Digitization and Enterprise Efficiency in Selected EU Countries

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Abstract. Digitization of enterprises becomes very popular recently. Companies should invest in digital transformation of their business processes to reach better efficiency level in order to stay competitive. My study analyses digital transformation on an enterprise level done for Denmark, Netherlands, Finland, Poland, Slovak Republic and Hungary, as well as the impact of digitization on enterprise efficiency in these countries. The results show a large digital gap between selected EU member states. Regarding results obtained, Denmark, Finland and Netherlands have a high level of digitization of both public and private sector. On the other hand, Slovakia, Hungary and Poland have significantly lower level of digitization. We can assume that reasons for such a digital gap observed are the low level of accessibility of digital infrastructure, lack of investments in the integration of digital technology, lack of training of personnel for developing the necessary human capital and the absence of the required business culture in Hungary, Slovakia and Poland. To accelerate the digital transformation of the private sector, Hungary, Slovakia, and Poland will need to make significant investments to improve access to digital infrastructure and enhance people's ICT skills. Results from the panel data fixed effects regression analysis showed that digital transformation of the private sector, especially regarding skilled human capital and successful integration of digital technology, supported by a high level of digital public services, is the way to improve labor and capital productivity in the country.

Keywords: Digitization, Enterprise Efficiency, Digital Divide

JEL classification: *D22, O57, O33*

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1 Introduction

The transformation from a traditional economy to a digital economy comes to the forefront when the country's conventional growth factors, such as natural resources, low labour costs, and foreign investments reach their limits. Considering the new realities of the modern world, many countries develop policies and action plans for stimulating investments in innovation and new technologies (Boris et al., 2018; Pianta et al., 2020; Sara, 2001; Hadad, 2017). On the other hand, to stay competitive in a global world where digitisation is a common trend, companies must invest in the digital transformation of their business processes to reach a better efficiency level, as digitisation provides a lot of opportunities to improve the production and business processes (Lv & Xiong, 2022). There are several aspects in which digitisation enables potential in production, such as optimisation of the business processes, including data-driven optimisation of the planning and production phases (Mortal & Schill, 2018).

The recent COVID-19 pandemic highlighted the urgency of following the path of digital transformation of economic activities and business processes to stay competitive (Gavrila & Ancillo, 2021).

The EU has developed policies, action plans and analytical documents to encourage a faster digital transformation in the member states of the economic union (EC, 2020; EIB, 2020; EC, 2021). However, the research reveals a significant digital divide between the European Union member states (Cruz-Jesus et al., 2011, 2012; Hayriye & Fatma, 2020). The goal of the current study is to make a comparative analysis of the current state of enterprise digitisation to explore the factors leading to a better and slower digital transformation in the selected countries of the European Union (Denmark, Netherlands, Finland, Slovakia, Poland and Hungary).

The modernisation of the Slovak, Polish and Hungarian economies, successful implementation of ICT and digital transformation of the private sector are essential sources for economic growth and development as their comparative advantages, such as low labour costs, are reaching their limits. To explore the missed opportunities of the countries with relatively lower digitisation of the private sector, we must examine the influence of enterprise digital transformation on the efficiency of business processes, business performance and the industry in general. The current research aims to reveal the impact of digitisation on the efficiency of enterprises in European Union (EU) member states. In the framework of the current study, the concept of digitisation is as follows: the automation of business processes by converting the information from a physical format into a digital format.

2 Literature review

In the framework of the current study, we consider the following definition of digitisation: "the social transformation triggered by the massive adoption of digital technologies to generate, process, share and transact information" (Katz et al., 2013). In the modern world, Information and Communication Technology (ICT) influences all areas of economic activity, including businesses, government and society. Despite the low affordability of ICT during the first years of their implementation, the rapid

diffusion of technology decreased their prices and enabled accessibility for the broader community.

Various studies argue that the digital transformation of the private sector largely contributes to the economic development and productivity growth in the country (Kuzmina et al., 2021; Li et al., 2022; Liu et al., 2022). The impact of digitisation on the companies' business processes goes through the following channels: human capital (Blizkiy et al., 2021; Bonci et al., 2022; Konovalova et al., 2021) and labour productivity (Aly, 2022), finance (Liu et al., 2022), technological innovation (Liu et al., 2022), business risks reduction (Liu et al., 2022).

Aly (2022) examined the relationship between digital transformation, economic development and productivity growth in developing countries, coming to a conclusion about a strong "positive relationship between the digital transformation index and economic development, labour productivity and job employment."

The literature review shows a lack of research on digital transformation on an enterprise level done for Poland, Slovak Republic and Hungary, as well as in the field of comparative analysis between the countries with high and low levels of digitisation. The current study aims to close this gap.

3 Methodology

The study will apply the following quantitative research methods: statistical, graphical and econometric analysis and secondary data collection and analysis. Methods of deduction and logical assumptions will complement the quantitative analysis. The secondary information will be collected from the following sources: the Eurostat database, the World Development Indicators database, the database of the European Commission on Digital Economy and relevant national statistical databases and survey results. The analysis will be done for the following countries: Denmark, Netherlands, Finland, Slovakia, Poland and Hungary.

The main research questions are as follows:

1 What is the current state of digitisation in the selected countries (Denmark, Netherlands, Finland, Slovakia, Poland and Hungary)?

2 How the digitisation influences the efficiency of enterprises in the selected countries?

3 What should be the policy of the countries with unfavourable digitisation conditions?

As the research hypothesis, we assume that digital transformation has a significant positive influence on the business processes efficiency; however, some EU member states' private sectors lack investments in the digitisation of enterprises, leading to less favourable competitiveness of their national companies in a globalised world.

The efficiency of the business processes will be measured through the capital and labour productivity indicators, which show the production material intensity. A lower material intensity indicates that one unit of production factor (capital and labour) provides more output; hence the company's business processes are more efficient.

The digitisation is measured using data from several indices and reliable survey results. The first indicator is the Digital Economy and Society Index (DESI) with its four components – human capital, connectivity, integration of digital technology and digital public services. Also, the following data from Eurostat is used: the number of enterprises that provided training to their personnel to develop/upgrade their ICT skills, the number of ICT specialists, and digital intensity. Also, the following data from the EIB Investment Survey will be analysed: access to digital infrastructure and implementation of digital technologies.

4 Results

4.1. Digitisation and productivity in the selected EU member states

Digital Economy and Society Index (DESI)

We are considering the DESI index through its four dimensions: human capital, connectivity, integration of digital technology and digital public services. Figure 1 presents the index and its components for Denmark, Netherlands, Finland, Slovakia, Poland and Hungary in 2021 and 2022.

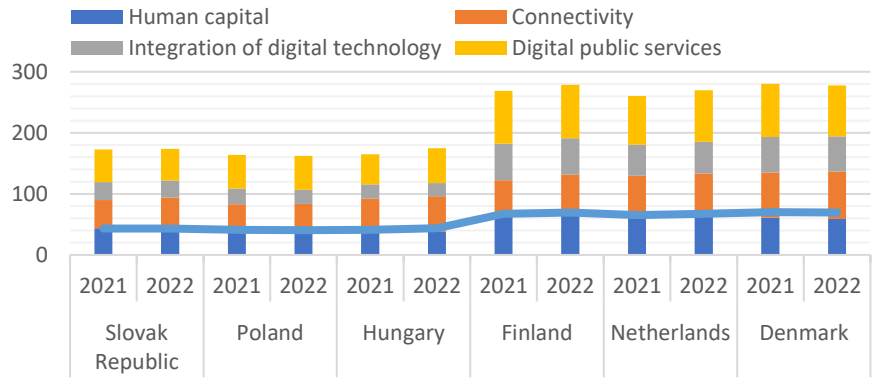

Figure 1. Digital Economy and Society Index (DESI) and its components, 2021-2022, *Source: European Commission Database*

It is evident from Figure 1 that there is a considerable digital gap between different EU member states. Slovakia, Poland and Hungary lack behind Finland, Netherlands and Denmark regarding all the DESI components. The highest gap is tracked in the case of digital public services, integration of digital technology and human capital. Concerning the digitalisation and effectiveness of the private sector, we should highlight the importance of the high level of digitisation of public services, as it would considerably decrease the transaction costs and time losses for the enterprises in the countries. On the other hand, the low level of integration of digital technology indicates the low level of digital transformation in business processes. However, a successful digital transformation also requires a cultural change in the companies. The latter can happen only if the companies have the human capital with the necessary skills. However, the low level of the human capital component of the DESI index indicates

the challenging nature of digital transformation in the Slovak Republic, Poland and Hungary.

EIB Investment Survey

Investments are the primary source for business development and the modernisation of business processes. In general, access to digital infrastructure can be a significant obstacle to investments. Figure 2 presents whether the enterprises of the selected EU member states consider access to digital infrastructure an obstacle.

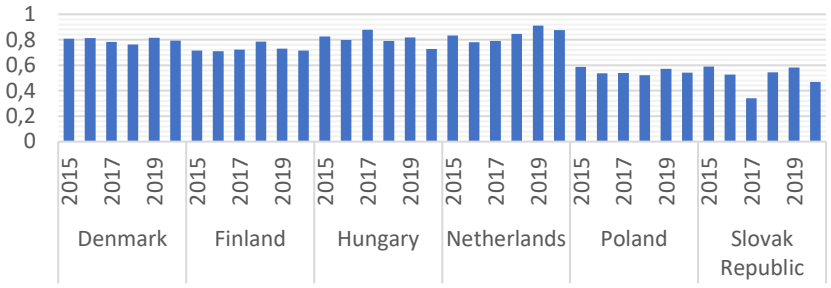

Figure 2. Access to digital infrastructure (no obstacle), 2015-2020
Source: EIBIS 2016, EIBIS 2017, EIBIS 2018, EIBIS 2019, EIBIS 2020, EIBIS 2021

Figure 2 shows a large gap between Poland and Slovakia and the other selected countries. In the case of Poland and Slovakia, a relatively low share of enterprises considers that there is no obstacle to accessing the digital infrastructure in their countries. Without the accessibility of digital infrastructure, the digital transformation of companies becomes very difficult.

Another important indicator is the share of companies implementing single or multiple digital technologies (Figure 3). Here we can see that the Slovak Republic experienced considerable development in 2020, reaching the level of Finland, the Netherlands and Denmark. While at the same time, Poland and Hungary considerably lack behind.

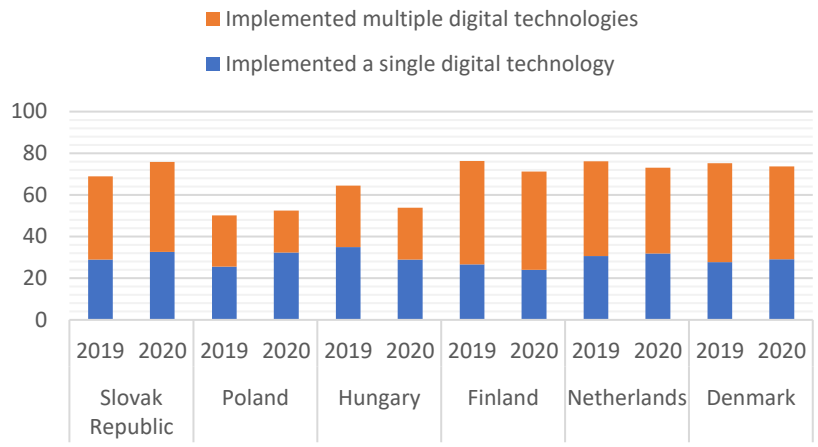

Figure 3. Implementation of digital technologies, 2019-2020
Source: EIBIS 2020, EIBIS 2021

Enterprise digitisation indicators

In 2021 the EU started calculating the digital intensity index for EU member states. The digital intensity shows how digitalised European enterprises are. Figure 4 presents the digital intensity index for the selected EU countries. The digital gap between the enterprises operating in Slovakia, Poland and Hungary and those operating in Finland, Netherlands and Denmark is considerably large. 56% of Slovak enterprises, 58% of Polish enterprises and 64% of Hungarian enterprises have a very low digital intensity index. At the same time, only 18%, 24% and 20% of enterprises operating in Finland, Netherlands, and Denmark, respectively, have a very low Digital intensity index.

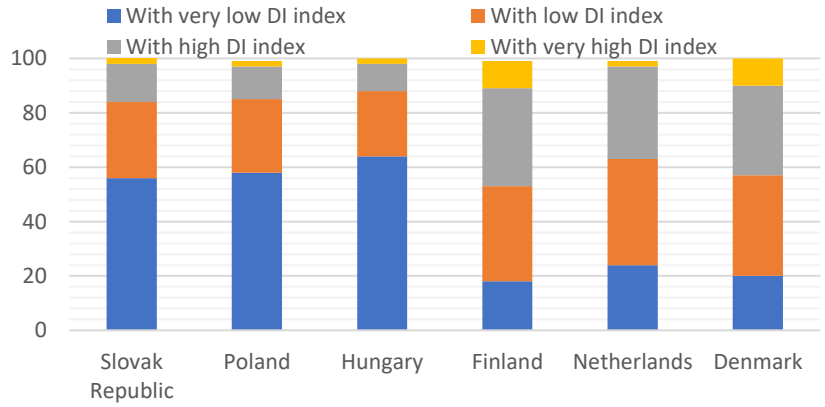

Figure 4. Digital intensity, 2021, *Source: Eurostat*

There are also considerable differences in the share of ICT specialists in total employment in the selected countries (Figure 5). Here we can see that the COVID-19

pandemic has accelerated the digital transformation in some countries leading to an increase in the share of employed ICT specialists and enterprises that employ ICT specialists. In Poland, the percentage of enterprises that employ ICT specialists reached 25% in 2020; in Hungary, 29%; and in Finland, 28%. However, in this regard, Slovakia lacks behind all the selected countries, with only 17% of enterprises employing ICT specialists as of 2020.

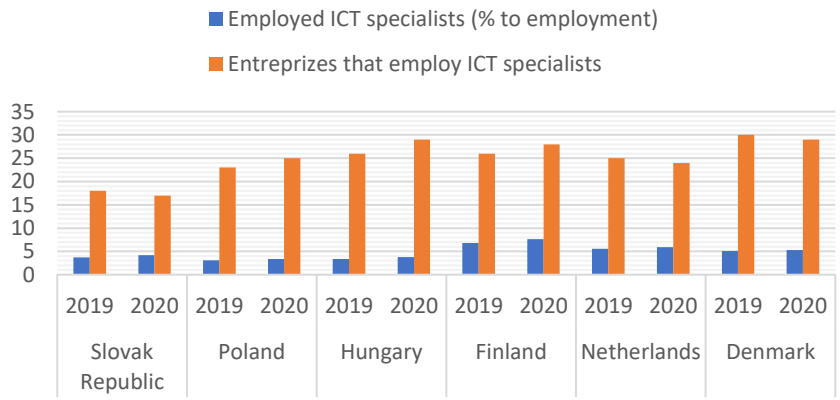

Figure 5. Employed ICT specialists (% to employment), enterprises that employ ICT specialists (share of all enterprises, without financial sector), 2019-2020
Source: Eurostat

The last indicator considered within the framework of the current research is the training enterprises provide for employees to develop their ICT skills. In the case of this indicator, again, we can see that a relatively low number of enterprises operating in Hungary, Poland and Slovakia provide ICT training for their personnel. We can link this back to the low level of the human capital component of the DESI index.

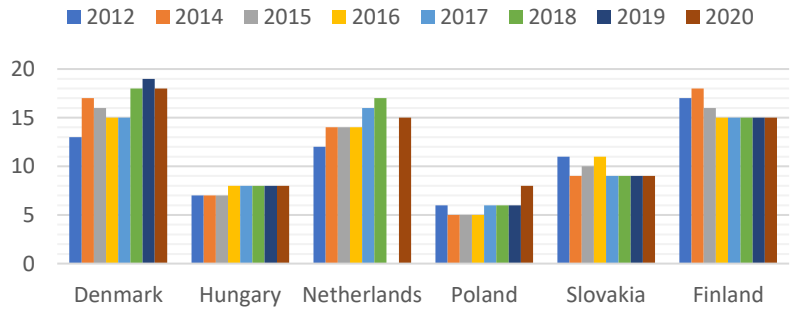

Figure 6. Enterprises that provided training to develop/upgrade the ICT skills of their personnel, 2012-2020
Source: Eurostat

After analysing the indicators of digital transformation of enterprises in the Slovak Republic, Poland, Hungary, Denmark, Finland and Netherlands, we should highlight

the large digital gap between these countries. The reasons for the existing digital gap are the low level of accessibility of digital infrastructure, lack of investments in the integration of digital technology, lack of training of personnel for developing the necessary human capital and the absence of the required business culture in Hungary, Slovakia and Poland.

Production efficiency

In the framework of the current study, production efficiency is estimated by the indicators of labour productivity and capital productivity which show the level of material intensity of production. These indicators are calculated based on the data on GDP, capital input and labour input. Capital productivity shows how much output is produced with a unit of capital stock, while labour productivity shows how much output is produced with a unit of labour input.

4.2. The influence of digitisation on the productivity of enterprises

To estimate the influence of digitisation on enterprise efficiency, we have conducted a panel data regression analysis. The dependent variable is the production efficiency measured by capital and labour productivity. The independent variables will be the components of DESI and the share of ICT specialists in total employment. All the variables are taken as the percentage change against the previous period. The time series have a normal distribution, are stationary and don't have seasonality. The study is done for the period from 2015 to 2019 for the following countries: Denmark, Netherlands, Finland, Slovakia, Poland and Hungary. The estimations of the panel data regression models were done using the econometric package EViews 10. Equations (1) and (2) present the models for estimating the significance of the influence of digitisation on productivity.

$$LP_{it} = C + \alpha HC_{it} + \beta Con_{it} + \gamma Int_{it} + \delta DPS_{it} + \tau Emp_{it} + u_i + \varepsilon_{it} , \quad (1)$$

$$CP_{it} = C + \alpha HC_{it} + \beta Con_{it} + \gamma Int_{it} + \delta DPS_{it} + \tau Emp_{it} + u_i + \varepsilon_{it} . \quad (2)$$

Where i = 1, …, N represent the selected EU member states; t = 1, …, T represent the corresponding periods from 2015 to 2020; HC_{it} represents a vector of time-varying explanatory variables for the human capital component of DESI across the selected EU member-states; Con_{it} represents a vector of time-varying explanatory variables for the connectivity component of DESI across the selected EU member states; Int_{it} represents a vector of time-varying explanatory variables for the integration of the digital technology component of DESI across the selected EU member states; DPS_{it} represents a vector of time-varying explanatory variables for the digital public services component of DESI across the selected EU member states; Emp_{it} represents a vector of time-varying explanatory variables for the share of employed ICT specialists in total employment across the selected EU member-states; LP_{it} and CP_{it} are the dependent variables; ε_{it} is the error term. The panels are balanced with a total number of observations equal to 36.

We have considered three possible panel data models: pooled OLS, Fixed effects and Random effects. For both models, the fixed effects method was chosen as it was the best fitting model for estimating the coefficients in equation (1) and equation (2)

according to the Lagrange multiplier (LM) test for comparing pooled-OLS and Random Effects estimation methods, and Hausman test for comparing the appropriateness of random effects and fixed effects methods. Table 1 presents the estimation results for equation (1) and equation (2) with a fixed effects model.

Table 1. Estimation results for unemployment

	Labor Productivity (Equation 1)			Capital Productivity (Equation 1)		
Regressor	Coeff.	t-Statistic	Prob.	Coeff.	t-Statistic	Prob.
HC	***13.53***	*1.945*	***0.0631***	*-1.08*	*-0.14*	*0.8895*
Con	*3.02*	*0.799*	*0.4314*	*0.94*	*0.226*	*0.8229*
Int	***8.42***	*2.633*	***0.0143***	***14.6***	*4.144*	***0.0003***
DPS	***6.74***	*1.921*	***0.0661***	***9.36***	*2.424*	***0.0229***
Emp	*-0.41*	*-0.226*	*0.823*	*-2.04*	*-1.024*	*0.3156*
C	*0.2*	*0.334*	*0.7413*	*-0.57*	*-0.857*	*0.3993*
R-square	*0.57678*			*0.66792*		
R^2 adj.	*0.40749*			*0.53509*		
F-statistic	*3.40709*			*5.0284*		
Prob(F-statistic)	*0.00622*			*0.0005*		
Durbin-Watson stat	*2.22129*			*2.341*		

Source: Author's calculations based on the Eurostat database and DESI country reports.

The adjusted R-square is 0.407 for the model (1), indicating that the regressors can explain 40.7% of the changes in the dependent variable. At the same time, according to the same indicator, the regressors can explain 53.5% of changes in capital productivity. The probability of the F-statistic is lower than 0.05. Hence, we can assume that model (1) and model (2) fit the data better than a model without HC, Con, Int, DPS and Emp as independent variables. The Durbin-Watson statistic shows no autocorrelation of residual values in the case of both models.

Equations (3) and (4) show the estimated fixed effects model for labor productivity and capital productivity for the selected EU member states.

$$LP_{it} = 0.2 + 13.53HC_{it} + 3.02Con_{it} + 8.42Int_{it} + 6.74DPS_{it} - 0.41Emp_{it}\ , \quad (1)$$

$$CP_{it} = -0.57 - 1.08HC_{it} + 0.94Con_{it} + 14.6Int_{it} + 9.36DPS_{it} - 2.04Emp_{it}. \quad (2)$$

The estimated coefficients of human capital, integration of digital technology and digital public services components of DESI have a p-value lower than 0.1; hence we can reject the null hypothesis of the coefficients being equal to zero and consider these indicators significant for labour productivity at a 10% significance level. On the other hand, estimated coefficients of integration of digital technology and digital public services components of DESI have a p-value lower than 0.05; hence we can reject the

null hypothesis of the coefficients being equal to zero and consider these indicators as significant for capital productivity at a 5% significance level.

For labour productivity, we have the following results:

- A 1% change in the human capital score of DESI leads to an increase in labour productivity by 13.53%.
- A 1% change in the integration of the digital technology score of DESI leads to an increase in labour productivity by 8.42%.
- A 1% change in the digital public services score of DESI leads to an increase in labour productivity by 6.74%.

For capital productivity, we have the following results:

- A 1% change in the integration of the digital technology score of DESI leads to an increase in labour productivity by 14.6%.
- A 1% change in the digital public services score of DESI leads to an increase in labour productivity by 9.36%.

4 Conclusion

The study showed a large digital gap between the selected EU member states. While Denmark, Finland and Netherlands have a high level of digitisation of public and private sectors, the Slovak Republic, Poland and Hungary significantly lag behind. According to the analysis presented above, we can assume that the main reasons for such a digital gap are the low level of accessibility of digital infrastructure, lack of investments in the integration of digital technology, lack of training of personnel for developing the necessary human capital and the absence of the required business culture in Hungary, Slovakia and Poland. These countries will need an excellent digital transformation strategy to transform the business culture in the private sector with the support of the digitisation of public services to reduce transaction costs and time for enterprises. To accelerate the digital transformation of the private sector, Hungary, Slovakia, and Poland will need to make significant investments to improve access to digital infrastructure and enhance people's ICT skills.

The panel data fixed effects regression analysis showed that digital transformation of the private sector, especially regarding skilled human capital and successful integration of digital technology, supported by a high level of digital public services, is the way to improve labour and capital productivity in the country.

References

1. ALY, H. (2022). Digital transformation, development and productivity in developing countries: is artificial intelligence a curse or a blessing? *Review of Economics and Political Science*, 2022, 7.4: 238-256.
2. BORIS, O. A., TIMOSHENKO, P. N., TADTAEV, D. M., & REBIY, E. Y. (2018). Integrated Innovation and Investment Policy as The Factor Of A Balanced Development Of The New Economy. *Quality-Access to Success*, *19*.
3. CRUZ-JESUS, F., OLIVEIRA, T., & BACAO, F. (2012). Digital divide across the European Union. Information & Management, 49(6), 278-291.

4. HADAD, S. (2017). Business Digitisation in the Romanian Economy. *Strategica. Shift. Major challenges of today economy, Bucharest: Tritonic*.
5. HAYRIYE, A. T. İ. K., & FATMA, Ü. N. L. Ü. (2020). Industry 4.0-related digital divide in enterprises: an analysis for the European union-28. Sosyoekonomi, 28(45), 225-244.
6. KATZ, R. L., KOUTROUMPIS, P., & CALLORDA, F. (2014). The Latin American path towards digitization. *Redes. com: revista de estudios para el desarrollo social de la Comunicación*, (9), 151-183.
7. KONOVALOVA, V. G., AGHGASHYAN, R. V., & GALAZOVA, S. S. (2021). Perspectives and restraining factors of HR analytics in the conditions of digitisation of human resources management. In *Socio-economic Systems: Paradigms for the Future* (pp. 1015-1024). Springer, Cham.
8. KUZMINA, E. Y., ALIBEKOVA, A. B., & SOKLAKOVA, I. V. (2021). Implementation of electronic document turnover as a factor of increasing the management effectiveness in the digital economy. In *Socio-economic Systems: Paradigms for the Future* (pp. 1553-1563). Springer, Cham.
9. LI, R., RAO, J., & WAN, L. (2022). The digital economy, enterprise digital transformation, and enterprise innovation. *Managerial and Decision Economics*.
10. LIU, C., ZHANG, W., & ZHU, X. (2022). Does Digital Transformation Promote Enterprise Development?: Evidence From Chinese A-Share Listed Enterprises. *Journal of Organizational and End User Computing (JOEUC)*, *34*(7), 1-18.
11. LV, P., & XIONG, H. (2022). Can FinTech improve corporate investment efficiency? Evidence from China. *Research in International Business and Finance*, *60*, 101571.
12. MORTAL, S. C., & SCHILL, M. J. (2018). The role of firm investment in momentum and reversal. *Journal of Empirical Finance*, *48*, 255-278.
13. PIANTA, M., LUCCHESE, M., & NASCIA, L. (2020). The policy space for a novel industrial policy in Europe. *Industrial and Corporate Change*, *29*(3), 779-795.
14. SARA, V. (2001). Investment in research in Australia: The role of the Australian Research Council. *Advanced Materials*, *13*(12-13), 869-872.
15. VICENTE, M. R., & MUÑIZ, A. S. G. (2021). A multidimensional analysis of the digital gender gap in European Union Member States. In Technology and Women's Empowerment (pp. 84-100). Routledge.