COMPARATIVE ANALYSIS OF INDUSTRY 4.0 FACTORS IN GEORGIA AND SLOVAKIA:
An Economic and Technological Perspective

FAKULTA MANAGEMENTU
Univerzita Komenského
v Bratislave

Nadia Mtchedlidze, PhD candidate
Comenius University, Faculty of Management
Department of Strategy and Entrepreneurship

E-Leader 2024
Bratislava, Slovakia

04.06.2024

"The Fourth Industrial Revolution is characterized by a range of new technologies that are fusing the physical, digital, and biological worlds, impacting all disciplines, economies, and industries, and even challenging ideas about what it means to be human.“

Schwab, K. *The Fourth Industrial Revolution*. World Economic Forum, 2016.

INTRODUCTION TO INDUSTRY4.0

- Germany's “Industrie 4.0”
- China's “Made in China 2025”
- India's “Made in India Initiative
- Italy's “Industria 4.0 Law”
- The“Smart Manufacturing Leadership Act” in the United States

GLOBAL INITIATIVES SUPPORTING INDUSTRY 4.0

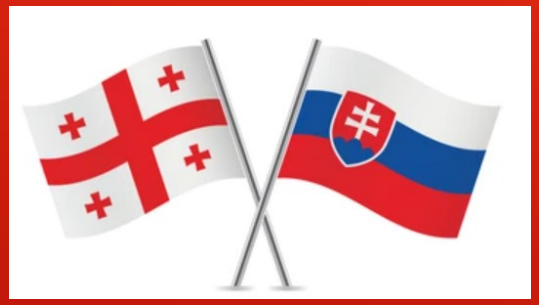
RESEARCH OBJECTIVE

Aim of the comparative analysis

Key economic and technological factors under review

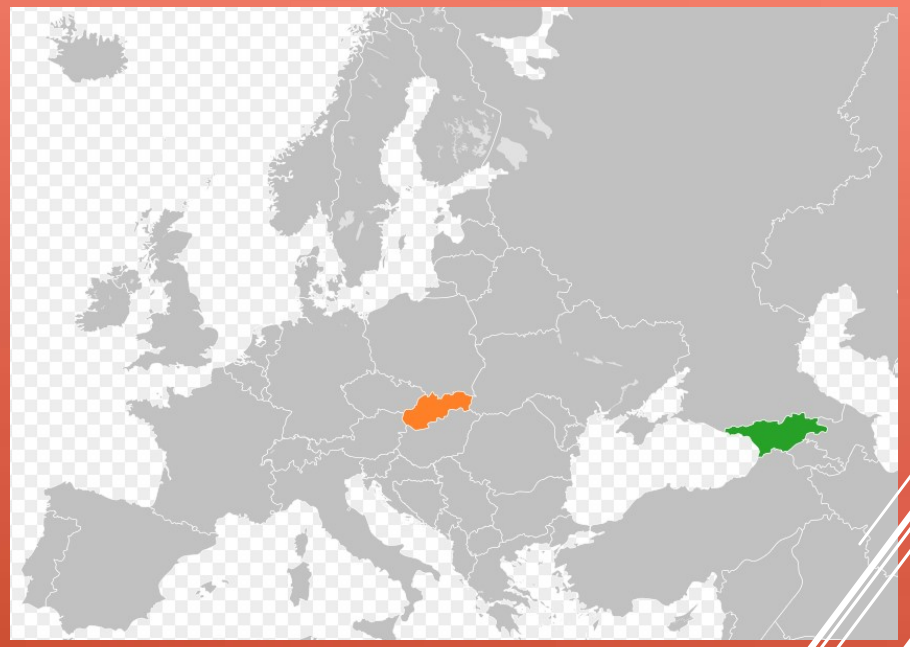
RESEARCH OBJECTIVE

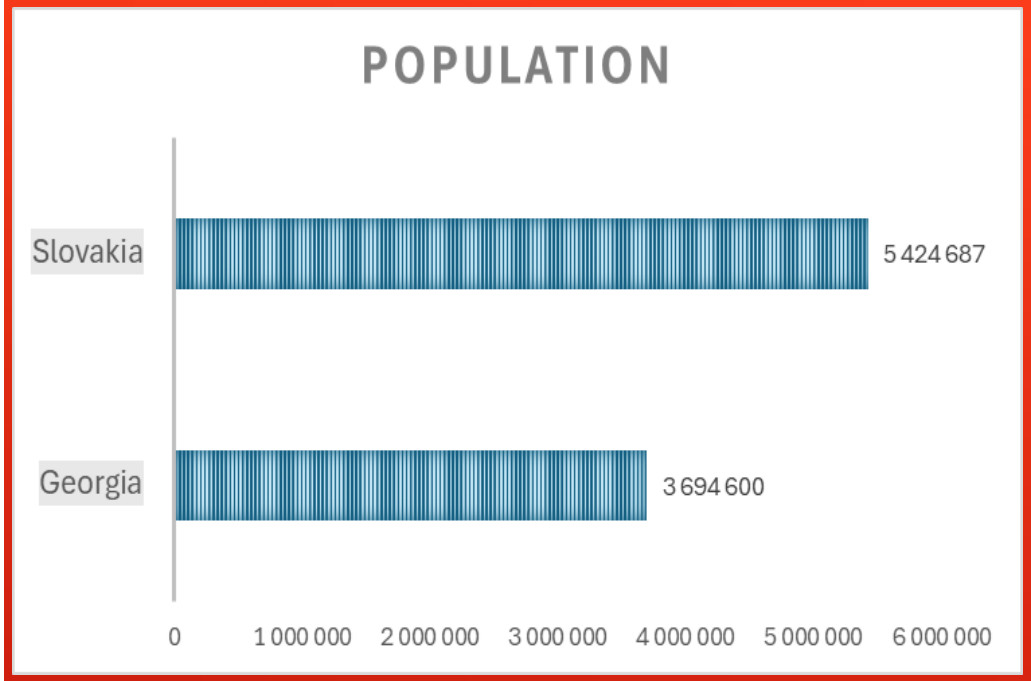
- The aim of the comparative analysis of Industry 4.0 factors in Georgia and Slovakia is to examine and contrast the economic and technological dimensions that influence the adoption and integration of Industry 4.0 technologies in these two countries.

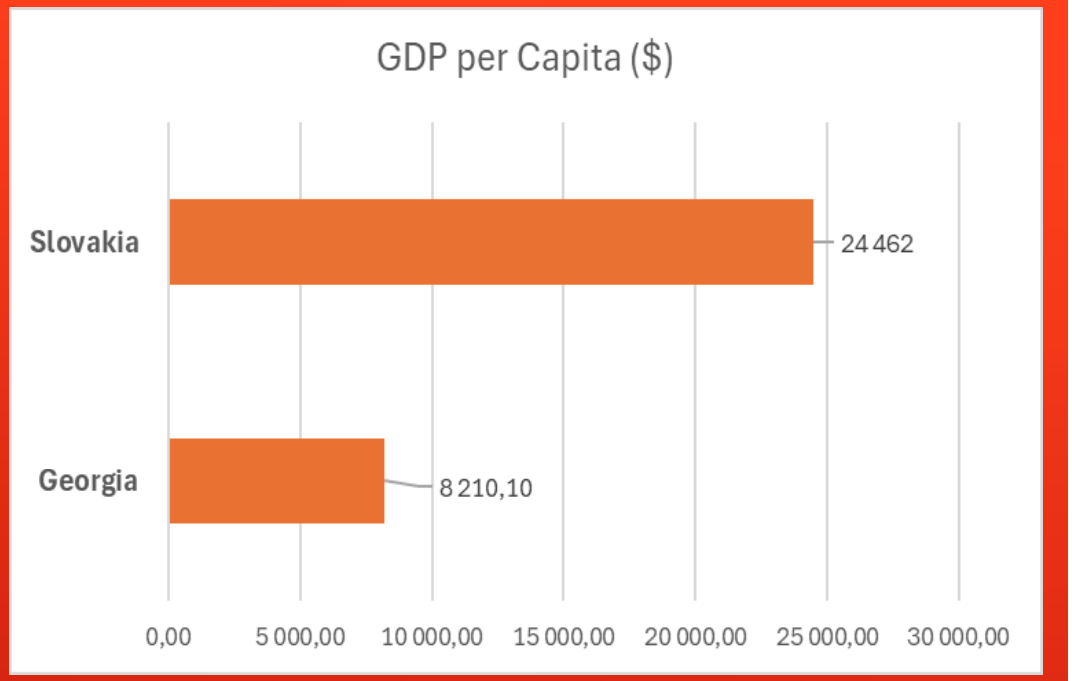


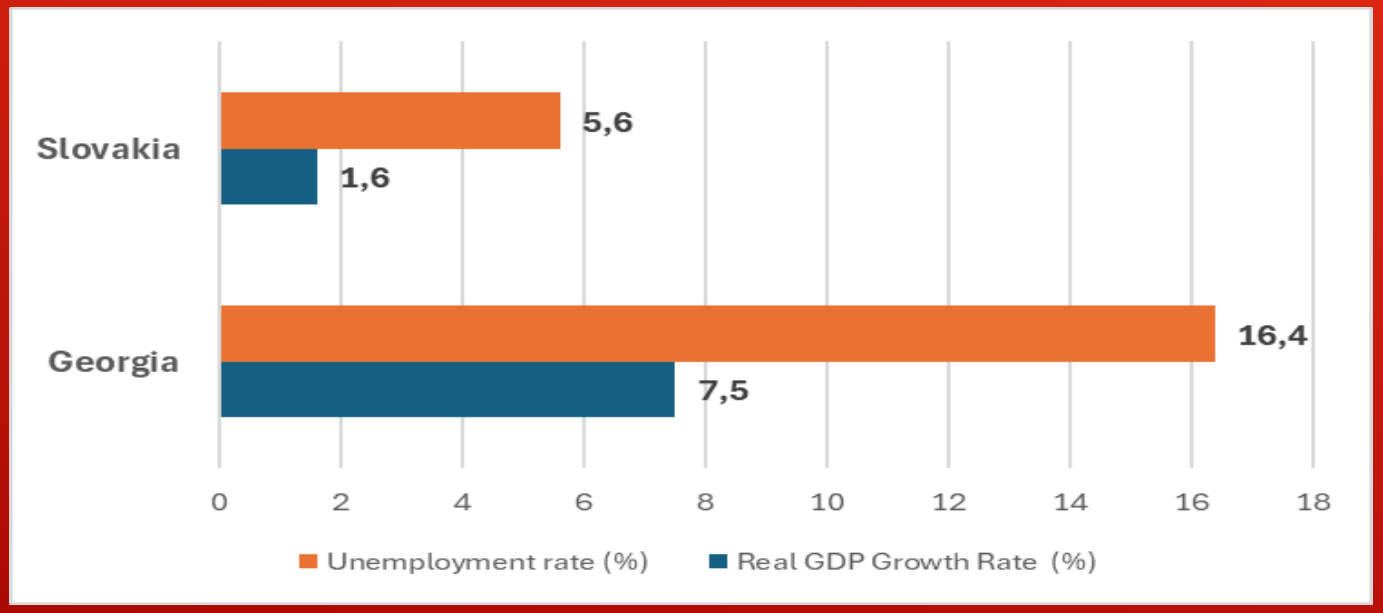
METHODOLOGY

- Approach and data sources
- Conceptual model framework
- VAR Model

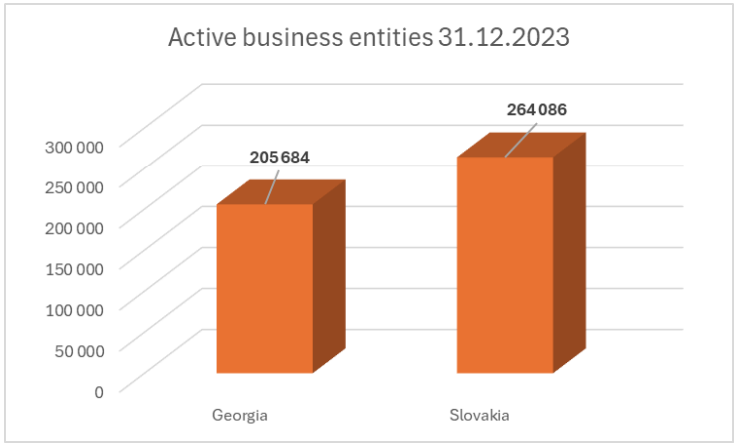


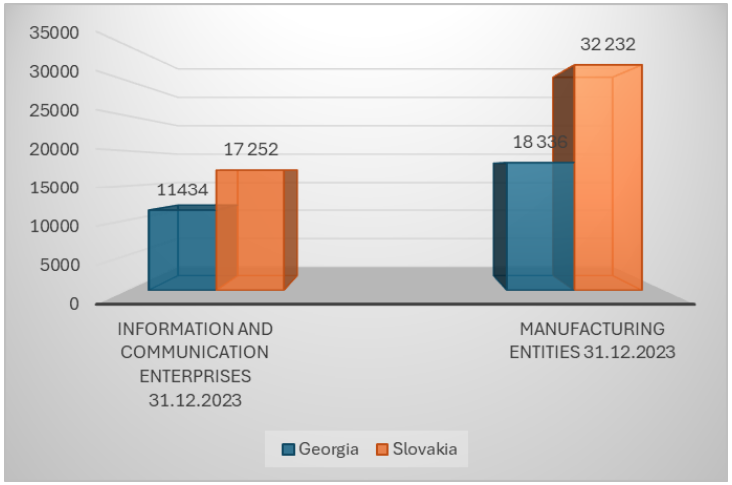






SOURCE: NATIONAL STATISTICS OFFICE OF GEORGIA AND STATISTICAL OFFICE OF THE SLOVAK REPUBLIC





SOURCE: NATIONAL STATISTICS OFFICE OF GEORGIA AND STATISTICAL OFFICE OF THE SLOVAK REPUBLIC

	Slovakia	Georgia
Digital Quality of Life Index 2023	33rd Place	65th Place
Global Innovation Index 2023	45th Place	65th Place
Government AI Readiness Index 2023	44th Place	99th Place

INDUSTRY 4.0 IN SLOVAKIA

Manufacturing Heritage: Major car manufacturers (Volkswagen, Kia, Peugeot-Citroën, Jaguar Land Rover)

Technological Adoption: Automation, IoT, and robotics in manufacturing

Industry Engagement: 90% of enterprises exploring or implementing Industry 4.0

INDUSTRY 4.0 IN SLOVAKIA

SMEs and Industry 4.0:

Diverse adoption; 61% familiar with Industry 4.0

Key factors: resource access, skilled labor, European supply chain integration

Support and Initiatives:

Initiatives and funding programs

Financial incentives for R&D and high-tech investments

Digital Transformation Strategy up to 2030 aligns with EU/global trends

Interest in Smart Industry:
Growing corporate interest beyond discussions.
Transformation of manufacturing plants into smart factories.
Technological Integration:
Use of IoT sensors and data analysis.
Potential increase in export value through Industry 4.0.

Industry 4.0: Positive Trends in Slovakia

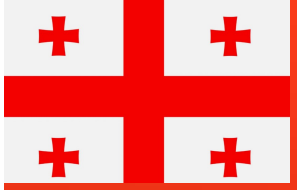
INDUSTRY 4.0: CHALLENGES IN SLOVAKIA

Digital Development:

- Advances in core network infrastructure.
- Shortage of competencies and human resources (Papula et al., 2017).

Digitization Lag:

- Slow progress in broadband internet and digital public services.
- Below EU average in 4G access and digital skills (EC, 2019a; DESI index, 2020a).



Insights from the Asian Development Bank's Report:

- Underexploited Potential: Digitalization not fully utilized by businesses, especially SMEs.
- Skills Gap: Significant disparity in digital skills, more pronounced outside Tbilisi.

INDUSTRY 4.0 IN GEORGIA

		2016	2017	2018	2019	2020	2021	2022	2023
Using Enterprise Resource Planning (ERP) program package in enterprises	Total	9,2%	16,1%	16,2%	9,8%	8,7%	7,9%	6,9%	10,4%
	Of which:								
	Small	X	X	X	8,9%	7,6%	7,3%	5,8%	9,5%
	Medium	X	X	X	24,9%	24,7%	20,7%	32,3%	35,3%
	Large	X	X	X	54,4%	51,5%	42,8%	57,5%	56,3%

Table 1: The share of enterprises that used ERP type software.

Source: Data obtained from the National Statistics office of Georgia - https://www.geostat.ge/en

- $BUS_t = \beta_0 + \beta_1 INT_t + \beta_3 ERP_t + u_t$

Business Total Turnover (BUS),

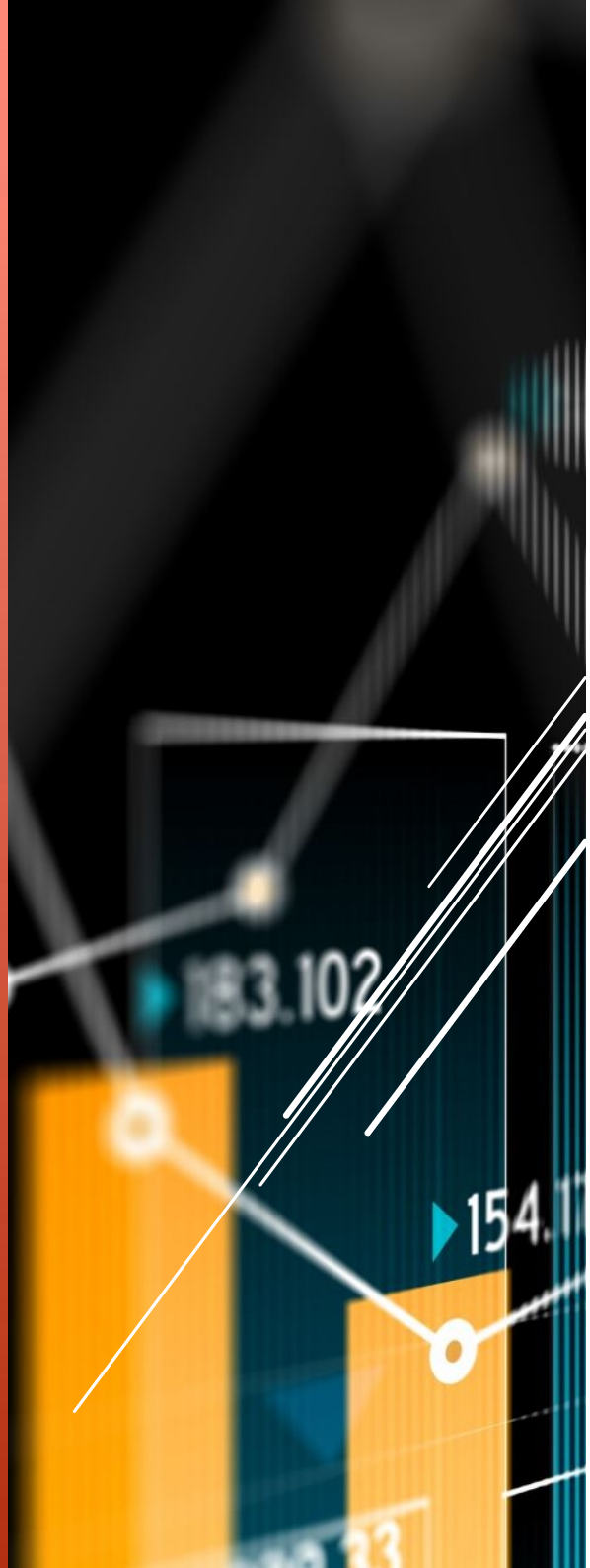
Internet Access in Enterprises (INT),

Enterprise Resource Planning Software Usage (ERP).

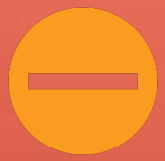
Hypothesis

- "Enhanced digital connectivity within enterprises, exemplified by increased internet access, significantly contributes to an improvement in business turnover growth."

ANALYZING THE IMPACT OF ICT ADOPTION ON BUSINESS GROWTH IN GEORGIA: A TIME SERIES ANALYSIS FROM 2016 TO 2022



INDUSTRY 4.0: CHALLENGES IN GEORGIA



Barriers for SMEs:

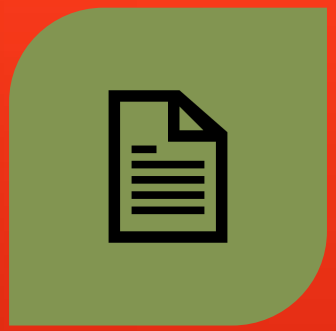
Limited resources and skilled labor.

Lower exposure to global markets.

Impact: Hinders rapid integration of Industry 4.0 technologies.

PROPOSED STATISTICAL MODEL

VARIABLES AND EXPECTED OUTCOMES



APPLICATION OF THE MODEL IN THE STUDY

STATISTICAL MODEL FOR FURTHER RESEARCH

EXPECTED OUTCOMES

Economic Growth: Positive correlation with improved technological infrastructure

SME Digital Adoption: Higher likelihood with better internet access and broadband speed

Innovation: Increased R&D expenditure and patent filings with advances in technology

VECTOR AUTOREGRESSION (VAR) MODEL

- $$\begin{bmatrix} EG_t \\ DA_t \\ IN_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \phi_{11}^{(i)} & \phi_{12}^{(i)} & \phi_{13}^{(i)} \\ \phi_{21}^{(i)} & \phi_{22}^{(i)} & \phi_{23}^{(i)} \\ \phi_{31}^{(i)} & \phi_{32}^{(i)} & \phi_{33}^{(i)} \end{bmatrix} \begin{bmatrix} EG_{t-i} \\ DA_{t-i} \\ IN_{t-i} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \\ \epsilon_{3t} \end{bmatrix}$$

- EG_t, DA_t, and IN_t are the values of Economic Growth, SME Digital Adoption, and Innovation at time t, respectively.
- c_1, c_2, c_3 are the intercept terms for each equation.
- $\phi_{ij}^{(k)}$ are the coefficients at lag k for the variable j in the equation of variable i.
- $\epsilon_{1t}, \epsilon_{2t}, \epsilon_{3t}$ are the error terms at time t, assumed to be white noise.

- Economic Growth (EG): Represented by indicators such as GDP growth rate.
- SME Digital Adoption (DA): Measured by the percentage of SMEs with high-speed internet access or the adoption rate of digital technologies.
- Innovation (IN): Captured by metrics such as R&D expenditure as a percentage of GDP and the number of patent filings.

VECTOR AUTOREGRESSION (VAR) MODEL

IMPULSE RESPONSE FUNCTIONS (IRFS)

Shock to SME Digital Adoption (DA)

Shock to Economic Growth (EG)

Shock to Innovation (IN)

- Summary of findings
- Final thoughts on the comparative analysis

CONCLUSION

REFERENCES

- SCHWAB, K. (2016): The Fourth Industrial Revolution, Penguin Random House UK, p. 12.
- PYP, D., HWANG, J., YOON, Y. (2021). Tech Trends of the 4th Industrial Revolution. Germany: Mercury Learning and Information, p.3
- Marrucci, A., Rialti, R., & Balzano, M. (2023). Exploring paths underlying Industry 4.0 implementation in manufacturing SMEs: a fuzzy-set qualitative comparative analysis. Management Decision.
- Bogoviz, A. V., Osipov, V. S., Chistyakova, M. K., & Borisov, M. Y. (2019). Comparative analysis of formation of industry 4.0 in developed and developing countries. Industry 4.0: industrial revolution of the 21st century, 155-164.
- Slovak investment and trade development agency (SARIO), (2021), Automative sector in Slovakia, Available online: sario-automotive-sector-in-slovakia-2021-02-05.pdf
- GRENCÍKOVÁ, A., KORDOŠ, M., & BERKOVIČ, V. (2020). The impact of industry 4.0 on jobs creation within the small and medium-sized enterprises and family businesses in Slovakia. Administrative sciences, 10(3), 71.
- TICK, A. (2023). Industry 4.0 Narratives through the Eyes of SMEs in V4 Countries, Serbia and Bulgaria. Acta Polytechnica Hungarica, 20(2).
- PAPULA, J., KOHNOVÁ, L., PAPULOVÁ, Z., & SUCHOBA, M. (2019). Industry 4.0: preparation of Slovak companies, the comparative study. Smart Technology Trends in Industrial and Business Management, 103-114.
- VALASKOVA, K., NAGY, M., ZABOJNIK, S., & LĂZĂROIU, G. (2022). Industry 4.0 wireless networks and cyber-physical smart manufacturing systems as accelerators of value-added growth in Slovak exports. Mathematics, 10(14), 2452.
- GYIMESI, Á. (2021). National industry 4.0 platforms in the Visegrad 4 Countries–A comparison with the frontrunner digital economies in Europe. Studia Universitatis Babes Bolyai-Oeconomica, 66(3), 21-39.
- TURMANIDZE R, DAŠIĆ P, POPKHADZE G. (2020): Digital infrastructure in Georgia as a condition for successful application. In: Industry 4.0. 2020, Vol. 5, N. 1, pp. 3-6
- NANITASHVILI, N. V., & VANDENBERG, P. (2023). GEORGIA'S EMERGING ECOSYSTEM FOR TECHNOLOGY STARTUPS. Asian Development Bank.
- OECD: Fostering Business Development and Digitalisation in Georgia. (2022). [Cited 03.11.2023]. Available online: Fostering Business Development and Digitalisation in Georgia (oecd.org)
- Digital Quality of Life Index,
- Global innovation index 2023. Accessed on 26.05.2024, available on: https://www.wipo.int/global_innovation_index/en/2023/

REFERENCES:

- Government AI readiness index 2023. Accessed on 26.05.2024. Available on https://oxfordinsights.com/ai-readiness/ai-readiness-index/
- Stentoft, J., Adsbøll Wickstrøm, K., Philipsen, K., & Haug, A. (2021). Drivers and barriers for Industry 4.0 readiness and practice: empirical evidence from small and medium-sized manufacturers. Production Planning & Control, 32(10), 811-828.
- Mtchedlidze, N., & Papulova, Z. (2023). Conference: International Relations 2023. Navigating Industry 4.0 in Georgia: Challenges and Opportunities on the Path to Technological Transformation. ResearchGate.
- Antony, J., Sony, M., Garza-Reyes, J. A., McDermott, O., Tortorella, G., Jayaraman, R., & Maalouf, M. (2023). Industry 4.0 benefits, challenges and critical success factors: a comparative analysis through the lens of resource dependence theory across continents and economies. Journal of Manufacturing Technology Management, 34(7), 1073-1097.
- Grenčíková, A., Kordoš, M., Bartek, J., & Berkovič, V. (2021). The impact of the Industry 4.0 concept on Slovak business sustainability within the issue of the pandemic outbreak. Sustainability, 13(9), 4975.
- Yüksel, H. (2022). Industry 4.0 transformation: factors affecting adoption and impacts on companies. International Journal of Industrial Engineering and Operations Management, 4(3), 63-89.
- Germany and Slovakia: Bilateral relations. [Cited 25.10.2023] Available online: Germany and Slovakia: Bilateral relations - Federal Foreign Office (auswaertiges-amt.de)
- Greener Slovakia, Strategy of the environmental policy of the Slovak Republic until 2030. [Accessed 28.10.2023]. Available online: greener-slovakia-2030.pdf (minzp.sk)
- NANITASHVILI, N. V., & VANDENBERG, P. (2023). GEORGIA'S EMERGING ECOSYSTEM FOR TECHNOLOGY STARTUPS. Asian Development Bank.
- National Statistics office of Georgia - https://www.geostat.ge/
- Statistical office of the Slovak Republic - https://slovak.statistics.sk/wps/portal/ext/Databases/

- Open floor for questions and discussion

Q&A