limited adoption of more advanced technologies. TICs also do not associate digitalisation with increased visitor autonomy, suggesting limited implementation of self-service solutions.

Table 2: Benefits of implementing digital technologies in TICs

| Benefits | Abs. | Rel. |
|---|---|---|
| Improved access to information | 39.0 | 75.0 |
| Shorter waiting times | 19.0 | 36.5 |
| Personalised recommendations | 8.0 | 15.4 |
| A more immersive destination experience | 9.0 | 17.3 |

Source: Authors' research

The variability in digitalisation across TICs indicates diverse approaches to digital transformation. To capture this heterogeneity, hierarchical cluster analysis using Ward's method was applied to indicators related to services, technologies, perceived benefits, and planned innovations. The dendrogram indicated a three-cluster solution, with a marked increase in linkage distance; cluster 2 was the largest group, followed by clusters 1 and 3 (Table 3). The robustness of the cluster solution was supported by the clear separation of clusters in the dendrogram and the interpretability of the resulting groups. In addition, the identified clusters showed internally consistent patterns across the analysed variables.

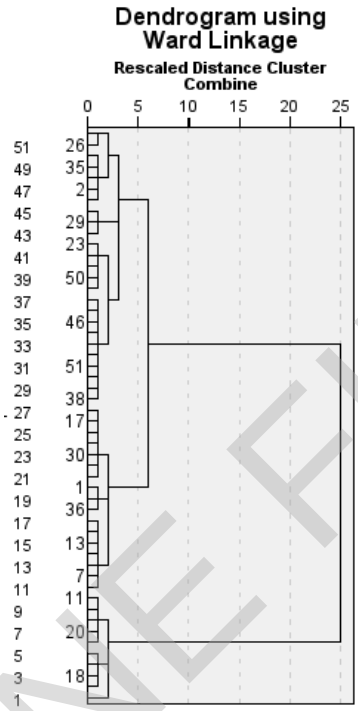
Table 3: Distribution of TICs into clusters according to the agglomeration plan

| Cluster | Abs | Rel. |
|---|---|---|
| 1 | 17.0 | 32.7 |
| 2 | 25.0 | 48.1 |
| 3 | 10.0 | 19.2 |
| Total | 52.0 | 100.0 |

Source: Authors' research

Figure 2 illustrates the dendrogram from the hierarchical cluster analysis. The division was determined based on a sudden increase in the rescaled distance in the agglomeration plan between phases 50 and 51, indicating that the three-cluster solution best represents the data structure.

Figure 2: Dendrogram of hierarchical cluster analysis of TICs




Source: Authors' research

Cluster 1 includes TICs that, in addition to providing information services, also offer a wide range of additional services, such as the sale of souvenirs (94.1%) and tickets (82.4%). These centres have also significantly implemented digital tools and technologies into their operations. This group includes 17 TICs (32.7%), of which 82.4% use digital maps and 47.1% have implemented a chatbot. All TICs in this cluster consider improved visitor access to information the most significant benefit of digitalisation. More than a third of the centres plan to introduce augmented reality (AR) for tourist tours in the future, and approximately 18% intend to use predictive analytics to provide personalised recommendations based on visitors' preferences. This cluster represents digitally advanced centres, so-called "digital leaders", who emphasise technological innovation, a personalised approach, and the speed and quality of their services.

From the TOE framework perspective, these TICs achieve a high level of technological maturity, as reflected in the broad adoption of both basic and more advanced digital tools. This level of digitalisation also indicates sufficient internal capacity and the ability to respond to external factors, including evolving visitor expectations and differences in local tourism development.

Cluster 2 comprises 25 traditional TICs (48.1%) with selected digital elements. This is the largest cluster, characterised by a moderate level of digitalisation. More than half of these

centres use interactive kiosks and mobile applications. Only 20% of centres use digital maps, while advanced technologies such as chatbots are implemented only in exceptional cases (8%). These are the so-called "digital followers" who are gradually implementing basic digital services, but not technologically complex ones. The perception of benefits is present but less pronounced than in cluster 1.

From the TOE framework perspective, these TICs achieve a moderate level of technological maturity, reflected primarily in the implementation of basic digital tools. This level of digitalisation also indicates more limited internal capacities and a more gradual approach to implementing innovations. At the same time, it points to a rather reactive ability to respond to external factors, such as changing visitor expectations and differences in local tourism development.

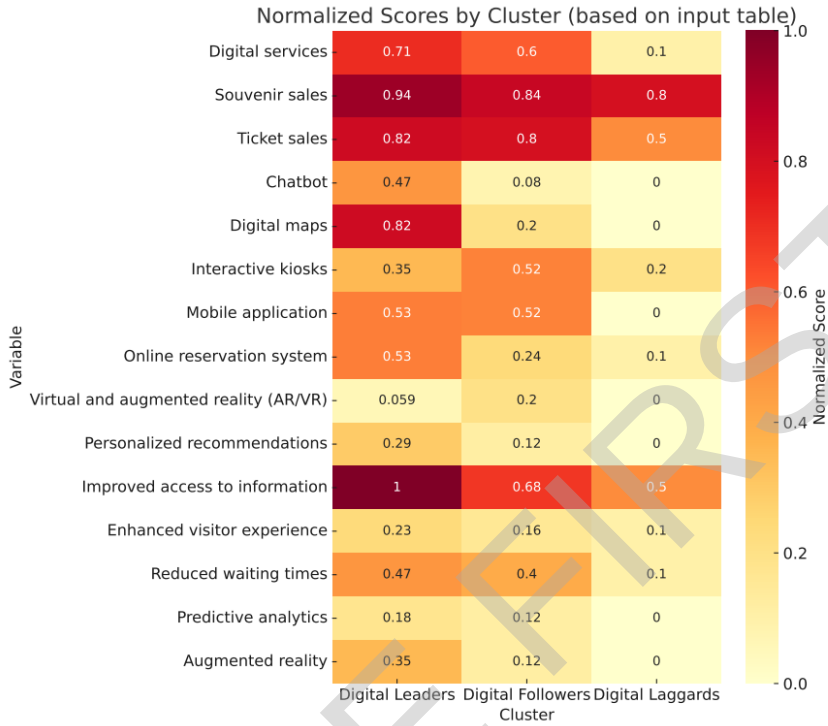
Cluster 3 comprises 10 TICs (19.2%) that exhibit minimal digital transformation. The normalised values are close to zero for most variables, indicating that these TICs use almost no digital tools. The digital solutions represented are mainly interactive kiosks (20%) and, in rare cases, online booking systems (10%). More advanced technologies are absent in this group. This group represents the so-called "digital laggards", i.e., centres that are likely to be smaller, operate in less developed or peripheral areas, and face limited financial, human, or technical capacities. These factors can significantly limit their ability to implement innovative solutions, despite the potential benefits that digitalisation brings to the tourism sector. Their focus remains on basic information and guide services, with modernisation and streamlining of operations through digital tools not yet a priority.

Within the TOE framework, these TICs exhibit low technological maturity, as evidenced by limited adoption of digital tools. This level of digitalisation also indicates limited internal capacity and lower readiness to implement innovations. At the same time, it points to less favourable external conditions, including lower visitor demand and the level of tourism development in the destination, which may constrain their ability to respond to digital transformation trends.

The results of the cluster analysis indicate significant heterogeneity in the level of digital transformation across TICs, reflecting differences in technological capabilities, organisational readiness, and external conditions. From a TOE perspective, the identified clusters can be interpreted as reflecting differences across the technological, organisational, and environmental dimensions. Digital leaders demonstrate higher levels of adoption of digital technologies and greater internal readiness to implement these tools. In contrast, digital laggards remain more focused on traditional service provision and exhibit lower levels of digital engagement. These differences suggest that digital transformation in TICs is shaped not only by the availability of technologies but also by internal capacities and the extent to which TICs respond to changing visitor expectations.

Figure 3 presents the heat map of selected services, digital technologies, perceived benefits, and planned innovations across the three TIC clusters. It shows the normalised percentage shares of TICs across individual variables, highlighting distinct patterns of digitalisation. The colour scale represents intensity: the richer the colour, the higher the share of TICs in each cluster.

Figure 3: Heat map of normalised levels of selected services, digital technologies, perceived benefits, and planned innovations in identified TIC clusters in Slovakia




Source: Authors' research

The low level of digitalisation in cluster 3 may limit the benefits achieved. Table 4 summarises the chi-square results, showing significant relationships between selected technologies and perceived benefits. Online booking systems are associated with reduced waiting times ($\chi^2 = 8.432$; $p = 0.004$), while VR/AR is linked to improved visitor experience ($\chi^2 = 7.976$; $p = 0.005$). In contrast, interactive kiosks and chatbots showed no significant relationships with selected benefits, possibly due to their limited use or implementation. These findings suggest that digital technologies generate different levels of benefits, highlighting the need for their targeted implementation and reinforcing the role of the technological dimension within the TOE framework.

Table 4: Relationships between implemented digital technologies and perceived benefits in TICs (chi-square)

| **Variable A** | **Variable B** | **$\chi^2$** | **P-value** | **Degrees of freedom** |
|---|---|---|---|---|
| Online booking system | Reduced waiting times | 8.432 | 0.004 | 1 |
| VR/AR | Improved experience | 7.976 | 0.005 | 1 |
| Interactive kiosks | Improved access to information | 0.240 | 0.624 | 1 |
| Chatbot | Personalised recommendations | 0.879 | 0.348 | 1 |

Source: Authors' research

Following on from the findings of the chi-square tests and previous analyses, Table 5 presents the main challenges TICs face when implementing digital technologies. It shows that high initial costs are the most frequently reported barrier. In terms of demand engagement, TICs report a lack of visitor interest (19.2%), which can affect the effectiveness of implemented technologies. Dependence on visitor interaction with innovations such as VR/AR means these systems may not be exploited if user interest is insufficient. Personnel and training challenges, including employee resistance (11.5%) and insufficient training (34.6%), can also affect the success of digitalisation. If employees are not prepared or willing to adapt to new technologies, the benefits of the implemented systems are reduced. Technological and security challenges are most closely associated with cyber threats and personal data protection (13.5%), both of which are critical factors in implementing online systems that process sensitive data. In addition, the lack of qualified technology management professionals (28.8%) and problems with integrating new technologies into existing systems (21.2%) point to further barriers that can slow down the effective deployment and long-term sustainability of digital solutions in TICs. These challenges can be interpreted through the TOE framework, where financial and technological constraints relate to the technological dimension, personnel and training issues correspond to the organisational dimension, and demand-related factors reflect the environmental dimension. This indicates that addressing organisational and human resource factors is essential for the successful implementation of digital technologies in TICs. This further suggests that technological investments alone are insufficient without parallel development of organisational capabilities.

Table 5: Challenges in implementing TICs

| Area of challenges | Challenge | Abs. | Rel. |
|---|---|---|---|
| Financial and investment | High initial costs | 34.0 | 65.4 |
| Demand engagement | Lack of interest from visitors | 10.0 | 19.2 |
| Personnel and training | Resistance from employees | 6.0 | 11.5 |
| | Lack of training for employees | 18.0 | 34.6 |
| Technology and security | Cybersecurity threats and personal data protection | 7.0 | 13.5 |
| | Lack of qualified experts for technology management and maintenance | 15.0 | 28.8 |
| | Problems with integrating new technologies into existing systems | 11.0 | 21.2 |

Source: Authors' research

Given the challenges identified, the successful digital transformation of TICs in Slovakia needs to focus primarily on improving the user experience, creating partnerships with technology organisations and experts, continuously training employees in digital tools and technologies, and prioritising the sustainability and environmental aspects of technologies.

The results of the analysis confirm significant heterogeneity in the level of digital transformation across TICs in Slovakia, aligning with international findings. Diversity in TICs' digital readiness is not a new phenomenon. More than a decade ago, D'Ambra and Mistilis (2010) noted differences in information centres' ability to respond flexibly to the changing needs of visitors.

Digital leaders, as the first identified group, tend to use modern digital tools, confirming the trend towards personalisation and deepening the destination experience. This aligns with the findings of Cuomo et al. (2021), who emphasise the importance of co-creating experiences and leveraging big data in designing tourism services. In contrast, the group of digital

laggards confirms the limitations identified in the literature, in particular, limited funding, a lack of employee skills, and lower visitor interest (Leung, 2019).

A comparison of policies and strategies at the national and international levels reveals different models of digitalising TICs, highlighting their close connection to the barriers identified in practice. The VisitScotland (2024) approach, which radically replaces brick-and-mortar TICs with digital platforms, demonstrates a high level of technological sophistication and political support for digitalisation. However, this model also carries risks related to the inclusiveness and accessibility of services for less digitally savvy users, which is consistent with Leung's (2019) findings on the uneven implementation of digital tools. In contrast, the concept of smart destinations within the European Union (European Commission, 2022; European Commission, 2023) emphasises the need to link physical and digital services, addressing the barriers to digital inclusion while promoting a hybrid model of information access in tourism.

Strategic frameworks confirm that the challenges of the digitalisation of TICs identified in the Slovak context, in particular high initial investments, limited professional capacities, and a lack of interest among some visitors, are not isolated problems but reflect broader European trends. Similar results are reported by the European Commission (2022), which emphasises that the lack of training and qualified staff is one of the most significant constraints to the successful implementation of digital solutions. Similarly, Kalbaska et al. (2017) point to the importance of strengthening digital competencies and e-governance skills among tourism stakeholders, which are essential for the effective implementation of digital and inclusive services.

On the other hand, the main benefit of digitalisation from the TICs perspective is improved access to information, as confirmed by the majority of the sample. Digital information channels thus strengthen the interpretive and educational functions of TICs, thereby enhancing the quality of services provided and the complexity of the visitor experience. This reinforces TICs' role as key intermediaries in the digital tourism ecosystem.

## 5. Conclusion

The study highlights the significant heterogeneity in the digital transformation of TICs in Slovakia and underscores the need for a differentiated approach to their support. Digital leaders exemplify good practice, effectively using modern digital technologies to personalise services and enhance the visitor experience, underscoring the importance of digitalisation for improving service quality. Conversely, digital followers and laggards face multiple barriers and therefore require systematic support to implement digital tools and develop employee competencies.

Successful TIC digitalisation is a key tool not only for improving the visitor experience but also for supporting effective destination management. Digitalisation enables strategic decision-making, optimises marketing and communication strategies, and manages visitor flows more effectively. The integration of modern digital technologies with traditional TIC services creates a synergistic effect that is essential for sustainable and inclusive tourism development. For this reason, it is necessary to include TIC digitalisation in standardised frameworks at the national level. The current Methodological Guide for Tourist Information Centres (AICES, 2018) does not adequately account for digitalisation, which limits the possibilities for the systematic development of TICs and the strengthening of employees' digital skills. Based on the identified barriers and experience from international strategies, it is recommended to update it and complement it with practical guidelines on selecting technologies according to TIC capacity, instructions for integrating interactive kiosks,

chatbots, and mobile applications into everyday operations, and case studies of successful TIC digital services. Public funding should prioritise investments in tools that directly improve visitor access to information, engagement, and experience, while ensuring that staff training programs are in place to maximise the utility of these technologies. TICs could establish partnerships with universities, tech companies, or regional innovation hubs to facilitate knowledge transfer and technical support. In addition, standardised methods should be implemented to monitor the effectiveness of digital solutions, for example through visitor satisfaction surveys or usage analytics, so that the benefits of digitalisation can be clearly measured and compared across centres. Such a comprehensive approach will not only minimise differences between individual TICs but also create an inclusive and adaptable system of services that responds to the changing needs of visitors and supports the long-term and sustainable development of Slovak tourism.

From a theoretical perspective, the study extends the application of the TOE framework to the context of TICs, which remain underexplored in the literature. By linking empirically identified clusters of digital maturity with the TOE dimensions, the findings provide a more nuanced understanding of how technological, organisational, and environmental factors jointly shape digital transformation in TICs. These findings are also relevant for destination managers and policymakers, as they enable a targeted approach to supporting digitalisation and developing employee competencies in TICs, particularly given their public funding. For example, digital leaders can serve as demonstration sites for training and mentoring other TICs. In contrast, digital followers could adopt stepwise implementation strategies, focusing first on core tools such as online booking or digital maps before moving to AR/VR experiences.

This study has several limitations. It places a stronger emphasis on the technological dimension of the TOE framework, while organisational and environmental aspects are captured to a lesser extent. In addition, data were collected cross-sectionally, providing a snapshot of the current level of digitalisation in Slovak TICs without capturing changes over time. Future research should adopt longitudinal approaches, incorporate organisational and environmental dimensions, and consider international comparisons to identify best practices and inform standardised frameworks for TIC digitalisation.

## CRediT author statement

**Kristína Pančíková:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Norbert Beták:** Conceptualization, Methodology, Validation, Formal analysis, Writing – review & editing. **Daniela Matušíková:** Supervision, Methodology, Validation, Writing – review & editing. **Tünde Dzurov Vargová:** Investigation, Data curation, Visualization, Writing – review & editing.

## Declaration of generative AI in the writing process

During the preparation of this work the authors did not use generative AI and AI-assisted technologies in the writing process.

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## Conflict of interest

The authors declare no conflict of interest.

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