DOI: https://doi.org/10.36719/2663-4619/118/14-23

**Mehdi Gasimzadeh**
Educational complex No. 132-134 of Azerbaijan Republic
https://orcid.org/0009-0000-3924-1352
mehdigasimzade09@gmail.com
**Elmira Gojayeva**
Azerbaijan State Economic University
PhD in Economics
https://orcid.org/0000-0001-8413-4812
elmira_qocayeva@unec.edu.az

# Assessing the Current Situation of Innovation in Companies: Case of Azerbaijan

## Abstract

The processes of scientific and technical progress are conditioned as the main drivers of socio-economic development in recent years. It should be noted that industrial revolutions have always had their effects on the economy at both the micro and macro levels. In particular, the fourth industrial revolution has formed high technologies of scientific and technical progress, which play an important role in the activity of economic agents and the formation of the future trajectory of socio-economic factors. Today, a number of scientific studies show that it is possible to sustainably increase the competitiveness of companies with preventive strategies. At the base of these strategies lies innovation. The concept of innovation, being a broad concept, characterizes a number of directions. The most important of these are Information and Communication Technologies (ICT). In the study, the modern state of using ICT in Azerbaijani companies and its certain effects on the production volume are evaluated. In this work, a number of indicators such as the use of ICT in Azerbaijani companies, the companies' access to the Internet, and the costs incurred for innovative activities were statistically analyzed. At the same time, indicators of the companies operating in the newly classified economic regions of Azerbaijan, including Karabakh and Eastern Zangezur economic regions, were included in the study.

***Keywords:*** *innovation, information and communication technologies, fourth ındustrial revolution, ınternet, software*

**Mehdi Qasımzadə**
Azərbaycan Respublikası 132-134 saylı Təhsil kompleksi
https://orcid.org/0009-0000-3924-1352
mehdigasimzade09@gmail.com
**Elmira Gocayeva**
Azərbaycan Dövlət İqtisad Universiteti
iqtisad üzrə fəlsəfə doktoru
https://orcid.org/0000-0001-8413-4812
elmira_qocayeva@unec.edu.az

# Şirkətlərdə innovasiyaların mövcud vəziyyətinin qiymətləndirilməsi: Azərbaycan nümunəsi

## Xülasə

Elmi-texniki tərəqqi prosesləri son illərdə sosial-iqtisadi inkişafın əsas hərəkətverici qüvvəsi kimi şərtlənir. Qeyd etmək lazımdır ki, sənaye inqilabları həmişə iqtisadiyyata həm mikro, həm də makro səviyyədə öz təsirlərini göstərmişdir. Xüsusilə, dördüncü sənaye inqilabı iqtisadi subyektlərin

fəaliyyətində və sosial-iqtisadi amillərin gələcək trayektoriyasının formalaşmasında mühüm rol oynayan elmi-texniki tərəqqinin yüksək texnologiyalarını formalaşdırmışdır. Bu gün bir sıra elmi araşdırmalar göstərir ki, qabaqlayıcı strategiyalarla şirkətlərin rəqabət qabiliyyətini davamlı şəkildə artırmaq mümkündür. Bu strategiyaların əsasında innovasiyalar dayanır. İnnovasiya anlayışı geniş anlayış olmaqla bir sıra istiqamətləri səciyyələndirir. Bunlardan ən mühümü İnformasiya və Kommunikasiya Texnologiyalarıdır (İKT). Tədqiqatda Azərbaycan şirkətlərində İKT-dən istifadənin müasir vəziyyəti və onun istehsal həcminə müəyyən təsiri qiymətləndirilir. Bu işdə Azərbaycan şirkətlərində İKT-dən istifadə, şirkətlərin internetə çıxış imkanları, innovativ fəaliyyət üçün çəkilən xərclər kimi bir sıra göstəricilər statistik təhlil edilib. Eyni zamanda, Azərbaycanın yeni təsnif edilmiş iqtisadi rayonlarında, o cümlədən Qarabağ və Şərqi Zəngəzur iqtisadi rayonlarında fəaliyyət göstərən şirkətlərin göstəriciləri tədqiqata daxil edilib.

***Açar sözlər:*** *innovasiya, informasiya və kommunikasiya texnologiyaları, dördüncü sənaye inqilabı, internet, proqram təminatı*

## Introduction

From the end of the 19th century, the processes of scientific and technical progress began to play a more important role in ensuring the sustainability of socio-economic development (Schumpeter, 1946). Each industrial revolution in itself had certain effects on the volume of output in various sectors of the economy (Allen, 2011). It was the fourth industrial revolution that formed an important interest in applying modern technologies to microeconomic subjects (Krafft et al., 2020, Guliyeva et al., 2025). As a result, positive trends in the growth of innovations have been observed in recent years (Kimani et al., 2020).

Today, innovation is a high-frequency idea in various speeches to increase the competitiveness of the country's economy at the macro level and companies at the micro level (Kahn, 2018). Innovation combines different directions, the most important of which is digital innovation. These innovations are realized through the opportunities provided by digital technologies (Nambisan et al., 2017; Lyytinen et al., 2016).

**Research**

The use of digital innovations can be observed in the activities of various subjects. Thus, fintech innovation in the banking sector, innovations in the education sector, innovations in the tourism sector, innovations in the agricultural and industrial sectors are very relevant today (Li et al., 2022; Serdyukov, 2017; Pantano & Stylidis 2021; Klerkx & Begemann 2020; Obradović et al. et al., 2021)

In such an era of high digitalization caused by scientific and technical progress, companies should pay special attention to the innovations offered by the fourth industrial revolution in order to increase their competitiveness (Mahmood & Mubarik 2020; Horváth, and Szabó, 2019; Frank et al., 2019). On the other hand, the application of innovations can characterize the reduction of general risks caused by force majeure in the economy. Thus, the COVID-19 pandemic once again acted as one of the factors that proved the importance of digital technologies and innovations.

For this reason, it is necessary to use innovations to ensure the competitiveness of Azerbaijani companies. Conducting analyzes in the mentioned direction can contribute to the formation of strategic planning and the easier implementation of indicative planning in the business sector. Especially in the context of the creation of Karabakh and East Zangezur economic regions with the implementation of a new classification of economic regions, the application of innovations in business entities that will operate in these economic regions can become a vital situation.

The main research questions are as follows:

RQ1: What is the current state of innovation use by companies in Azerbaijan?

RQ2: Is the use of ICT sufficient in the economic regions of Azerbaijan?

**Literature Review**

We will cover more ICT within the impact of innovation on businesses, which is a broad concept in itself. ICT is one of the main drivers of digital innovation (OECD, 2015). In their study of ICT in Greek and Swiss companies, Arvanitis & Loukis used the percentage of firms whose employees use

the Internet and other ICT-oriented indicators. As a result, it was determined that Swiss firms are more effective than Greek firms in creating innovation (Arvanitis & Loukis, 2009).

Díaz-Chao et al., analyzed ICT, innovation and productivity of firms in the province of Girona, Spain, and proposed different hypotheses. As a result, the fact that ICT has certain effects on the productivity and labor productivity of small firms in Spain has come to the fore. Researchers have used interesting indicators in descriptive statistics, such as the size of firms, distribution according to the level of ICT use, and distribution of firms according to the sectors in which they operate (Díaz-Chao et al., 2015).

Skorupinska & Torrent-Sellens analyzed the relationship between ICT and productivity in their study of Bulgaria, Poland, Romania, Serbia and Ukraine. Here, the researchers used various indicators including the use of ICT by companies and their access to the Internet (Skorupinska & Torrent-Sellens 2017).

In his study of Tanzania, Mwantimwa highlights the statistical picture of computer, internet and software usage in firms of different sizes in Ghana, Democratic Republic of Congo, Tanzania, Uganda, Zambia and Kenya. The researcher notes that the use of various directions of ICT is an important factor for increasing the efficiency of product processing in companies (Mwantimwa 2019).

In general, it should be noted that the use of ICT is an integral part of the strategic planning of companies, so many researches have been conducted in this direction.

**Table 1.** Some studies written on the role of ICT in companies.

| Author | Title of study | Region |
|---|---|---|
| Black & Lynch | How to Compete: The Impact of Workplace Practices and Information Technology on Productivity | USA |
| Gretton et al. | The effects of ICTs and complementary innovations on Australian productivity growth | Australia |
| Stare et al. | Exploiting ICT potential in service firms in transition economies | Slovenia |
| Miyazaki et al. | Corporate productivity and the stages of ICT development | Japan |
| Yunis et al. | Impact of ICT-based innovations on organizational performance: The role of corporate entrepreneurship | Lebanon |
| DeStefano et al. | Broadband infrastructure, ICT use and firm performance: Evidence for UK firms | UK |
| Koutroumpis et al. | Small is big in ICT: The impact of R&D on productivity | Germany, France, Sweden and UK |
| Li et al. | Does ICT create a new driving force for manufacturing?—Evidence from Chinese manufacturing firms | China |
| Magoutas et al. | Digital Progression and Economic Growth: Analyzing the Impact of ICT Advancements on the GDP of European Union Countries | EU countries |

Source: (Black & Lynch 2001; Gretton et al. 2004; Stare et al. 2006; Miyazaki et al. 2012; Yunis et al. 2017; DeStefano et al. 2018; Koutroumpis et al. 2020; Li et al. 2022; Magoutas et al. 2024)

As it can be seen, today ICT and the long-term strategy of companies are so closely related that there is quite a lot of research in this field. In recent years, the interest of companies in Azerbaijan in innovations has characterized the relevance of the research. Here, innovation refers more to the ICT process.

**Methodology**

The study is based on the qualitative research method. At the same time, it includes analyses such as statistical analysis and comparative analysis. The research database is based on indicators from the State Statistical Committee of the Republic of Azerbaijan. The research will proceed with the following steps:

First: Systematic analysis of key indicators of ICT use in Azerbaijani businesses

Second: Analysis of indicators related to the use of computers and internet in Azerbaijani businesses

Third: Assessment of costs on software and ICT hardware in Azerbaijani businesses

Fourth: Study of ICT usage by businesses in economic regions of Azerbaijan

**Result and Discussion**

It was noted that innovation has a broad meaning and that the study characterized the use of innovations precisely in the sense of using ICT. In this regard, it is important to first systematically analyze the key indicators related to the use of ICT by Azerbaijani businesses. The table below will form the basis of the analysis in this direction.

**Table 2.** Key indicators of ICT use in Azerbaijani businesses during 2014-2023 (in percentage)

| Name of the indicator | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| Share of business that used computers in the total number of all businesses | 58,6 | 63,1 | 65,3 | 66,9 | 67,2 | 62,8 | 63,9 | 65,2 | 65,8 | 66,6 |
| Ratio of the number of employees who have used a computer to the number of employees working in all businesses | 23,2 | 28,0 | 29,6 | 30,7 | 33,4 | 33,9 | 35,1 | 35,8 | 36,2 | 36,6 |
| Share of businesses with Internet access in the total number of all businesses | 45,7 | 48,0 | 51,6 | 52,5 | 52,9 | 51,5 | 52,5 | 54,2 | 54,8 | 56,0 |
| Ratio of the number of employees who have used the Internet to the number of employees working in all businesses | 16,5 | 20,4 | 21,9 | 23,1 | 25,3 | 25,8 | 26,9 | 28,1 | 29,4 | 30,1 |

Source: Compiled by the authors based on data from the State Statistical Committee of Azerbaijan (https://stat.gov.az/)

There are a number of additional researchers who use these statistics.

Gretton et al. show in their research that over a 9-year period (1993-2001) computer use in Australian businesses (excluding agriculture, forestry and fishing, general government and others) increased by approximately 30 percent (Gretton et al. 2004). In Azerbaijan, the share of companies using computers in all companies increased by 8% over 10 years, reaching 66.6% in 2023, which is approximately 20% less than Australia's indicator in 2001.

At the same time, it should be noted that there is a slight increase in the proportion of employees using computers in Azerbaijani enterprises as a percentage of the total number of employees. Thus, while the aforementioned indicator was 23.2% in 2014, it reached 36.6% in 2023.

Skorupinska & Torrent-Sellens found that companies with internet access account for 95.79% of all companies in Bulgaria, 100% of all companies in Poland, 96.43% of all companies in Romania, 80% of all companies in Serbia, and 86.64% of all companies in Ukraine (Skorupinska & Torrent-Sellens, 2017). In Azerbaijan, this indicator has increased by 10.3% over the last 10 years, reaching 56% in 2023. However, this indicator still lags behind the indicators of Eastern European countries.

On the other hand, the proportion of employees using the Internet in all companies in Azerbaijan is also increasing. Thus, in 2023, the said indicator was 30.1%, which is 13.6% more than in 2014.

To further explore the use of innovations in companies in Azerbaijan, it is becoming necessary to analyse computer usage indicators.

**Table 3.** Use of computers and internet in Azerbaijani businesses during 2014-2023 (in percentage)

| Name of the indicator | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Distribution of enterprises that have used computers by number of employees** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| With 1-4 employees | 25,1 | 25,2 | 25,3 | 27,4 | 29,8 | 39,9 | 45,0 | 47,0 | 49,2 | 49,1 |
| With 5-9 employees | 15,8 | 15,8 | 16,0 | 17,1 | 16,5 | 15,0 | 16,2 | 15,9 | 15,7 | 15,7 |
| With 10-49 employees | 34,2 | 34,0 | 33,7 | 30,7 | 27,8 | 23,9 | 22,9 | 22,7 | 21,9 | 21,9 |
| With 50-249 employees | 18,4 | 18,4 | 18,4 | 18,2 | 19,5 | 15,7 | 11,5 | 10,3 | 9,5 | 9,5 |
| With 250 or more employees | 6,5 | 6,6 | 6,6 | 6,6 | 6,4 | 5,5 | 4,4 | 4,1 | 3,7 | 3,8 |
| **Distribution of enterprises with Internet access by number of employees** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| With 1-4 employees | 15,9 | 16,3 | 16,3 | 21,9 | 23,7 | 34,7 | 40,7 | 43,0 | 46,1 | 46,2 |
| With 5-9 employees | 15,4 | 15,7 | 15,7 | 17,5 | 15,4 | 14,9 | 16,3 | 16,2 | 15,4 | 15,4 |
| With 10-49 employees | 36,9 | 36,8 | 36,8 | 30,1 | 28,9 | 24,6 | 23,7 | 23,5 | 22,6 | 22,7 |
| With 50-249 employees | 23,5 | 22,9 | 22,9 | 22,3 | 24,1 | 19,1 | 13,9 | 12,4 | 11,4 | 11,3 |
| With 250 or more employees | 8,3 | 8,3 | 8,3 | 8,2 | 7,9 | 6,7 | 5,4 | 4,9 | 4,5 | 4,4 |

Source: Compiled by the authors based on data from the State Statistical Committee of Azerbaijan (https://stat.gov.az/)

Analysis of the number of employees of companies using ICT has been reflected in a number of studies (Arvanitis & Loukis, 2009; Díaz-Chao et al., 2015; Mwantimwa, 2019). However, there are various differences in the distribution of the number of employees. For instance,Arvanitis & Loukis divided the number of employees into 0, 1-20, 21-40, 41-60, 61-80, and 81-100. What's important here is that when researchers analyzed companies in Greece and Switzerland, they found that companies with fewer employees had higher levels of internet access, while companies with more employees had lower levels (Arvanitis & Loukis, 2009).

The same situation is typical for Azerbaijan. Thus, the highest indicator of both computer and Internet access in 2023 belongs to enterprises with 1-4 employees. Over the past 10 years, the share of these enterprises in total enterprises has increased by 24 percent due to computer use and the share of total enterprises has increased by 30.3 percent due to Internet use.

These indicators have decreased in enterprises with 250 or more employees. The main reason for this is that in Azerbaijan there are mainly small manufacturing-type enterprises with 1-4 employees and a small number of enterprises with 250 or more employees.

In enterprises with 10-49 employees, these indicators are decreasing. Thus, over the past 10 years, the share of these enterprises in total enterprises due to computer use has decreased by 12.3%, and the share of these enterprises in total enterprises has decreased by 14.2% due to Internet use

One of the important areas in the field of innovation is the costs that companies incur on ICT, and the table below includes these costs.

**Table 4.** Some of the costs of software and ICT equipment in Azerbaijani businesses (in million manat)

| **Cost** | **2019** | **2020** | **2021** | **2022** | **2023** |
|---|---|---|---|---|---|
| **Total** | **128,6** | **157,7** | **216,4** | **244,4** | **298,5** |
| including software costs | 38,2 | 48,5 | 84,2 | 103,1 | 132,1 |
| **Share of software costs in GDP, percentage** | **0,05** | **0,07** | **0,09** | **0,08** | **0,09** |
| **License costs** | **29,9** | **32,6** | **64,8** | **78,8** | **103,7** |
| Including: operating systems | 8,0 | 14,8 | 30,6 | 47,9 | 68,1 |
| databases | 2,7 | 2,6 | 1,7 | 0,9 | 1,8 |
| programming tools | 3,8 | 2,4 | 10,7 | 6,8 | 5,1 |
| other software | 15,4 | 12,8 | 21,8 | 23,2 | 28,7 |
| **Technical support costs** | **34,0** | **44,0** | **62,5** | **68,1** | **74,8** |
| including: support for technical equipment | 15,1 | 17,5 | 25,9 | 23,7 | 28,3 |
| support for system software | 11,5 | 12,9 | 12,3 | 22,8 | 24,4 |
| support for application software | 7,4 | 13,6 | 24,3 | 21,6 | 22,1 |
| **ICT equipment costs** | **25,4** | **28,3** | **27,5** | **25,0** | **33,6** |
| including: technical equipment intended for users | 13,4 | 11,5 | 13,7 | 10,5 | 12 |
| server equipment | 6,7 | 8 | 7,1 | 9,8 | 16 |
| network equipment | 3,9 | 6,8 | 5,3 | 2,9 | 3,5 |
| ICT security equipment | 1,4 | 2 | 1,4 | 1,8 | 2,1 |
| **Costs for connecting to the Internet** | **19,7** | **23,1** | **28,2** | **35,8** | **41,1** |

Source: Compiled by the authors based on data from the State Statistical Committee of Azerbaijan (https://stat.gov.az/)

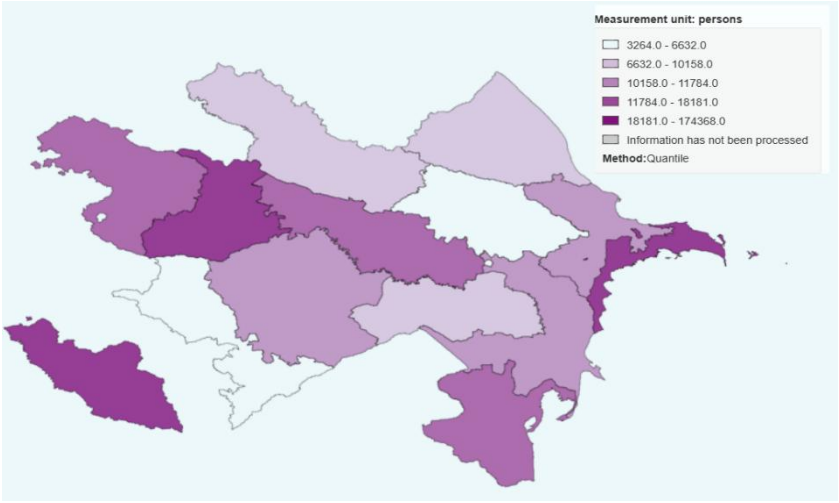
Analysis of the cost section shows that total costs have increased 2.3 times over 5 years. Software costs and license costs have increased 3.5 times over these years. Operating system costs account for the largest share of license costs. Thus, operating costs, which were 8 million manats in 2019, were 68.1 million manats in 2023, which is an 8.5-fold increase.

Technical support costs have increased by 2.2 times. If we look at the main sections of technical support costs, we will see that a proportional increase is observed in these sections. ICT equipment costs have increased by 1.3 times. At the same time, a 2.1-fold increase is also observed in internet connection costs. It should be noted that since there have been only the data on expenditures for the last 5 years (2019-2023), it was not possible to conduct a more extensive analysis.

However, overall, these costs do not have the power to characterize the development of innovation in enterprises and are significantly lower than the country's potential. Thus, in the simplest case, software costs do not even constitute 1 percent of GDP. In such a case, of course, the fact that enterprises experience serious problems related to ICT comes to the fore.

If we consider the issue of Azerbaijan's economic regions, we can see a disproportionate situation here as well.

**Figure 1.** Share of enterprises with internet access in total number of enterprises used computers by kinds of activity (percent) in 2023

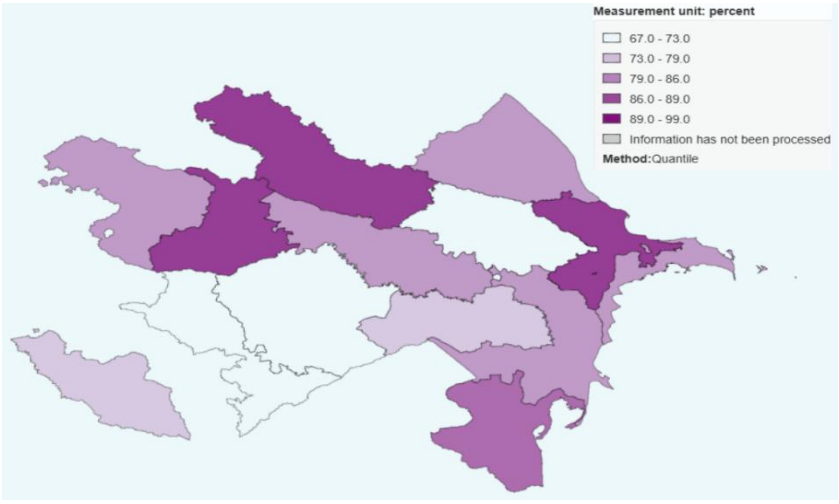



Source: Compiled by the authors based on data from the State Statistical Committee of Azerbaijan (https://stat.gov.az/)

When analyzing the share of enterprises with Internet access in the economic regions of Azerbaijan in total enterprises for 2023, it is seen that only 3 economic regions showed high results. Thus, this indicator was 97.1% in the Absheron-Khizi economic region, 91.5% in the Ganja-Dashkasan economic region, and 89% in the Shaki-Zagatala economic region.

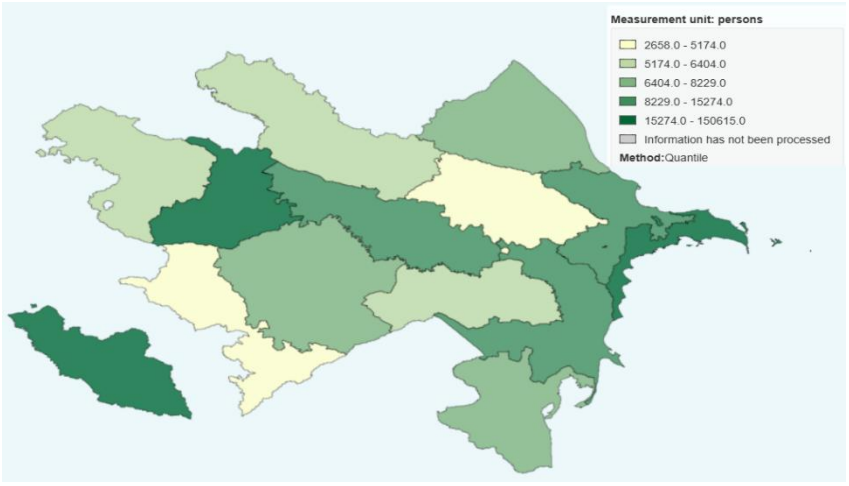
The lowest indicators are in the East-Zangazur, Garabagh and Mountainous Shirvan economic regions. The said indicator is estimated as 67.3% in the East-Zangezur economic region, 71.2% in the Garabagh economic region, and 72.7% in the Mountainous Shirvan economic region.

**Figure 2.** Number of employees using computers (persons)




Source: Compiled by the authors based on data from the State Statistical Committee of Azerbaijan (https://stat.gov.az/)

**Figure 3.** Number of employees using internet (persons)




Source: Compiled by the authors based on data from the State Statistical Committee of Azerbaijan (https://stat.gov.az/)

The figures of employees' use of computers and the Internet by economic regions allow us to say that at least a little proportionality has been achieved in the existing directions. However, the East Zangazur economic region lags behind in this direction. Since restoration work is still ongoing in the territories of Azerbaijan liberated from occupation after the Second Karabakh War, it may take some time for the economic region in question to catch up with the indicators of other economic regions. In general, the indicators in question for economic regions can be considered satisfactory.

## Conclusion

It should be noted that the Fourth Industrial Revolution has clearly changed the main direction of economic development. One of the main directions that characterizes the achievement of high profitability is precisely innovation. A significant part of innovation, which is a broad concept, is related to ICT.

ICT, a key innovation tool in Azerbaijani companies, has grown over the past 10 years. However, this growth rate is below current potential. As such, the use of ICT in Azerbaijani companies is still significantly lower than in Eastern European countries. On the other hand, proportional analysis showed that companies' costs within the framework of ICT development are quite low. Low costs, however, block the more efficient use of innovations. For this, it may seem necessary to stimulate internal investment sources and new investment contours.

Analysis by economic regions showed that the distribution of ICT use at the regional level is relatively proportional. However, the East-Zangazur and Garabagh economic regions lag behind in some sense. The main reason for this is the long-term lack of habitation in these territories and their occupation. The reintegration of these territories into the Azerbaijani economy after the Second Garabagh War will characterize the growth of these indicators in the upcoming years.

## References

1. Allen, R. C. (2011). *Global economic history: A very short introduction* (Vol. 282). Oxford University Press, USA.
2. Arvanitis, S., & Loukis, E. N. (2009). Information and communication technologies, human capital, workplace organization and labour productivity: A comparative study based on firm-level data for Greece and Switzerland. *Information Economics and Policy, 21*(1), 43–61.
3. Black, S. E., & Lynch, L. M. (2001). How to compete: the impact of workplace practices and information technology on productivity. *Review of Economics and Statistics, 83*(3), 434–445.

4. DeStefano, T., Kneller, R., & Timmis, J. (2018). Broadband infrastructure, ICT use and firm performance: Evidence for UK firms. *Journal of Economic Behavior & Organization, 155*, 110–139.
5. Díaz-Chao, Á., Sainz-González, J., & Torrent-Sellens, J. (2015). ICT, innovation, and firm productivity: New evidence from small local firms. *Journal of Business Research, 68*(7), 1439–1444.
6. Frank, A. G., Mendes, G. H., Ayala, N. F., & Ghezzi, A. (2019). Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective. *Technological Forecasting and Social Change, 141*, 341–351.
7. Gretton, P., Gali, J., & Parham, D. (2004). The effects of ICTs and complementary innovations on Australian productivity growth. In *The Economic Impact of ICT: Measurement, Evidence and Implications* (pp. 105–130). OECD Publishing.
8. Guliyeva, A., Rzayeva, U., Azimzadeh, A., & Guliyeva, A. (2025). Humanitarian crises in the digital age. In *International Relations Dynamics in the 21st Century: Security, Conflicts, and Wars* (pp. 41–62). IGI Global.
9. Horváth, D., & Szabó, R. Z. (2019). Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting and Social Change, 146*, 119–132.
10. Schumpeter, J. A. (1949). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Harvard University Press.
11. Kahn, K. B. (2018). Understanding innovation. *Business Horizons, 61*(3), 453–460.
12. Kimani, D., Adams, K., Attah-Boakye, R., Ullah, S., Frecknall-Hughes, J., & Kim, J. (2020). Blockchain, business and the fourth industrial revolution: Whence, whither, wherefore and how? *Technological Forecasting and Social Change, 161*, 120254.
13. Klerkx, L., & Begemann, S. (2020). Supporting food systems transformation: The what, why, who, where and how of mission-oriented agricultural innovation systems. *Agricultural Systems, 184*, 102901.
14. Koutroumpis, P., Leiponen, A., & Thomas, L. D. W. (2020). Small is big in ICT: The impact of R&D on productivity. *Telecommunications Policy, 44*(1), 101833.
15. Krafft, M., Sajtos, L., & Haenlein, M. (2020). Challenges and opportunities for marketing scholars in times of the fourth industrial revolution. *Journal of Interactive Marketing, 51*, 1–8.
16. Li, C., He, S., Tian, Y., Sun, S., & Ning, L. (2022). Does the bank's FinTech innovation reduce its risk-taking? Evidence from China's banking industry. *Journal of Innovation & Knowledge, 7*(3), 100219.
17. Li, D., Chen, Y., & Miao, J. (2022). Does ICT create a new driving force for manufacturing?—Evidence from Chinese manufacturing firms. *Telecommunications Policy, 46*(1), 102229.
18. Lyytinen, K., Yoo, Y., & Boland Jr, R. J. (2016). Digital product innovation within four classes of innovation networks. *Information Systems Journal, 26*(1), 47–75.
19. Magoutas, A. I., Chaideftou, M., Skandali, D., & Chountalas, P. T. (2024). Digital progression and economic growth: Analyzing the impact of ICT advancements on the GDP of European Union countries. *Economies, 12*(3), 63.
20. Mahmood, T., & Mubarik, M. S. (2020). Balancing innovation and exploitation in the fourth industrial revolution: Role of intellectual capital and technology absorptive capacity. *Technological Forecasting and Social Change, 160*, 120248.
21. Miyazaki, S., Idota, H., & Miyoshi, H. (2012). Corporate productivity and the stages of ICT development. *Information Technology and Management, 13*, 17–26.
22. Mwantimwa, K. (2019). ICT usage to enhance firms' business processes in Tanzania. *Journal of Global Entrepreneurship Research, 9*(1), 46.
23. Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management. *MIS Quarterly, 41*(1), 223–238.
24. Obradović, T., Vlačić, B., & Dabić, M. (2021). Open innovation in the manufacturing industry: A review and research agenda. *Technovation, 102*, 102221.

25. OECD. (2015). *OECD Science, Technology and Industry Scoreboard 2015: Innovation for growth and society*. OECD Publishing.
26. Pantano, E., & Stylidis, D. (2021). New technology and tourism industry innovation: Evidence from audio-visual patented technologies. *Journal of Hospitality and Tourism Technology, 12*(4), 658–671.
27. Serdyukov, P. (2017). Innovation in education: What works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning, 10*(1), 4–33.
28. Skorupińska, A., & Torrent-Sellens, J. (2017). ICT, innovation and productivity: Evidence based on eastern European manufacturing companies. *Journal of the Knowledge Economy, 8*, 768–788.
29. Stare, M., Jaklič, A., & Kotnik, P. (2006). Exploiting ICT potential in service firms in transition economies. *The Service Industries Journal, 26*(3), 287–302.

Received: 11.02.2025
Accepted: 15.04.2025