DIGITAL TECHNOLOGIES AND ICT TOOLS AS ENABLERS OF LEARNING AND INNOVATION IN THE SME SECTOR

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ABSTRACT
This paper explores the relationship between the level of digital maturity and innovation of SMEs in Bosnia and Herzegovina, with a particular focus on the role of ICT as one of the drivers of innovation within the enterprise. Based on data collected from 304 enterprises from different sectors, a composite ICT index was created that quantifies the level of digital maturity of enterprises, as well as an innovation index that measures their activities in the field of innovation. Using descriptive statistics, sectoral segmentation, and K-means cluster analysis, the paper identifies significant differences in the level of digitalization between sectors, and also companies a positive relationship between a higher ICT index and greater innovation. The results show that enterprises with a higher level of digital maturity also achieve a higher level of innovation, while enterprises with a lower ICT index show a lower propensity to innovate. Based on the analysis, three clusters were formed that clearly distinguish enterprise profiles according to digital-innovation behavior. Furthermore, the findings of this research provide an empirical basis for the development of a targeted policy to support the digital transformation of sectoral SMEs, while identifying sectors with the lowest digital capacities as priorities for government intervention. The results obtained should be viewed with caution due to the subjectivity of the respondents' responses. As a practical suggestion, vouchers for digital tools and reskilling programs for the construction and hospitality sectors could accelerate the digital literacy of these companies. The paper aims to contribute to the understanding of the relationship between digital technologies and the innovation capabilities of enterprises in a transitional economic context.

Keywords: *Digital maturity, ICT index, Innovation, SMEs, Cluster analysis, Small and medium-sized enterprises*

JEL classification: *O33, L26, M15*

1. INTRODUCTION

In the modern business environment, which is characterized by accelerated technological development, many small and medium-sized enterprises are faced with various challenges, but also with the opportunities brought by digital transformation. ICT tools today do not only represent operational support, but are also a strategic resource that can stimulate innovation, improve communication, and facilitate learning within the organization. However, in the context of developing countries, to which Bosnia and Herzegovina belongs, the question remains to what extent these technologies are truly integrated into the practice of SMEs and

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whether they bring concrete business benefits. Within the current literature, SMEs are recognized as a particularly sensitive but key part of the economy, which often has limited resources for implementing the digital transformation process. However, even partial digitalization of SMEs, which includes tools such as CRM systems, online communication, and informal sources of knowledge, can have a positive impact on the competitiveness of enterprises.

Precisely for this reason, the aim of this research is to examine the patterns of use of ICT tools in SMEs in Bosnia and Herzegovina, as well as their connection with innovation and organizational capacities. The focus is also placed on identifying the so-called "digital performance gap", where ICT investments do not lead to the expected results due to weak internal capacities or lack of support. The sample includes 304 companies from different sectors, and the collected data enabled the construction of an ICT index that quantifies the level of achieved digital sophistication. The findings show a positive correlation between the ICT index and the presence of innovation within the company, with companies that generate higher values developing new products and services more often. In addition, the cluster analysis identified three types of companies: digitally passive, highly innovative, and digitally advanced. It is noticeable that sectoral differences are pronounced, with sectors such as information and communications leading the way, while construction and part of the manufacturing industry lag behind, which together highlight the need for differentiated approaches in policies to support the digitalization of companies. The theoretical basis, methodological framework, key findings, and recommendations are presented below.

Recent studies confirm that digital transformation has become a crucial determinant of SME competitiveness across both developed and developing economies. According to the European Commission (2024) and OECD (2023) reports, digital tools enable knowledge diffusion and innovation scaling among SMEs. Similarly, Kraus *et al*. (2022) and Scuotto *et al*. (2023) highlight that SMEs in emerging markets face a persistent digital gap that limits their ability to exploit learning and innovation opportunities through ICT adoption.

1.1. Research problem

Although the importance of digital transformation in developing countries, such as Bosnia and Herzegovina, is very important for increasing productivity within companies, it remains an open question whether the application of digital technologies in SMEs brings concrete and measurable organizational benefits. Although digitalization is often perceived as an inevitable and positive process, empirical findings on its impact on innovation, productivity, and knowledge exchange are limited and often contradictory. Many companies invest in ICT tools, but such investments do not automatically guarantee a higher level of innovation, nor better internal communication. This phenomenon, known as the “digital performance gap”, indicates the difference between the technical presence of digital solutions and their actual usability in practice. In addition, the application of ICT varies by sector, with the IT sector leading the way in digitalization, while traditional industries lag behind. However, differences also exist between companies within the same sector, indicating that organizational culture, knowledge, and access to resources play a key role.

In this context, the central research question is: "To what extent does the use of digital technologies in SMEs in Bosnia and Herzegovina contribute to innovation, knowledge exchange, and organizational learning? In accordance with the central research question, additional questions arise:

- Do companies with higher ICT intensity have a higher level of innovation?

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- Can a digitally advanced type of company be distinguished?
- Are there any sectoral differences in the use of digital tools?
- Does informal and accessible digital knowledge, such as YouTube, Google, etc., have an impact on productivity growth?

The answers to these questions form the basis for setting hypotheses and empirical analysis aimed at better understanding the real contribution of digitalization to business processes in SMEs in Bosnia and Herzegovina.

1.2. Research objectives

The main objective of this research is to examine how the level of digital sophistication of SMEs in Bosnia and Herzegovina affects their ability to innovate, learn, and adapt to rapid change. Digital sophistication was measured through an ICT index that includes the use of key digital tools, while innovation was analyzed through new or improved products, services, and communication. Organizational learning was also observed through access to informal digital sources of knowledge and openness to change.

Specific objectives include:

1. Construction of an ICT index to measure the intensity of use of digital tools in business.
2. Analysis of the relationship between ICT intensity and the level of innovation in enterprises.
3. Assessment of the impact of informal digital sources of knowledge on the perception of productivity and agility.
4. Identification of sectoral differences in the degree of digitalization, as well as by enterprise size.
5. Segmentation of enterprises through cluster analysis to recognize different types of digital practices.
6. Formulation of recommendations for SME support policies based on actual patterns of ICT use.

1.3. Research questions

Based on the set objectives, this research addresses the following key research questions:

1. To what extent do small and medium-sized enterprises in Bosnia and Herzegovina use digital technologies and ICT tools in their daily business operations?
2. Is there a connection between the intensity of use of ICT tools and the degree of innovation of companies?
3. Does access to and use of informal digital sources of knowledge have a positive impact on the perceived productivity and flexibility of employees?
4. How do patterns of use of digital tools differ by industry sector and company size?
5. Can recognizable types of companies be identified based on the level of digital sophistication and innovation capacity?

1.4. Hypotheses

Based on the previously stated research problem, objectives and questions, the following working hypotheses were formulated and tested using quantitative statistical methods:

- Hypothesis H1 - There is a positive and statistically significant relationship between the level of digital maturity measured by the ICT index and innovation performance in SMEs.
- Hypothesis H2 - The intensity of ICT tool usage differs significantly across industrial sectors, reflecting contextual and structural disparities.

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- Hypothesis H3 - SMEs can be categorised into distinct digital-innovation profiles based on their ICT maturity and innovation outcomes.

2. LITERATURE REVIEW

As part of the literature review related to this topic, several papers specifically discuss the importance of digital technologies and ICT tools as factors that encourage innovation within small and medium-sized enterprises. As part of the study, Požgaj and Vlahović investigated how Web 2.0 technologies (e.g., social networks, wikis, video-sharing platforms) facilitate informal learning. The poll was conducted at Zagreb's Faculty of Economics and Business and asked students about their sentiments towards platforms, including blogs and video-sharing sites. Web 2.0 promotes interaction, knowledge co-creation, and peer-to-peer interchange, leading to ongoing and user-driven learning outside conventional classrooms, according to the authors. The results demonstrate a substantial student preference for such technologies, making them almost ideal for lifelong informal learning. The study suggests that small and medium-sized enterprises (SMEs) may use Web 2.0 to share information and improve skills internally (Požgaj and Vlahović, 2011).

In another article, it is described how digital platforms sponsored by the EU operate as "digital ecosystems" to empower SMEs. The authors use biological ecosystem analogies to describe how open-source Web-2.0 infrastructures, such as DBE/OPAALS initiatives, improve interoperability, reduce costs, and promote innovation in SME networks. The digital infrastructure enables distributed software composition, evolutionary self-organization, and collaborative problem solving, resulting in scalable settings for SMEs to collaborate and compete. The significance of open standards and co-evolutionary interactions among participating enterprises is highlighted (Briscoe and Stanley, 2010).

In the other study, it is explored how Web 2.0 technologies, such as wikis, blogs, and social media, encourage knowledge exchange among Malaysian university students. According to a poll of 287 people, essential elements that increase participation with digital technologies include awareness, simplicity of use, infrastructure, and collaborative norms. The study indicates that effective knowledge-sharing ecosystems need a supportive culture, user-friendly platforms, and institutional awareness initiatives. While the study focused on education, the conclusions are applicable to SMEs: effective ICT adoption is dependent not just on technology availability, but also on organizational culture and support (Usman and Oyefolahan 2014).

When it comes to digital maturity of SMEs, it has been receiving increasing attention in various empirical studies as it has been shown to be a key factor between technological infrastructure and innovation performance of firms. For example, Bánhidi and Dobos (2025) developed the SME-DMI, which is presented as an entropy digital maturity index, designed for SMEs in Hungary, which includes tools, infrastructure and digital skills. Jie *et al*. (2025) investigate in their work how digital maturity in high-tech SMEs drives the level of innovative activities of firms. If we look at the industrial context, Krulčić (2025) developed a DAMA-AHP model for assessing digital maturity specifically adapted to SMEs, highlighting the challenge of expanding business capacities in relation to the targeted level of digitalization.

Other authors conducted a study to examine how ICT use influences competitiveness, innovation, and environmental consequences in the glass, ceramics, and cement concrete sectors. Using quantitative data and case studies, the authors show that ICT adoption considerably improves innovation capability and market competitiveness. Examples include

improved process management, product creation, and market response. Notably, the study considers environmental impacts: although some ICT applications cut emissions through optimised processes, others may unwittingly raise them due to increased energy use. The study suggests that while ICT is a strong engine of innovation and competitiveness, enterprises must consider environmental trade-offs while integrating digital technology (Ollo-López and Aramendia-Muneta, 2012).

Other research uses Rogers' diffusion of innovation theory to investigate how Internet use affects innovative attitudes and behaviours in 150 families in Xanthi, Greece. Key findings reveal that younger people and those with a higher degree of education have bigger information requirements and utilise the Internet more often. These users are more open to innovation, educated decision-making, and scientific perspectives. The study found that socioeconomic characteristics, personality traits, and communication behaviour all had a substantial impact on Internet adoption and innovation propensity. While the focus is on homes, the results give indirect insight into SMEs, where comparable demographic and behavioural determinants might support ICT-enabled innovation (Chatzoglou and Vraimaki, 2010).

Based on a 2010 survey of nearly 4,000 UK Open University students, this study investigates age-related digital technology access, attitudes, and study practices. Almost all respondents had access to a computer and the Internet; however, younger people used technology more often and were more positive about digital tools. However, there was no clear generational gap around the age of 30, which calls into question "net generation" ideas. Notably, older learners preferred deep and purposeful study approaches over superficial engagement with knowledge. Positive attitudes towards digital technology were linked to deeper learning techniques and improved academic approaches across all ages (Jelfs and Richardson, 2013).

On the other hand, another research looks into the role of e-marketplace platforms (centralised online marketplaces) in allowing Saudi SMEs to embrace e-commerce. The survey results from 157 SMEs show that technology infrastructure, organisational preparedness, and external assistance (e.g., legislation, training) are significant factors of successful adoption. Many SMEs reported a lack of knowledge, technical expertise, and trust as the primary impediments. The authors contend that e-mall platforms can reduce entrance barriers by offering common infrastructure, marketing reach, and streamlined payment/logistics systems. The study's model explains 62% of the variation in adoption intent, highlighting the need to support policies and information resources. Insights are important for SMEs worldwide, especially in Bosnia and Herzegovina, since they demonstrate how organised digital environments can drive adoption and innovation (Bahaddad *et al*., 2012).

The purpose of another study is to look at how Malaysian manufacturing SMEs employ virtual R&D cooperation. According to the authors' findings from 163 survey responses, trust, communication quality, and IT infrastructure all have a major impact on the performance of virtual R&D teams. Companies that use tools such as video conferencing, document sharing, and project management platforms report increased innovation output, faster time-to-market, and cost savings. Cultural elements, including openness and top management, contribute to improved cooperation outcomes. The essay provides significant insight into how SMEs with minimal R&D resources may harness ICT technologies to form virtual innovation networks. This makes it particularly relevant for SMEs in Bosnia and Herzegovina striving to innovate through lean digital collaboration (Ale Ebrahim *et al*., 2012).

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Additionally, it is important to emphasize that research focused on the determinants of digital transformation in SMEs shows a complex set of factors from the technological and organizational domains. Omrani *et al*. (2023) use the T-O-E framework and quantitative methods on a large sample of SMEs to identify key drivers of digital technology adoption, given that digital infrastructure and existing innovativeness of the company have proven to be strong predictors of progress. Also, Ladu *et al*. (2024) in their work study the alignment of regulations as an institutional context and its impact on digital maturity, emphasizing in particular that the regulatory environment can slow down adoption even when technologies are available. Consequently, Tarutė *et al*. (2024) in their work on the digital orientation of SMEs emphasize that organizational culture and innovation orientation of the company interact with each other, but also condition the success of digitalization, especially in stressful circumstances such as pandemics.

Haseeb studies how ICT management techniques impact organisational innovation in Pakistani manufacturing enterprises (n = 210). Using structural equation modelling, the article demonstrates that strategic ICT planning, IT infrastructure maturity, continual staff training, and committed ICT leadership all have a favourable impact on innovation outcomes—both product and process. Companies with more ICT maturity claim better information exchange, faster decision-making, and increased R&D efficiency. The report suggests holistic ICT governance frameworks and capacity-building, which are especially important for SMEs looking to systematically incorporate innovation using ICT technologies (Haseeb, 2015).

3. METHODOLOGY

The research in this paper is based on a quantitative approach to examine the relationship between digital maturity and innovation of small and medium-sized enterprises in Bosnia and Herzegovina. Data were collected through a structured questionnaire during 2024, and after eliminating invalid responses, 304 companies from different sectors were included in the analysis.

In the process of constructing the ICT index, which includes 8 items, respondents rated the frequency of ICT tool use on a 5-point Likert scale. Items covered by this index are cloud services, collaboration platforms, CRM/ERP, e-invoicing/e-payments, cybersecurity practices, data analytics, website/e-commerce and digital document management. The innovation index includes binary/ordinal indicators of product, process, marketing, and organisational innovation in the last three years, and it is computed as the standardised mean.

The main independent variable is the ICT index, which is constructed by summing the scores on eight Likert-scale questions that assess the importance of digital tools in knowledge management. The maximum score is 40, and the reliability of the scale (Cronbach $\alpha = 0.84$) companies the internal consistency. The Innovation Index, Perception of the benefits of informal digital knowledge, and Sectoral affiliation of companies were used as dependent variables. Associations were assessed with Pearson and Spearman correlations with coefficients (r, ρ), 95% CIs, n, and p-values. Sectoral differences in the ICT index were tested using Kruskal–Wallis; we report H(df) and p, with Dunn–Bonferroni post-hoc comparisons where applicable. K-means clustering used z-standardised variables and was guided by elbow and silhouette diagnostics. The analysis consisted of three parts. First, a statistically significant positive relationship between ICT and the Innovation Index was confirmed through Pearson/Spearman correlation analysis. Second, the Kruskal-Wallis test identified differences in ICT indices across sectors, with the information and communication sector proving to be the

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most digitally mature. Third, K-means cluster analysis identified three types of companies: digitally passive, highly innovative, and digitally advanced.

It is important to emphasize that the research is limited by the self-assessment of respondents and the cross-sectional design, but it still provides valid insights into digital behaviors and can serve as a basis for creating a typology of SMEs according to the degree of digital maturity and innovation. The research was anonymous and voluntary, so no personal data was collected. It is important to emphasize that there was no need for formal ethical approval because it was anonymous survey research. Anonymized data and code are available from the authors upon reasonable request.

4. ANALYSIS OF RESULTS

This section presents the results of a quantitative analysis of the collected data, with the aim of testing the hypotheses and better understanding the role of digital technologies and ICT tools in the context of innovation and internal capacities of small and medium-sized enterprises in Bosnia and Herzegovina. This analysis is based on descriptive statistical indicators, correlations, comparisons between sectors, and cluster segmentation of the sample. Special focus is placed on the aggregated ICT index, which is a composite measure of the intensity of use of various digital tools and technologies in business, as well as on the innovation index, which is constructed based on self-assessment of the presence of new products, services, and processes. It is important to emphasize that at the beginning, the distribution of the ICT index among enterprises is considered as an indicator of general digital maturity, and then the connection of the ICT index with the level of innovation of enterprises, as well as differences in digital maturity between the sectors of activity from which the enterprises come, is examined. For sectors with $n < 20$, results are presented descriptively without inferential claims. Where feasible, small sectors were consolidated into broader industry groups to improve statistical power. Finally, a cluster analysis is conducted to identify recognizable patterns in the behavior and capacities of enterprises.

Table 1: ICT Summary

Statistic	Value
Number of Companies	304
Mean	31,75658
Standard Deviation	4,195702
Minimum	16
25th Percentile	29
Median	32
75th Percentile	35
Maximum	40

(Source: Author's creation)

In Figure 1, a histogram of the distribution of the ICT index is shown, which further strengthens the previously mentioned findings. In the above chart, it is clearly visible that most companies gravitate towards the mean values of the index, with a slight decrease in frequency at both ends of the spectrum. This distribution indicates a general technological balance among companies, while at the same time there is a smaller number of entities with high digital capacities, which could represent potential "locomotives" of digital transformation in the SME sector. Taking into account all the indicators shown, it can be concluded that the analyzed companies,

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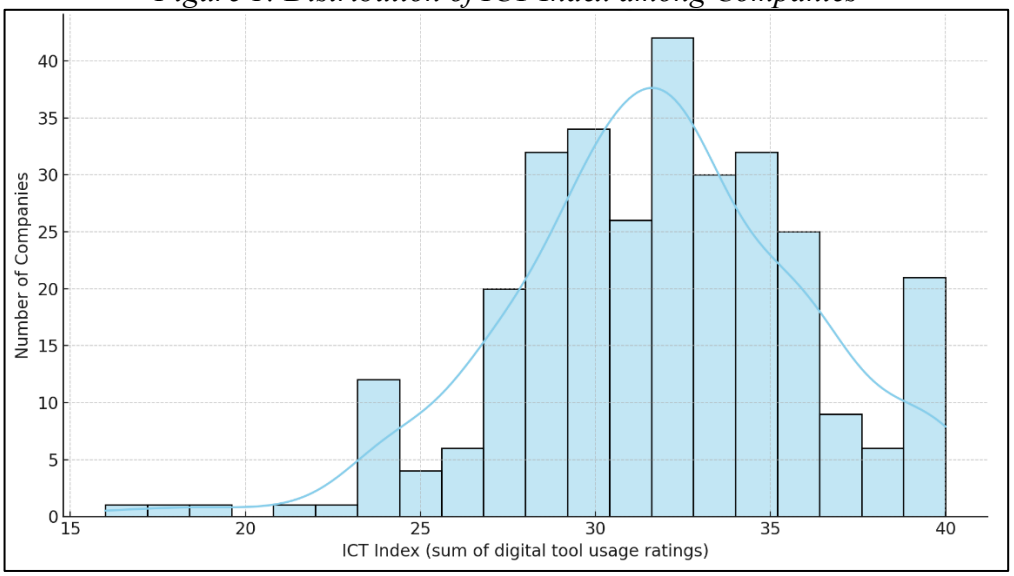
although on average they show a solid level of digital maturity, still have room for further development, which is especially important when considering the advantages that digital transformation can bring in terms of innovation, efficiency and competitiveness.

Figure 1: Distribution of ICT Index among Companies



(Source: Author's creation)

In order to better understand the level of digital maturity among companies, an analysis of the average ICT index by sectors from different industries was conducted. The results are presented in Table 2, where the values of the mean ICT score, standard deviations, and the number of companies included in the analysis are given for each sector. The results obtained show the present differences in the level of adoption and application of digital tools among sectors, although these differences are, on average, relatively moderate. The sectors showing the highest average ICT index are Real Estate (L) with a value of 34.5, then Health and Social Work (Q) with 34.17, and Information and Communication – ICT Services (J) with 32.86. These industries are characterized by a greater need for digital infrastructure solutions, automation and software support in everyday work, which may explain the higher level of integration of ICT tools. On the other hand, sectors such as Construction (F) with 29.5, Hotels and Accommodation (I) with 30.8, and Administrative and Support Activities (N) with 30.29, record lower ICT index values, indicating a lower level of digital transformation in these sectors. Special attention should be paid to the ICT services sector (J), which not only has one of the highest ICT indices, but also a relatively high number of companies in the sample (n=50), which allows for a more reliable interpretation of the results. Its average (32.86) further confirms that companies that develop or distribute digital solutions themselves are among the leaders in their use and can serve as a reference point for other sectors.

Table 2: Kruskal–Wallis test of ICT index across sectors, Dunn–Bonferroni post-hoc[1]

Sector	Number of Companies	Mean ICT Index	Standard Deviation
Activities of providing accommodation, and preparation and serving of food (Hotel and catering) (I)	5	30,80	1,788854

[1] Sectors with n<20 are reported descriptively; inferential comparisons are not interpreted.

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Administrative and support activities (N)	7	30,28	2,058663
Agriculture, fishing and forestry (A)	1	32,00	-
Arts, Entertainment and Recreation (R)	2	30,00	2,828427
Construction (F)	20	29,50	3,762698
Education (P)	3	31,00	5,567764
Financial and insurance activities (K)	23	32,17	4,030026
Health and social work (Q)	6	34,16	4,996666
Information and communication - ICT services (J)	50	32,86	4,463046
Manufacture (C)	43	31,27	3,737363
Mining and quarrying (B)	2	31,00	1,414214
Other service activities (S)	57	31,33	4,680252
Production and supply of electricity, gas and steam (D)	5	32,80	3,193744
Professional, scientific and scientific activities (M)	13	31,85	4,278749
Public administration and defence (O)	1	35,00	-
Real Estate Business (L)	4	34,50	1,290994
Transport and storage (H)	6	33,17	3,125167
Wholesale and retail trade (G)	56	31,82	4,390515

(Source: Author's creation)

Standard deviations in most sectors range from 3 to 5, which means that within the sector, there are companies with different levels of digital maturity. This is especially pronounced in sectors such as Other Service Activities (S) and Education (P), which tells us about the possible space for targeted improvements through sector strategies and digital education. Taking into account all the values presented, it can be concluded that sector affiliation to a certain extent affects the level of digital maturity, and that future digital transformation policies should be designed to take into account sector specificities and targeted investments, especially in industries with a below-average ICT index.

In order to better understand the structure of companies in terms of their digital maturity and innovation capacities, a cluster analysis was conducted, which grouped companies based on the value of the ICT and innovation index. The aim of the analysis was to identify typical patterns among companies and clear differences between previously formed groups. The results are shown in Table 3 and Figure 2.

As part of this part of analysis, three clusters of companies were identified, which differ significantly in terms of the average value of the ICT and innovation index:

- Cluster 0 includes 92 companies with the highest average ICT index of 36.27 and, at the same time, a solid average innovation index of 2.64. This group of companies is called *"digitally advanced"* - technologically advanced companies that are simultaneously inclined to innovate products, processes, or some other business models. The low standard deviation of the ICT index (2.27) indicates a consistently high level of digitalization within the group.

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- Cluster 1, with 126 companies, shows the highest average innovation index of 3.11, but also the lowest ICT index of 29.62, so this group can be characterized as *"highly innovative",* which indicates that innovation does not always have to be based on high digital sophistication, but can also rely on other sources, such as human capital, knowledge and creativity.
- Cluster 2, which includes 86 companies, has a low average innovation index (1.80) and ICT index (30.06), which indicates *"digitally passive"* companies, which show a lower level of digitalization and introduce innovations less often. This group of companies can represent a target population for digital and innovation incentive policies.

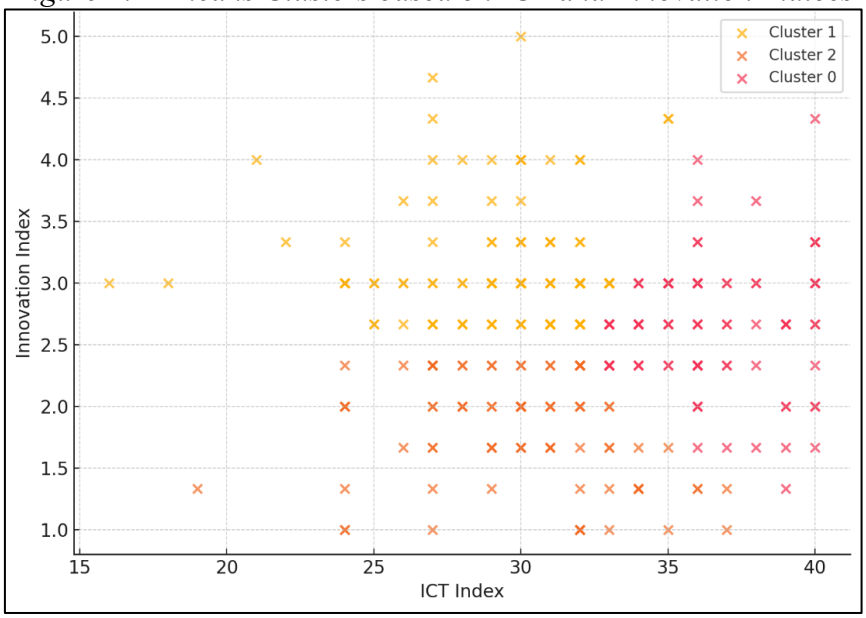
Table 3: Cluster profiles and validation metrics (means by cluster; silhouette, CH, within-cluster SSE)

Cluster	ICT Index - Mean	ICT Index - SD	ICT Index - N	Innovation Index - Mean	Innovation Index - SD	Innovation Index - N
0	36,27174	2,268287	92	2,644928	0,5083055	92
1	29,61905	3,121172	126	3,108466	0,4691920	126
2	30,05814	3,340851	86	1,798450	0,4406741	86

(Source: Author's creation)

The distribution shown in Figure 2 confirms these differences and indicates the spatial separation between clusters in two-dimensional space, further highlighting the clear polarization between companies that invest in digital tools and innovation at the same time, and those that lag behind on both grounds. In conclusion, the cluster analysis confirms that high digital maturity does not automatically guarantee high innovation, but also that clear patterns of behavior can be identified among companies that combine both elements.

Figure 2: K-means Clusters based on ICT and Innovation Indices



(Source: Author's creation)

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5. DISCUSSION

The obtained research results showed several key patterns that provide a better insight into the state and trends of digital maturity and innovation in small and medium-sized enterprises in Bosnia and Herzegovina. These results provide a better overview in the context of previously set goals and research questions, and testing the formulated hypotheses.

The first objective of the research was to quantitatively measure the level of use of information and communication technologies in the SME sector, through the construction of a composite ICT index. The results of the descriptive analysis showed that the average value of the ICT index was 31.76, on a scale of 0–40, with a standard deviation of 4.19. These values indicate that most companies have a moderate to high level of digital integration, considering the included indicators such as the use of computers and the Internet in everyday business, presence on social networks, online communication with clients, as well as internal organizational solutions based on digital tools. Furthermore, the data presented in Table 1 and Figure 1 illustrate an even distribution among companies, with a slight emphasis on higher values, thus confirming the existence of a certain foundation for further digital transformation. In this sense, it can be concluded that the first research objective has been partially achieved, given that the ICT index successfully quantifies the level of digital maturity, but at the same time differences in digital progress among companies are also revealed. Observed associations may be partly driven by unmeasured factors such as company size, management quality, workforce education, or industry competition.

When it comes to the sectoral analysis, shown in Table 2, significant differences between sectors were observed, which directly answers the second research question, which is whether and to what extent the sector of activity affects the digital maturity of companies. Namely, sectors such as information and communication technologies, healthcare, and real estate show above-average values of the ICT index, while construction, hospitality, and administrative support activities show significantly lower values. These results support Hypothesis H2, according to which the level of digital maturity differs significantly between sectors. Given that sectors with greater exposure to market competitive pressures and the need for sophisticated management, e.g., the ICT sector, financial activities, are also more digitally advanced, this further confirms the importance of contextual factors.

A particularly interesting insight emerges from the cluster analysis presented in Table 3 and Figure 2, which approached companies from a combined perspective of their digital maturity and innovative potential. Cluster 0, with the highest ICT index and a solid innovation index, represents the so-called “digitally advanced”. Their position confirms Hypothesis H1 that higher use of ICT tools is positively correlated with a higher probability of introducing innovations. However, this correlation is not perfect, since Cluster 1 contains companies with the highest average innovation index, but also the lowest ICT index, which indicates the existence of “analog innovators”, i.e., companies that innovate despite a limited technological environment. This result directly contributes to testing Hypothesis H3, according to which there is no strict dependence between digital maturity and innovativeness. The research shows that ICT can be a strong accelerator of innovation, but is not always a necessary condition, which indicates the existence of alternative paths to innovation, such as reliance on human capital, creative management methods, or traditional business models that are adapted to new market demands. The third identified cluster (Cluster 2), characterized by low values of both indices, represents enterprises that are both technologically and innovationally inert. This segment indicates the existence of deep barriers to the adoption of both ICT and innovation,

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suggesting the need for systematic institutional support, including subsidies, educational programs, and facilitated access to digital resources.

Considering all that has been shown, the research confirms that the first research objective has been fully achieved, while the second and third objectives have enabled the validation of two out of three hypotheses. The analysis also pointed out the limitations of previous approaches that rely exclusively on technological indicators, without insight into the actual creative and adaptive capacity of the company. A significant contribution of this research is reflected in the methodological approach that combines descriptive and exploratory statistics with cluster analysis, thus enabling a multi-layered insight into the ways of behavior within the SME sector. Also, the results indicate the need for personalized digital and innovation support policies that will not be linear, but differentiated in accordance with the specificities of the cluster and sector. The "analog innovators" cluster should be regarded as a preliminary typology. Future work should validate it through qualitative case studies in order to identify compensating capabilities that substitute for digital tools. In addition, the results can serve as a basis for the development of diagnostic tools intended for SMEs, which would enable self-assessment of their digital maturity and identification of obstacles to the introduction of innovations. In this context, a digital-innovation readiness index can be developed that would serve as a tool for decision-making at the company level, but also as an indicator for shaping public policies. In conclusion, although the research confirmed certain expected patterns of business behavior, such as the positive association between ICT and innovation, it also revealed important exceptions that indicate the complexity of the real business environment.

This study is subject to common-method bias risks, self-reporting, and a cross-sectional view. Sectoral inference is constrained by small *n* in multiple categories. Future work should combine administrative usage data with survey responses, expand sector coverage, and employ panel designs to track innovation outcomes.

6. CONCLUSIONS

The research conducted as part of this paper provided important insight into the level of digital maturity and innovation of small and medium-sized enterprises in Bosnia and Herzegovina, taking into account the use of information and communication technologies as a key driver of modernization and competitiveness. Through the construction of a composite ICT index, sectoral and cluster analysis, and the interconnection of digital maturity and innovation, results were obtained that have both theoretical and practical significance. Conclusions are necessarily limited by self-reported data, cross-sectional design and small sub-samples in several sectors.

First, the research showed that the majority of the observed enterprises use ICT tools to some extent in their daily business, with the average value of the ICT index being relatively high. However, there is evident variation among enterprises, both based on the sector of activity and their overall digital and innovation profile. Sectors such as information and communication services, healthcare and the financial sector lead in digital maturity, while sectors such as construction and hospitality are significantly below average. Secondly, through cluster analysis, three groups of companies were identified: digital leaders with strong ICT capacities and relatively high innovation scores, then analog innovators, who innovate without a strong digital infrastructure, and digitally-innovation-inert companies that lag behind in both aspects. It is precisely this segmentation that provides additional value in terms of creating targeted support measures, which is particularly important in the context of formulating public policies and digital transformation strategies. Thirdly, although a positive correlation is confirmed

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between the use of ICT tools and innovation, the results indicate that digital maturity is not the only or exclusive prerequisite for innovation. There are companies that, despite a low level of digitalization, demonstrate a high level of innovative behavior, which implies the need for a broader approach in understanding innovation factors, including human capital, managerial practices, organizational culture and market impulses.

Finally, the research results can serve as a basis for shaping future development interventions. The development of tools for self-assessment of the digital readiness of the SME sector, institutional support through financial and educational programs, as well as the establishment of sector-differentiated digital and innovation acceleration policies are recommended. The data also indicate the need for additional research that would include longitudinal analysis, qualitative insights, and broader geographical coverage. Policy-wise, under-digitised sectors could benefit from digital adoption vouchers thar are tied to demonstrable use, targeted reskilling bootcamps in data and cybersecurity for SMEs, and a self-assessment tool for SME digital readiness embedded in local business-support programs. In conclusion, although limited in scope and time frame, the research enabled the validation of key assumptions and opened the space for further scientific research and practical engagement in the field of digital transformation and innovation in the SME sector.

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