Innovation Digital Transformation: Challenges, Opportunities, and Inspirations for the Business Environment in Slovakia

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Abstract

Key processes associated with innovation and digital transformation in the business environment in Slovakia are closely tied to the implementation of EU strategies and programs, which address the challenges of the 21st century. The Digital Europe Program (2021–2027) is one of the first EU financial instruments aimed at bringing modern technologies closer to citizens and businesses. According to Angela Merkel, "Digitalization is the key to the future because it enables innovation and transformation in all areas of life," and it is one of the six pillars of the EU Recovery and Resilience Plan. Slovakia, as part of the EU, faces its own specific challenges and opportunities in the field of innovation management and digital transformation. On the one hand, there is significant potential, especially in the area of small and medium-sized enterprises, which constitute a vital part of the Slovak economy. On the other hand, Slovakia still lags behind the EU average in many key digitalization indicators, such as digital skills, the adoption of digital technologies, and access to innovative forms of financing. This underscores the need for stronger support for digitalization, not only from the state but also through European programs and initiatives. This article will explore how Slovakia is implementing global strategies and how these contribute to enhancing efficiency, productivity, and competitiveness.

Keywords: innovation, digital transformation, SMEs, Industry 4.0, business environment

JEL Classification: O31, O33, L26

1. Introduction

The world we live in today is changing at an extraordinary pace. Innovation has become the primary driving force of progress, transforming every aspect of our lives. Whether in healthcare, transportation, education, or information technology,

innovation is pushing the boundaries of what is possible and offering new solutions to the challenges we face as a society. Each innovation represents a step toward a better future, enabling us to use technologies that, just a few years ago, seemed like distant science fiction. Innovations involve the introduction of new products or services, new methods of production, the opening of new markets, or changes in organizational structure (Schumpeter, 1934),

Innovation can be understood as the practical implementation of new ideas into products, services, processes, systems, and social relations. It refers to the introduction of changes that are new to a society, business, or group. Generally, it is a process in which existing elements are combined in a new way in order to create something unique (Hrašková, 2008).

Innovation, as a concept, offers companies a way to navigate the rapidly evolving world of technology and discovery. Since innovation plays a crucial role in guiding companies toward a better future, it is essential to note that innovation concepts must be managed with care. Innovation management, in turn, requires a specific and strategic approach to effectively implement changes aimed at improvement. This process involves selecting from a range of feasible options—those that offer the highest potential for success (Matriano, 2021).

Adopting a strategic innovation perspective enables companies to view their entire business holistically, not just the products and processes that generate cash flow. The success of globally recognized companies often depends on innovation integrated with a comprehensive and systematic approach (Dogan, 2017).

It should be noted that the overall positive impact of innovation can be uncertain in the short term. Innovations may increase input costs and simultaneously lead to outcomes that only partially affect production—either positively or negatively. In many cases, the operating returns from production do not offset the higher investment costs. Such an inverse relationship has indeed been demonstrated through the technology index. One possible explanation for these findings may involve the spatial factor, which is an inherent component of innovation (Foltz and Lang, 2003).

Greater success with innovation is often associated with increased knowledge and efficiency. It should be noted, as previously mentioned, that no significant correlation was found between years of experience and farm profitability (Stefanides-Tauer, 1999).

However, in the long term, various factors intricately influence the relationship between innovation and farm profit. While innovations typically involve upfront costs, their benefits may not be realized until beyond the first year—benefits that are usually assessed through long-term profitability. This time lag can sometimes discourage farmers from adopting innovations. When innovations are adopted, annual reporting

may distort their outcomes. For instance, if an innovation incurs costs in the first year but results in increased profit in the second year, annual reports may show a decline in profit initially and a rise in revenue only later, as the expenses and returns fall into different accounting periods. Therefore, the implementation of bioeconomy-based innovations represents a vital strategic effort to enhance long-term profitability.

Innovations can be categorized into several types, each having a distinct impact on both the company and its customers (Tidd & Bessant, 2013). Product innovations focus on the development and introduction of new or improved products that offer greater value or enhanced functionality to customers. Process innovations aim to improve production and operational procedures to increase efficiency and reduce costs. Organizational innovations involve changes in a company's management and structure that lead to better coordination and communication within the organization (CityMagazine, 2024). Marketing innovations emphasize new approaches to the promotion and sale of products and services (Christensen, 1997).

2. Materials and methods

The aim of this work is to highlight the challenges and opportunities associated with innovation management and digital transformation within the business environment in Slovakia. It also seeks to identify inspiring approaches and recommend measures to enhance the competitiveness and innovation performance of Slovak enterprises.

To achieve this goal, the focus will be placed on the key challenges Slovak businesses face in the areas of innovation management and digital transformation. Additionally, the study will explore the opportunities that these processes offer for the Slovak business environment. The work will also showcase several successful examples—both domestic and international—of innovative practices and digital transformation initiatives that can serve as inspiration for Slovak companies.

An important part of this work will be the formulation of recommendations for businesses, the government, and supporting institutions in Slovakia, aimed at enhancing innovation performance and ensuring a successful digital transformation.

This work will apply both qualitative and quantitative research methods to comprehensively examine innovation management and digital transformation in Slovak enterprises.

Literature Review - We will process relevant domestic and international scientific literature focused on innovation management, digital transformation, competitiveness, and the business environment. This includes the analysis of academic articles, books, studies, reports, and strategic documents—such as Slovakia's Innovation Strategy and the European Union's digitalization strategies.

Qualitative Research - Through case studies, we will analyze specific examples of both successful and unsuccessful implementation of innovation management and digital transformation in Slovak companies.

Quantitative Research - We will utilize existing statistical data from sources such as Eurostat, the European Commission, the Statistical Office of the Slovak Republic, and other relevant institutions to quantify the level of digitalization, innovation activity, and competitiveness of Slovak enterprises.

3. Results and discussion

3.1. Digital Europe Programme

The Digital Europe Programme is one of the EU's first financial instruments aimed at bringing advanced technologies closer to both citizens and businesses. The programme supports the implementation of modern technologies to drive digital transformation and is being carried out during the 2021–2027 period.

The EU is addressing the need for digitalisation through its Recovery and Resilience Plan, which aims to make Europe "greener, more digital, and more resilient." Digital transformation is one of the six main pillars of this plan.

A key development in supporting SMEs in their digital transformation journey is the European Commission's Communication of 10 March 2020, entitled "An SME Strategy for a Sustainable and Digital Europe" (European Commission, 2020). Thisstrategy aspires to "provide targeted advice on sustainability and digitalisation, while also connecting support structures so that every SME can access assistance close to home." It is built upon three main pillars:

1. Building capacities and supporting transformation towards sustainability and digitalisation;
2. Reducing regulatory burdens and improving market access;
3. Improving access to finance.
4. The online business environment within the European Union is dynamic and constantly evolving. EU policy places strong emphasis on:
5. Supporting innovation and key digital technologies;
6. Upholding ethical principles and values in relation to artificial intelligence;
7. Strengthening Europe's cybersecurity capabilities;
8. Increasing digital skills;
9. Developing a "Gigabit Society", including the rollout of 5G technologies.

3.2. Business Environment in Slovakia

The business environment in Slovakia is significantly shaped by the structure of its economy, which is dominated by small and medium-sized enterprises (SMEs), accounting for more than 99% of all businesses. SMEs play a crucial role in employment and contribute substantially to the country's economic growth. Slovakia's business environment is highly industry-oriented, with the automotive sector being one of its most important pillars. Additionally, the presence of multinational corporations contributes to economic stability, but also increases the country's dependency on global market trends.

In 2024, a total of 993,000 vehicles were produced in Slovakia. The automotive sector directly employs more than 165,000 people, with total employment in the sector reaching 244,000. The automotive industry accounts for 9.2% of Slovakia's gross domestic product, making it the most important sector and the main driving force of the national economy.

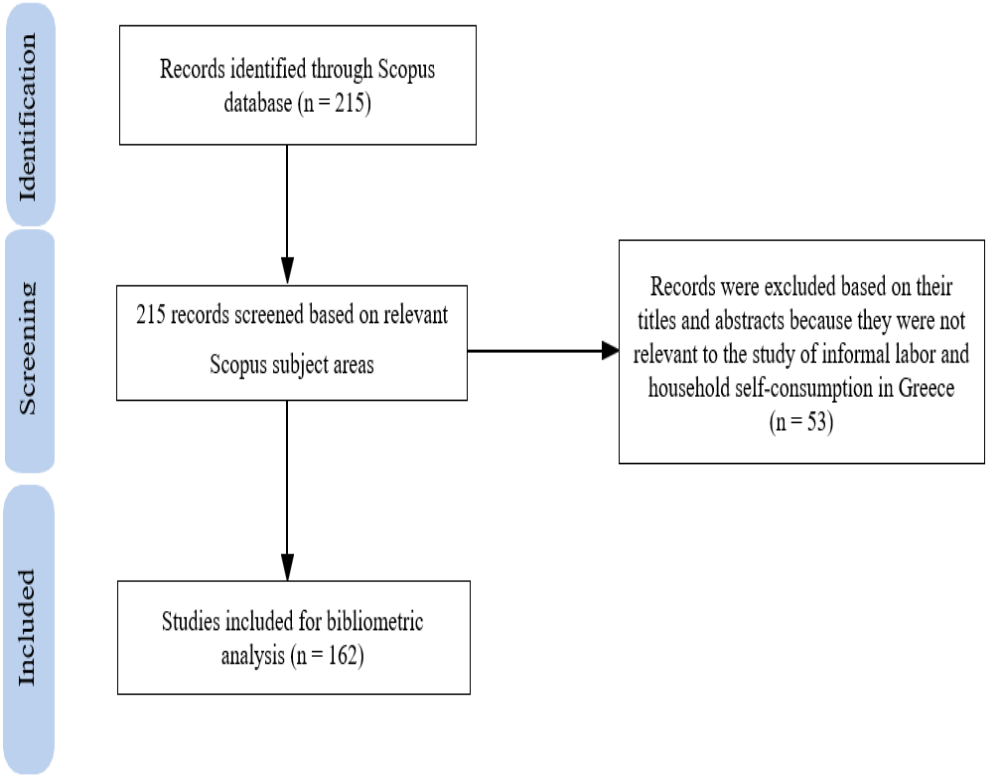
Thanks to four established car manufacturers—Volkswagen, Stellantis, Kia, and Jaguar Land Rover—and more than 350 local suppliers, Slovakia is the world leader in car production per capita. In 2022, Swedish premium car manufacturer Volvo also chose Slovakia as the location for its newest production plant.

According to the European Commission, the automotive industry is essential to the prosperity of Europe as a whole. It provides direct and indirect employment for 13.8 million Europeans, representing 6.1% of total EU employment. Of these, 2.6 million are employed directly in motor vehicle production, which makes up 8.5% of total industrial employment across the EU.

Slovakia leads the EU-27 in terms of workforce exposure to the automotive industry, with 16% of its industrial workforce engaged in this sector.

However, the broader Slovak business environment faces significant challenges. In the latest Global Innovation Index (GII) 2024 by the World Intellectual Property Organization (WIPO), Slovakia ranked 46th out of 133 countries. Notably, its business environment ranked a low 124th, indicating high levels of uncertainty and persistent challenges for entrepreneurs. Among the EU-27, only Romania scored lower in this category.

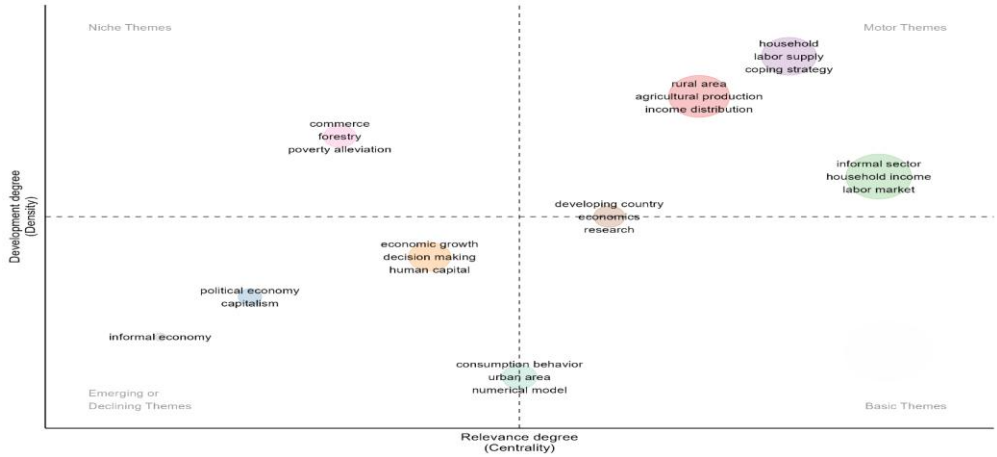
Figure 1: Innovation input to output performance, 2024



Source: Global Innovation Index Database, WIPO, 2024.

The European Innovation Scoreboard (EIS), compiled by the European Commission, provides a comprehensive assessment of the research and innovation environment in EU member states. Slovakia ranks below the EU-27 average in most of the monitored indicators, highlighting the need to intensify efforts in supporting innovation and research.

Figure 2: Performance of EU Member States' innovation systems



Source: EIS 2023

Compared to other European Union Member States, Slovakia has several specific characteristics. Digitalisation, which is currently a key factor in economic development, lags behind the EU average. This issue is particularly visible in the insufficient use of digital technologies by small businesses and the low level of digital skills among the population.

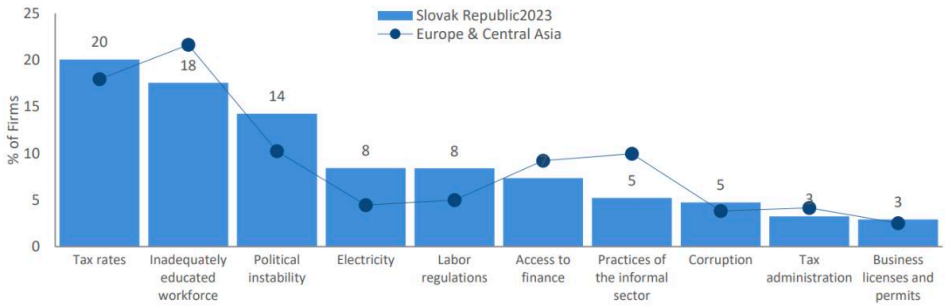
On the positive side, Slovakia has a qualified workforce, especially in technical fields. However, the country faces brain drain and labor shortages in certain regions.

The Slovak business environment faces several major challenges. Companies need to invest in modern technologies and digitalisation processes, which require financial resources and expertise that are often lacking. Bureaucracy and frequent legislative changes pose additional obstacles to business operations. Furthermore, there are significant regional disparities in economic development, with eastern Slovakia lagging the western part of the country.

Despite these challenges, the business environment in Slovakia offers many opportunities. One of the most significant is the availability of funding from European Union sources, which companies can use for digitalisation, innovation, and internationalisation. Slovakia's growing startup ecosystem, supported by incubators and accelerators, also creates favorable conditions for the development of innovative projects. In addition, Slovakia's strategic location in Central Europe allows for easier expansion into neighboring markets and makes it easier to leverage the advantages of the EU single market.

The following figure presents the 10 main constraints of the business environment in Slovakia compared to regional averages, based on the Enterprise Surveys Slovakia 2023 conducted by the World Bank.

Figure 3: Top ten business environment constraints



Source: Enterprise Surveys

Strategic and conceptual documents that address the challenges of technological progress include the Digital Transformation Strategy of Slovakia 2030. This strategy outlines the policy direction and specific priorities of the Slovak Republic in the area of digital transformation. Slovakia's overarching goal is to modernize its economy by 2030 through the adoption of innovative and environmentally friendly industrial solutions, supported by a knowledge-based data economy.

Another key document is the Slovakia 2021–2027 Programme, which serves as the main programming framework for utilizing European Union funds in Slovakia during the 2021–2027 period. This programme is designed to ensure more efficient and flexible use of EU resources and acts as a key investment instrument aimed at improving the quality of life for the Slovak population. It focuses on several critical areas, including environmental and climate goals, innovation, education, and regional development.

3.3. Digitalization of the Business Environment

In the field of digitalization, Slovakia is on par with other V4 countries, but lags behind more developed OECD and EU nations. As a result, digital transformation has become a national priority. In the context of enhancing business competitiveness, Slovakia aims to establish an innovative digital and data-driven economy.

A key approach to achieving this goal is through supporting the adoption of digital technologies and enhancing the digital skills of small and medium-sized enterprises (SMEs).

The National Digital Skills Strategy of the Slovak Republic and the Action Plan for 2023–2026 set out a framework and specific steps to improve the digital skills of Slovakia's population. The strategy aims to ensure that all citizens have access to the digital competencies necessary for success in the digital economy and society.

A major challenge for both Slovakia and the EU is falling behind in the field of artificial intelligence (AI). Compared to the United States and China, AI investments in the EU are significantly lower. While the US invested $62 billion and China $7.3 billion in AI, Europe lags with only $5.5 billion. This investment gap could have serious consequences, especially as a few major companies—none of them European—are expected to dominate the AI landscape.

Despite these challenges, the digitalization of businesses in Slovakia presents many opportunities to enhance efficiency, competitiveness, and innovation. Key areas where Slovak companies can leverage digitalization include:

Automation and Industry 4.0

The automation of production processes and the adoption of Industry 4.0 technologies—such as robotics, the Internet of Things (IoT), and AI—can significantly boost productivity, lower costs, and improve monitoring and optimization of manufacturing.

Digital Payments and FinTech

Implementing digital payment systems and using FinTech solutions can simplify financial operations, enhance cash flow, and improve the security of transactions. Examples include platforms like PayPal, Stripe, or local digital payment solutions.

Cybersecurity

As digitalization advances, protecting sensitive data and systems from cyber threats is crucial. Investing in cybersecurity measures such as encryption, firewalls, and regular monitoring is key to safeguarding corporate information.

Support for Innovation and Research

Businesses can take advantage of various grants and financial incentives to foster innovation and research in digital technologies.

Education and Digital Skills Development

Investing in employee training in digital skills is essential for successful digital transformation. Collaboration between companies and educational institutions can help upskill the workforce and prepare them for the digital economy.

Digital Transformation of Public Administration

Businesses benefit from a digitalized public administration, which simplifies bureaucracy and improves access to public services. Examples include electronic documents, online registrations, and digital signatures—all of which make doing business easier.

E-commerce

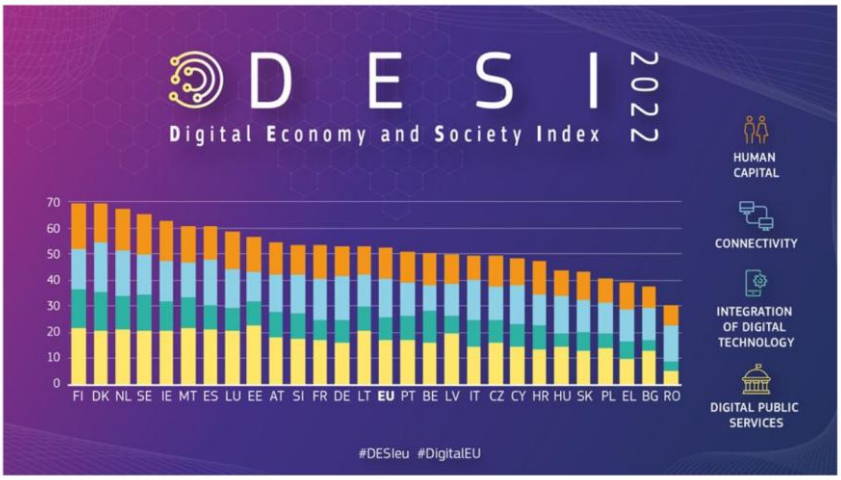
Developing and optimizing e-commerce platforms, including the use of social media and digital marketing, can help businesses attract new customers and enhance customer experience.

Benefits of Digitalization

1. Increased efficiency and productivity – Streamlining operations through process automation and the use of digital tools leads to higher productivity, reduced costs, and time savings.
2. Better communication – Digital tools enhance internal and external communication across various platforms.
3. Better decision-making – Access to real-time data and analytics improves the quality and speed of business decisions.
4. Improved customer service and experience – Digitalization enables more personalized, faster, and more efficient interactions with customers.
5. *Disadvantages of Digitalization in Slovakia*
6. High costs – Initial investments in technology and training can be financially demanding, especially for small and medium-sized enterprises (SMEs).
7. Security risks – Increased reliance on digital systems raises the risk of cyberattacks, data breaches, and privacy concerns.
8. Lack of qualified IT professionals – Slovakia faces a shortage of skilled workers in the IT sector, which slows down the implementation of digital solutions.

The level of online business in Slovakia, according to the Digital Economy and Society Index, is shown in Figure 4.

Figure 4: The level of online business in Slovakia



Source: DESI

The level of online entrepreneurship in Slovakia lags behind the European Union (EU) average, which is reflected in various aspects of the digital transformation of businesses. According to the Digital Economy and Society Index (DESI) 2021, Slovakia ranked 22nd out of 27 EU Member States, achieving a score of 43.2, while the EU average was 50.7.

In February 2020, the European Commission approved the Digital Package, which includes three key documents:

1. Shaping Europe's Digital Future
2. A European Data Strategy
3. Excellence and Trust in Artificial Intelligence

On 9 March 2021, the European Commission published the Communication on the Digital Compass to 2030. It is a response to the COVID-19 pandemic, which changed perceptions of the importance of digitalisation in society and the economy, and accelerated the pace of digital transformation. The document outlines specific objectives in four key areas:

1. Digital skills
2. Digital infrastructure
3. Digital transformation of enterprises
4. Digitalisation of public services

The Digital Europe Programme is one of the first EU financial instruments designed to bring technology closer to citizens and businesses. The programme aims to finance

the implementation of modern technologies to support digital transformation and runs from 2021 to 2027.

3.4. Innovative Economy

Traditional and innovative economies represent two different approaches to economic growth, entrepreneurship, and value creation. While the traditional economy relies on stable, often industrial sectors with a focus on efficiency and mass production, the innovative economy emphasizes creativity, new technologies, and constant adaptation to changing conditions.It brings rapid growth and dynamism but also involves a higher degree of risk. The innovative economy supports the entrepreneurial ecosystem—including startup culture and venture capital—reduces dependence on physical resources and promotes digitalization.

What makes it especially relevant today is its potential to address global challenges, such as:

1. Climate change
2. Urbanization
3. Energy efficiency

The business models of the innovative economy are shaped by rapidly changing market conditions, technological advancement, and evolving consumer behaviour. They are characterized by:

1. Digitalization
2. The sharing economy
3. Personalized services
4. Data-driven decision making

4. Conclusion

Selected examples of innovation and digitalization successes in Slovak companies:

1. Volkswagen Slovakia

Volkswagen Slovakia demonstrates high efficiency and quality in its automotive production processes, showcasing successful digital transformation and innovation in the industry.

An excellent example of innovation is the use of FTS (Fahrerloses Transportsystem)—automated guided vehicles. These are developed by the Slovak company CEIT in close collaboration with the Slovak University of Technology in Bratislava.

The FTS systems operate using magnetic strips on the floor and ensure timely and accurate delivery of materials across nearly all production halls, significantly enhancing logistics and operational efficiency.

Picture 1: Robotization at Volkswagen

Source: Volkswagen

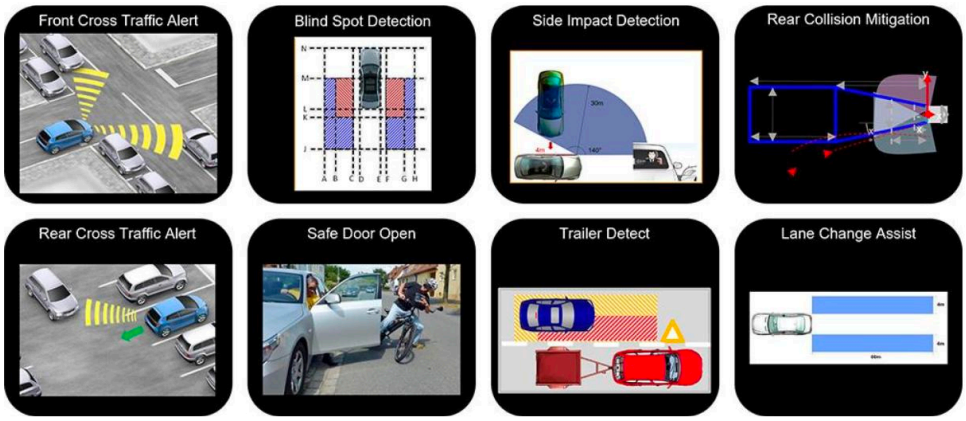
2. Magna Slovteca s.r.o.

Magna Slovteca s.r.o., a subsidiary of the Canadian corporation Magna International, specializes in producing components for leading global automotive brands. Magna International is recognized as a pioneer in automotive innovation, offering cutting-edge technologies that enhance vehicle safety and performance. Notable innovations include:

1. ICON Radar – an advanced digital radar system designed for precise object detection, improving driving awareness and accident prevention.
2. ClearView™ Vision System – enhances driver visibility and overall safety through intelligent camera and display technologies.
3. Interior Sensing Systems – utilizes facial and behavioral recognition to monitor driver alertness and passenger conditions, contributing to both safety and comfort.

These technologies reflect Magna's commitment to smart mobility solutions and represent a step forward in the global digital transformation of the automotive industry.

Picture 2: Command system of the company Magna Slovteca s.r.o



Source: Magna Slovteca s.r.o.

3. Tatra Banka, a.s.

Tatra Banka, a.s. is one of the largest and most influential financial institutions in Slovakia. Founded as the first private bank in the country, it has played a crucial role in shaping the Slovak banking sector.

Since 2019, Tatra Banka has been part of Raiffeisen Bank International, one of the strongest banking groups in Austria. This partnership has accelerated its growth and strengthened its position in the Slovak market.

Tatra Banka is a leader in banking innovation, particularly in the areas of:

1. Digital banking – offering advanced mobile and internet banking services.
2. Artificial intelligence – implementing AI-driven solutions for customer support and personalized financial services.
3. Cybersecurity – maintaining high standards for secure transactions and data protection.

Its continuous investment in digital transformation makes Tatra Banka a model for modern banking in Central Europe.

Picture 3: Tatra Banka card design

Source: Tatra banka

Based on the analysis of the innovation economy and digitalization in the conditions of enterprises in Slovakia, we propose the following recommendations in the areas:

For enterprises:

1. Strategies for more effective implementation of innovation management (e.g. open innovation, agile methodologies).
2. Approaches to successful digital transformation (e.g. selection of appropriate technologies, development of digital skills).
3. Building an innovation culture in the organization.
4. Possibilities of cooperation with research institutions and other enterprises.
5. Use of existing support programs and tools.

For the government and support institutions (e.g. SARIO, Slovak Business Agency):

6. Improving the legislative and regulatory environment for innovation and digital transformation.
7. Supporting investments in research, development and innovation.
8. Initiatives for the development of digital skills and education.
9. Supporting the internationalization of innovative Slovak companies.
10. Streamlining and better coordination of existing support programs.
11. Creating platforms for cooperation between businesses, research and public administration.

For the business environment as a whole:

1. Supporting the creation of innovation ecosystems and clusters.
2. Raising awareness of the importance of innovation and digital transformation.
3. Supporting connections with international innovation networks.

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