APPROACH TO PRIORITISATION OF EU COUNTRIES REGARDING DIGITAL ECONOMY

Viktorija Skvarciany – Daiva Jurevičienė

Abstract

The digital economy is gaining more attention as a significant part of services moved to the online environment, especially during the COVID-19 pandemic. The transition to the digital economy is inevitable; hence it is necessary to find out where the countries are now and then develop the digital economy strategy. Consequently, the current study aims at prioritisation of the EU countries regarding the digital economy level. In the current paper for digital economy level measurement, three Digital Economy and Society Index's dimensions directly linked to the digital economy are used. They are as follows: Use of Internet Services, Integration of Digital Technology and Digital Public Services. For prioritisation, the multicriteria decision-making method VIKOR was employed. The results revealed that in terms of the "Use of Internet Services" dimension, the three leading countries are Finland, Sweden, and the Netherlands; in terms of "Integration of Digital Technology" – Ireland, Belgium, and the Netherlands; in terms of "Digital Public Services" – Spain, Finland, and Latvia.

Key words: digital economy, digitalisation, Digital Economy and Society Index (DESI), VIKOR.

JEL Code: O10, O30.

Introduction

One of the European Union's priorities is *A Europe fit for the digital age* (von der Leyen, 2019). Three activities were announced, including *Shaping Europe's digital future*, which is being implemented through three pillars. One of them is *a fair and competitive digital economy* (European Commission, 2020a). Hence, one could state that the digital economy is one of the primary areas of the EU, especially in the COVID-19 era. Consequently, it is necessary to assess the digital economy level in different countries to understand where the countries are now, as it will help set a strategy for development in terms of the digital economy. Hence, the current study aims to prioritise the EU countries regarding the level of the digital economy.

1 Theoretical Background

The digital economy is of great attention in academic literature. The transition to the digital economy is inevitable. Mainly it has sped up during the COVID-19 pandemic as a lot of services and activities moved online. However, this process is hardly measurable, i.e. it is not clear how to measure the level of the digital economy. There are different approaches to that issue. For example, OECD (2018) presented indicators helpful in measuring the digital economy. These indicators are divided into four groups: infrastructure, empowering society, innovation and technology adoption, and jobs and growth. However, OECD does not provide any data on these indicators; hence, this methodology is hard to use. Another organisation that seeks to measure the digital economy is the European Commission, which provided the Digital Economy and Society Index (DESI) (European Commission, 2020b). DESI summarises „relevant indicators on Europe's digital performance and tracks the evolution of EU Member States in digital competitiveness" (European Commission, 2020b). DESI is a representation of five groups of indicators that are as follows: connectivity, human capital, use of Internet services, integration of digital technology, and digital public services. One of the most advantages of that index is that the European Commission provides data on all EU countries and the United Kingdom.

Different scientists use DESI for various purposes. Some scholars used DESI for the statement of the current country's position and forecasting the progress of the digital economy (Laitsou et al., 2020). Some scholars use DESI to compare the improvement in terms of the digital economy of different countries (Banhidi et al., 2019; Todorut & Tselentis, 2018). Some researchers employ DESI for the computation of the digital competitiveness of a country (Jurčević et al., 2020). Other scientists use DESI to examine the relationship between digitalisation and sustainable development (Jovanovic et al., 2019). The current study uses the sub-dimensions of three dimensions of DESI linked to the digital economy. I.e. Internet services, integration of digital technology, and digital public services to prioritise the EU countries plus the UK to find out which sub-dimensions have led the country to be a leader in the digital economy.

2 Methodology

To prioritise countries regarding the digital economy, applied *the VIsekriterijumska optimisacija i KOmpromisno Resenje* (VIKOR) methodology. The main idea of the VIKOR is to choose a solution that is closest to the ideal one in each criterion such that the alternatives

are based on the particular measure of „closeness“ to the „ideal“ solution (Sayadi et al., 2009). VIKOR is created to compare the gap between alternative and ideal alternative by three indicators – the maximum group benefit value *S*, the minimum individual regret value *R*, and the benefit ratio value *Q* (Wang et al., 2021). In the present study, three ranking procedures are made to prioritise countries in all DESI dimensions linked to the digital economy. In „Use of Internet Services“ dimensions, 11 sub-dimensions were evaluated. In „Integration of Digital Technology“, 7 sub-dimensions were assessed, and in „Digital Public Services“ 5 sub-dimensions were evaluated as well. The VIKOR method needs initial weights in advance (Kraujalienė, 2019); hence, the weights were selected as proposed by DESI. All the dimensions with their sub-dimensions and assigned weights are presented in Tab. 1.

Tab. 1: Indicators to Measure Digital Economy

Digital economy dimensions and their sub-dimensions	Weight	Desirable values
Use of Internet Services		
People who never used the Internet	0.125	–
Internet users	0.125	+
News	0.0833	+
Music, videos and games	0.0833	+
Video on demand	0.0833	+
Video calls	0.0833	+
Social networks	0.0833	+
Doing an online course	0.0833	+
Banking	0.0825	+
Shopping	0.0825	+
Selling online	0.0825	+
Integration of Digital Technology		
Electronic information sharing	0.1002	+
Social media	0.1002	+
Big data	0.2	+
Cloud	0.2	+
SMEs selling online	0.1333	+
Commerce turnover	0.1333	+
Selling online cross-border	0.1333	+
Digital Public Services		
Government users	0.2	+
Pre-filled forms	0.2	+
Online service completion	0.2	+
Digital public services for businesses	0.2	+
Open data	0.2	+

Source: European Commission (2020b)

The first step of VIKOR, as another multicriteria decision-making method, is a normalisation of values of a decision matrix which is performed using the following formula:

$$f_{ij}(\mathrm{x}) = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}},$$

where:

f_{ij} – normalised value of *i*-th alternative respective *j*-th criterion (i = 1, ..., m; j = 1, ..., n).

The second step includes the determination of the best and worst benefits of each criterion. the following formula can determine the best and worse benefits:

a. If the criterion is positive, then:

$$f_j^* = \max_i f_{ij}, \;\; f_j^- = \min_i f_{ij}; \;\; j = 1,2,\dots,n$$

b. If the criterion is negative, then:

$$f_j^* = \min_i f_{ij}, \;\; f_j^- = \max_i f_{ij}; \;\; j = 1,2,\dots,n$$

The positive ideal solution (and negative ideal solution) can be expressed as follows:

$$f^* = \{f_1^*, f_2^*, f_3^*, \dots, f_n^*\}$$

$$f^- = \{f_1^-, f_2^-, f_3^-, \dots, f_n^-\}.$$

During the third step, the values and representing the group utility and individual regret, respectively, can be calculated by the formulas below:

$$S_i = \sum_{j=1}^{n} w_j \frac{(f_j^* - f_{ij})}{(f_j^* - f_j^-)}$$

$$R_i = \max_j \left[w_j \frac{\left(f_j^* - f_{ij}\right)}{\left(f_j^* - f_j^-\right)} \right],$$

where: w_j – the weight of the criteria.

The fourth step is the value's Q_i, representing the VIKOR index for each alternative computation by the following formula:

$$Q_i = \gamma \frac{(S_i - S^*)}{(S^- - S^*)} + (1 - \gamma) \frac{(R_i - R^*)}{(R^- - R^*)},$$

where: $S^* = \min_i\{S_i\}; \;\; S^- = \max_i\{S_i\}; \;\; R^* = \min_i\{R_i\}; \;\; R^- = \max_i\{R_i\}$

γ – the maximum group utility represented by value 0.5 (Ikram et al., 2020).

The fifth step is the countries' prioritisation. The countries are ranked by sorting the *S*, *R*, and *Q*, values in decreasing order such that the best rank is assigned to the alternative with the smallest VIKOR value (Acuña-Soto et al., 2019). The best alternatve is chosen based on Q value (Wei et al., 2020).

3 Empirical Findings

Even though the UK left the EU, it is included in DESI; hence, it is left in the current research. As mentioned before, the prioritisation procedure was done in each dimension, linked to the digital economy separately. First of all, the EU countries were ranked in terms of the „Use on Internet Services“ dimension (see Tab. 2).

Tab. 2: Ranking list for alternatives regarding „Use of Internet Services“ dimension

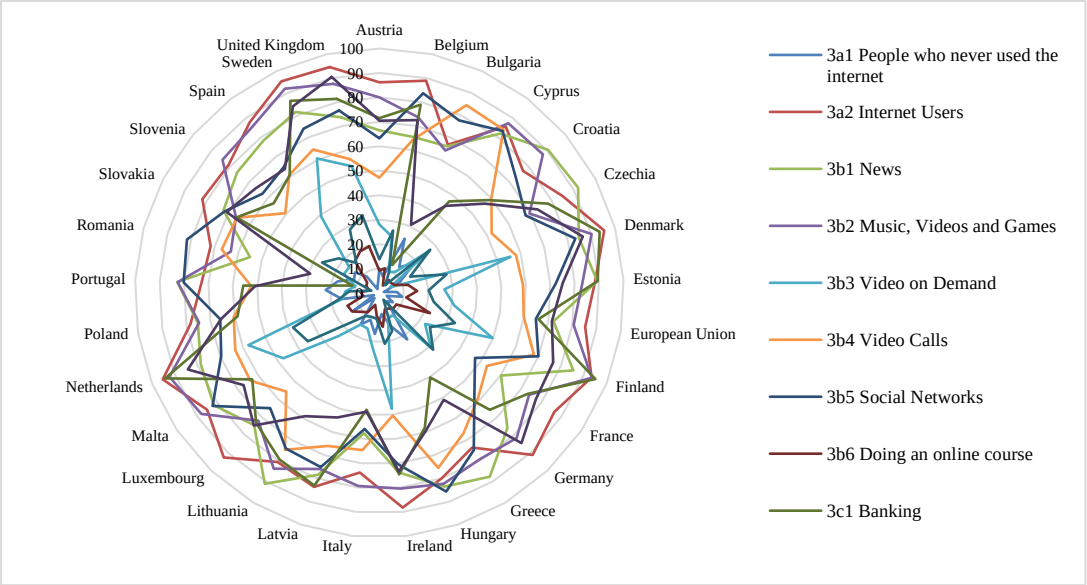
	R value	S value	Q value	Rank in Q
Finland	0.037	0.149	0.001	1
Sweden	0.045	0.148	0.043	2
Netherlands	0.047	0.166	0.075	3
Denmark	0.059	0.163	0.14	4
United Kingdom	0.063	0.186	0.183	5
Estonia	0.057	0.303	0.25	6
Malta	0.061	0.311	0.278	7
Spain	0.053	0.381	0.295	8
Belgium	0.06	0.343	0.299	9
Germany	0.063	0.348	0.324	10
European Union	0.055	0.416	0.336	11
Luxembourg	0.065	0.368	0.35	12
Ireland	0.076	0.36	0.406	13
Lithuania	0.073	0.436	0.456	14
Slovakia	0.071	0.451	0.458	15
Hungary	0.074	0.447	0.472	16
Latvia	0.076	0.471	0.499	17
Czechia	0.083	0.446	0.522	18
Cyprus	0.081	0.47	0.528	19
France	0.083	0.479	0.55	20
Slovenia	0.076	0.531	0.554	21
Austria	0.083	0.489	0.558	22
Poland	0.075	0.541	0.558	23
Croatia	0.091	0.485	0.598	24
Italy	0.094	0.643	0.754	25
Portugal	0.111	0.602	0.814	26
Greece	0.112	0.61	0.827	27
Romania	0.104	0.726	0.883	28
Bulgaria	0.125	0.715	0.991	29

Source: authors‘ calculations

From Tab. 2, it should be seen that the first three positions went to Finland, Sweden, and the Netherlands. One could explain that those countries are among the top 5 countries, with the lowest number of people who have never used the Internet, and hence among the top 5 countries in which there is the most significant number of Internet users. Those two sub-dimensions have the highest weight (Tab. 1), hence are the most influential and, therefore, led the countries to the current positions. The same situation is with the countries in the last three places, i.e. the number of people who have never used the Internet is the highest. The number of internet users is the lowest—the behaviour of other sub-dimensions presented in Fig. 1.

Fig. 1 shows the following sub-dimensions received unordinary high values: „Video on demand“, „Doing an online course“, „Selling online“. Of course, the country could not reach the high values regarding those sub-dimensions without access to the Internet. Hence, we can conclude that the government should provide access to the Internet to achieve a high level of the digital economy, and residents should be encouraged to use it.

Fig. 1: Graphical representation of „Use of Internet Services“ sub-dimensions according to the Q value



Speaking about the „Integration of Digital Technology“ dimension, one should notice that Finland, Malta, and Luxembourg were eliminated from the calculations due to the missing data in several sub-dimensions. The results of the ranking procedure are presented in Tab. 3.

Tab. 3: Ranking list for alternatives regarding „Integration of Digital Technology“ dimension

	R value	S value	Q value	Rank in Q
Ireland	0.065	0.141	0	1
Belgium	0.074	0.24	0.095	2
Netherlands	0.086	0.237	0.135	3
Denmark	0.098	0.289	0.212	4
United Kingdom	0.09	0.463	0.293	5
Sweden	0.145	0.345	0.421	6
Lithuania	0.14	0.487	0.494	7
Estonia	0.129	0.621	0.536	8
European Union	0.136	0.609	0.553	9
Croatia	0.135	0.616	0.554	10
Slovenia	0.14	0.615	0.572	11
Czechia	0.161	0.511	0.585	12
Spain	0.144	0.614	0.586	13
France	0.151	0.584	0.595	14
Portugal	0.148	0.614	0.598	15
Germany	0.167	0.623	0.678	16
Slovakia	0.157	0.739	0.711	17

Austria	0.182	0.625	0.734	18
Italy	0.173	0.76	0.782	19
Latvia	0.173	0.798	0.807	20
Cyprus	0.2	0.721	0.859	21
Greece	0.193	0.783	0.873	22
Hungary	0.183	0.858	0.881	23
Romania	0.192	0.838	0.903	24
Poland	0.196	0.838	0.916	25
Bulgaria	0.2	0.949	1	26

Source: authors‘ calculations

Tab. 3 shows that the leading countries changed. It could be because we removed Finland from this part of the study. Nevertheless, the Netherlands left in the top 3 countries regarding „Integration of Digital Technology“. The last three positions changed a little bit, and Poland appeared instead of Greece. The graphical representation on sub-dimensions value presented in Fig. 2. to understand which sub-dimensions led to such disposition of countries.

Fig. 2: Graphical representation of „Integration of Digital Technology“ sub-dimensions according to Q value

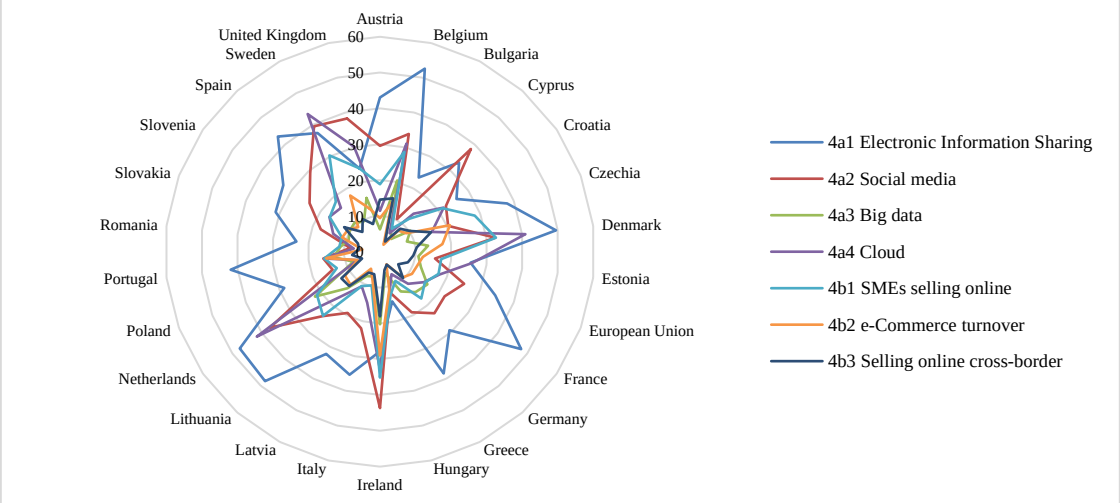


Fig. 2 shows that the most potent sub-dimensions in the leading countries are electronic information sharing, social media, and SMEs selling online. Hence, we can state that doing business online is the driver of the digital economy. Countries with a lower level of the sub-dimensions mentioned before should pay attention to preparing a strategy for the development of online businesses.

The last dimension investigated in the current research is „Digital Public Services“. The results of the ranking procedure are provided in Tab. 4.

Tab. 4: Ranking list for alternatives regarding the „Digital Public Services“ dimension

	R value	S value	Q value	Rank in Q

Spain	0.044	0.146	0.019	1
Finland	0.052	0.155	0.052	2
Latvia	0.055	0.19	0.088	3
Denmark	0.069	0.134	0.091	4
Estonia	0.08	0.122	0.116	5
Netherlands	0.07	0.258	0.19	6
Austria	0.086	0.253	0.237	7
Ireland	0.096	0.239	0.258	8
European Union	0.091	0.385	0.358	9
Sweden	0.122	0.281	0.377	10
Lithuania	0.13	0.254	0.379	11
France	0.134	0.28	0.416	12
Luxembourg	0.118	0.362	0.427	13
Slovenia	0.115	0.409	0.456	14
Belgium	0.134	0.402	0.509	15
Poland	0.129	0.463	0.543	16
Malta	0.168	0.316	0.553	17
Cyprus	0.142	0.446	0.571	18
Portugal	0.168	0.35	0.577	19
Germany	0.145	0.456	0.589	20
United Kingdom	0.177	0.362	0.615	21
Czechia	0.14	0.546	0.644	22
Bulgaria	0.147	0.54	0.661	23
Italy	0.2	0.44	0.752	24
Croatia	0.182	0.649	0.861	25
Greece	0.178	0.695	0.883	26
Hungary	0.2	0.608	0.885	27
Slovakia	0.197	0.641	0.903	28
Romania	0.2	0.754	1	29

Source: authors‘ calculations

Table 4 shows that the first three leading positions are for Spain, Finland, and Latvia. The graphical representation of the sub-dimensions values is provided in Fig. 3 to see the sub-dimensions that helped those countries reach the leading role.

Fig. 3: Graphical representation of „Digital Public Services“ sub-dimensions according to the Q value

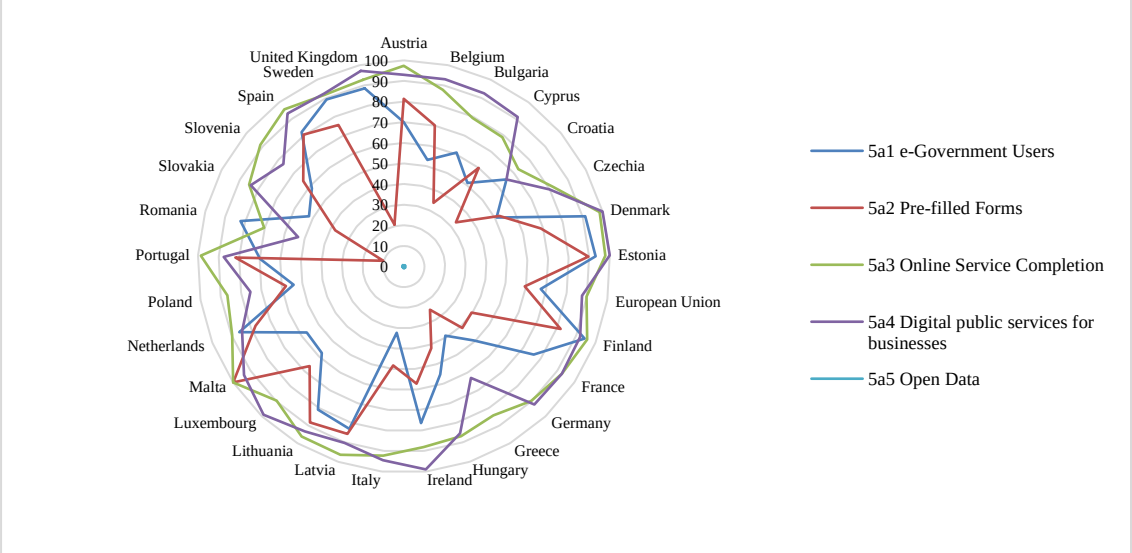


Fig. 3 shows that the highest level of e-Government users is in Finland. This sub-dimension is on the high level in Spain as well, however relatively low in Latvia. Still, in Latvia is a high level of online service completion. To sum up, we could state that public digital services such as e-Government could be drivers of the digital economy.

Conclusions

The current article analyses the EU countries' state in terms of the digital economy. The countries were ranked in three dimensions connected to the digital economy based on the European Commission's Digital Economy and Society Index. They are as follows: Use of Internet Services, Integration of Digital Technology, Digital Public Services. The rest two dimensions – Connectivity and Human Capital – were omitted from the study as they refer more to society, not to the digital economy. We completed the prioritisation procedure was by using a multicriteria decision-making method VIKOR. According to it, in terms of the "Use of Internet Services" dimension, the three leading countries are Finland, Sweden, and the Netherlands; in terms of "Integration of Digital Technology" – Ireland, Belgium, and the Netherlands; in terms of "Digital Public Services" – Spain, Finland, and Latvia.

Funding

This project has received funding from the European Social Fund (project No 09.3.3-LMT-K-712-19-0151) under the grant agreement with the Research Council of Lithuania (LMTLT).

References

Acuña-Soto, C. M., Liern, V., & Pérez-Gladish, B. (2019). A VIKOR-based approach for the ranking of mathematical instructional videos. *Management Decision, 57*(2), 501–522. https://doi.org/10.1108/MD-03-2018-0242

Banhidi, Z., Dobos, I., & Nemeslaki, A. (2019). Comparative Analysis of the Development of the Digital Economy in Russia and EU Measured with DEA and Using Dimensions of DESI. *St Petersburg University Journal of Economic Studies*, *35*(4), 588–606. https://doi.org/10.21638/spbu05.2019.405

European Commission. (2020a). *A fair and competitive digital economy*. The European Digital Strategy. http://bit.ly/2VdWQgf

European Commission. (2020b). *The Digital Economy and Society Index (DESI)*. https://ec.europa.eu/digital-single-market/en/digital-economy-and-society-index-desi

Ikram, M., Zhang, Q., & Sroufe, R. (2020). Developing integrated management systems using an AHP-Fuzzy VIKOR approach. *Business Strategy and the Environment*, *29*(6), 2265–2283. https://doi.org/10.1002/bse.2501

Jovanovic, M., Dlacic, J., & Okanovic, M. (2019). How does the digitalization impact society's sustainable development? Measures and implications. *Economics of Digital Transformation*, 299–316.

Jurčević, M., Mostarac, V., & Lulić, L. (2020). The Digital Transformation of Croatian Economy Compared with EU Member Countries. *Ekonomski Vjesnik / Econviews*, *33*(1), 151–164.

Kraujalienė, L. (2019). Comparative Analysis of Multicriteria Decision-Making Methods Evaluating the Efficiency of Technology Transfer. *Business, Management and Economics Engineering*, *17*(1), 72–93. https://doi.org/10.3846/bme.2019.11014

Laitsou, E., Kargas, A., & Varoutas, D. (2020). Digital Competitiveness in the European Union Era: The Greek Case. *Economies*, *8*(4), 85. https://doi.org/10.3390/economies8040085

OECD. (2018). *G20 DETF – Measurement of the Digital Economy*. https://bit.ly/3j73Ft8

Sayadi, M. K., Heydari, M., & Shahanaghi, K. (2009). Extension of VIKOR method for decision making problem with interval numbers. *Applied Mathematical Modelling*, *33*(5), 2257–2262. https://doi.org/10.1016/j.apm.2008.06.002

Todorut, A. V., & Tselentis, V. (2018). Digital Technologies and the Modernization of Public Administration. *Quality - Access to Success*, *19*(165), 73–78.

von der Leyen, U. (2019). *A Union that strives for more: My agenda for Europe - Political Guidelines for the next European Commission 2019-2024*. https://bit.ly/30d4NnH

Wang, X., Xu, Z., Wen, Q., & Li, H. (2021). A multidimensional decision with nested probabilistic linguistic term sets and its application in corporate investment. *Economic Research-Ekonomska Istraživanja*, 1–19. https://doi.org/10.1080/1331677X.2021.1875255

Wei, G., Wang, J., Lu, J., Wu, J., Wei, C., Alsaadi, F. E., & Hayat, T. (2020). VIKOR method for multiple criteria group decision making under 2-tuple linguistic neutrosophic environment. *Economic Research-Ekonomska Istraživanja*, *33*(1), 3185–3208. https://doi.org/10.1080/1331677X.2019.1691036

Contacts

Viktorija Skvarciany

Vilnius Gediminas Technical University – VILNIUS TECH

Sauletekio ave. 11, LT-10223, Lithuania
viktorija.skvarciany@vilniustech.lt

Daiva Jurevičienė
Vilnius Gediminas Technical University – VILNIUS TECH
Sauletekio ave. 11, LT-10223, Lithuania
daiva.jureviciene@vilniustech.lt