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Evaluation of the connection of innovation activities within selected OECD countries in the area of Construction Minerals

Zuzana ŠIMKOVÁ[1], Iwona KRZYŻEWSKA[2], Michaela KOŠČOVÁ[3] and Roman DANDA[4]*

Authors' affiliations and addresses:
[1,4] Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies, Letná 9, 042 00 Košice, Slovakia
e-mail: zuzana.simkova@tuke.sk, roman.danda@tuke.sk

[2] WSB University, Department of Transport and Information Technology, WSB University Cieplaka 1c, 41-300 Dabrowa Górnicza, Poland
e-mail: ikrzyzewska@wsb.edu.pl

[3] Mathematical Institute, Slovak Academy of Sciences, Štefánikova 898/49 Bratislava 81473, Slovakia
e-mail: michaela.koscova@mat.savba.sk

***Correspondence:**
Zuzana Šimková, Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies, Letná 9, 042 00, Košice, Slovakia
tel: +42155 602 2966
e-mail: zuzana.simkova@tuke.sk

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Abstract
Mineral resources form the basis of production in the metallurgical, electrical, chemical, construction, ceramic and glass industries, as well as in other industries. However, they are still non-renewable and depletable raw material resources, which also have restrictive uses due to their uneven geological and geographical distribution. Manufacturing and construction in Europe are largely dependent on the extraction of non-energy raw materials in terms of basic raw materials. This fact is further emphasized by the related sectors, which depend on a stable supply of raw materials. But building tomorrow's economy also means we need to take care of our environment today. Therefore, raw materials need to be mined in such a way that we protect the natural environment in order to ensure sustainability.
In particular, the current time, but also the historically emerging geopolitical strife in the world or the COVID-19 pandemic prove, that raw materials are the driving force of many countries. Therefore, at the end of these new events, but also in view of the fourth industrial revolution, it is necessary, at the same time desirable, to look for new alternatives, possibilities and sources of raw materials in non-traditional areas. Such are waste, until now unused remnants of old mining activities, or the search for completely new materials. Innovation is a fundamental concept that is increasingly linked to the field of raw materials, as well as with many countries that are characterized by a high level of innovation activity. Therefore, in the article we focused on an extremely current topic, the analysis of the innovation potential of OECD countries in connection with the level of Construction minerals consumption.

Keywords
Construction Minerals, innovation activities, OECD countries

Introduction

Mining and processing of raw materials are at the beginning of all industrial value chains (Cehlár et al., 2013). As global demand for raw materials grows, basic raw materials will continue to play a key role (Lederer et al., 2021). Global value chains have become a dominant feature of world trade. The process of production of goods from raw materials to the finished product, intended for the final consumer, is carried out primarily where the necessary professional and material prerequisites are available, at competitiveness costs and quality (MHSR, 2018b). The European Union has a long tradition of extracting and processing raw materials, as well as rich reserves of aggregates and non-metallic minerals, some metals such as copper and zinc, but also some critical raw materials (Pavolová et al., 2016). The EU is nearly self-sufficient in Construction minerals and several industrial minerals (EC, 2021). Nevertheless, the use of these raw materials is not optimal for various reasons, such as insufficient investment in geological exploration and extraction, demanding and lengthy national permitting processes, or low public acceptance (Nieć et al., 2014). Weaknesses in EU mining, processing, recycling, refining and unbundling capacity reflect a lack of resilience and high dependence on supplies from other parts of the world (Gałaś et al., 2021). Even some materials mined in Europe (such as lithium) currently have to leave Europe for processing. Technologies, capabilities and skills in refining and metallurgy are a key link in the value chain. Not only is the global consumption of raw materials constantly increasing, but also the dependence of many countries on their imports from other countries of the world (Manhart et al., 2019; Slusarczyk and Kot, 2012; Shuyan & Fabus, 2019). Nevertheless, the prediction also testifies to this, where the global material use per capita represents huge increasing from 3 tons per capita in 1990 to 9 tons in 2060, within non- metallic minerals (see Figure 1) (EC, 2021).

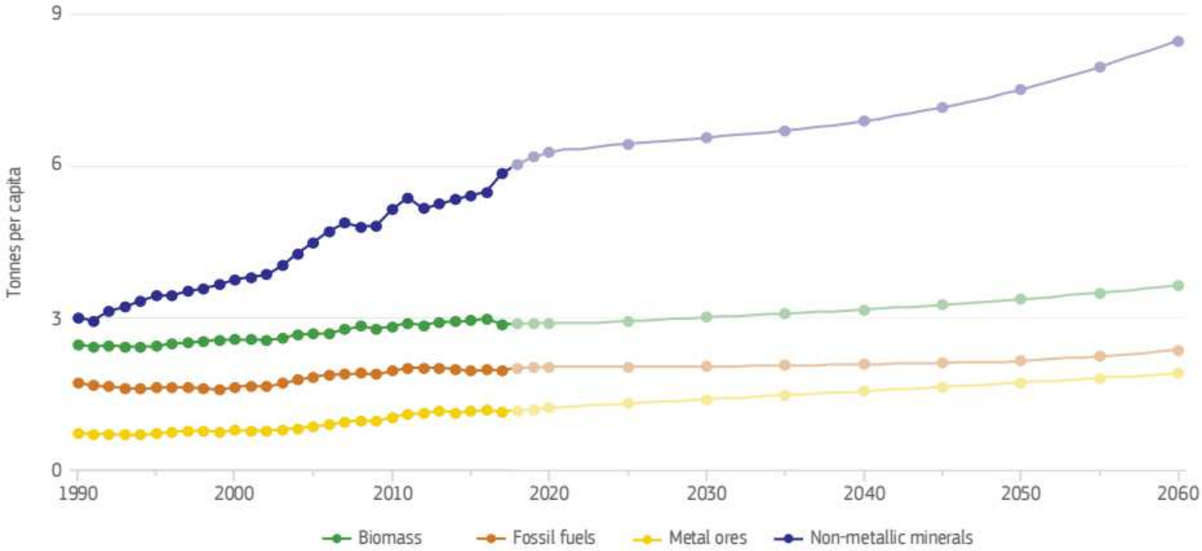

Fig. 1. Global material use per capita by resource type: a) historical data (world, 1990-2017) and b) projection (world, 2018-2060) (EC, 2021)

These shortcomings and weaknesses in existing raw material supply chains affect all industrial ecosystems (Schiffleitner et al., 2012). That is why they require a more strategic approach: adequate stocks to avoid unexpected disruptions to production processes; alternative sources of supply in the event of disruption, closer partnerships between critical raw material actors and downstream user sectors, which will attract investment in strategic development in this area (Lusty and Gunn, 2014; Táncošová and Slaný, 2004).

At the same time, the crisis caused by the COVID-19 pandemic may have an impact on the further direction of industrial policy with the effort to greater diversification and regionalization of production processes, respectively gaining economic sovereignty in strategic areas (Gałaś et al., 2021). It is likely that the topics of diversification of production activities, strengthening domestic production, defining strategic sectors and building strategy reserves will be the subject of discussions at EU level in the coming years (Carvalho, 2012; Sinicakova & Gavurova, 2017). Often, even unequal conditions or the favoring of selected European companies in competition with Chinese and American companies lead some EU Member States to seek to relax changes to fusion rules in order to strengthen the competitiveness of large European companies (EC, 2011; Dvorsky et al. 2021; Antosko et al. 2015; Bacik et al., 2019).

Raw materials form the basis of the European economy in order to secure jobs and competitiveness and are essential for maintaining and improving our quality of life (Čulková et al., 2020; Belas et al. 2019). Ensuring reliable, sustainable and unhindered access to and circulation of raw materials in the economy is therefore a growing concern within the EU, not only regionally but also globally, also in the face of current geopolitical tensions (Coulomb, 2015; Wróblewski et al., 2017; Masood et al. 2017; Hudáková et al. 2019; Urbancová et al., 2020; Cihelková et al. 2020).

However, serious market distortions can cause distortions with a significant impact on trade, the environment and employment. The possibility of these results enhances the development of innovative business practices, including those based on natural environment-friendly technologies (Holotová et al., 2020; Piwowar, 2020; Zielińska, 2020; Ivankova et al., 2021; Rigelský et al., 2021; Stefko et al., 2021; Gavurova et al., 2021b), influencing positive shifts in quality of life and sustainable development (Mishchuk & Grishnova, 2015; Rajnoha et al., 2021; Tvaronavičienė et al., 2021). Raw materials strategies aim to shape appropriate policies to help reduce such market distortions and mitigate their effects (Massari and Ruberti, 2013; Petruf et al. 2015; Turisová et al. 2021). When it comes to raw materials, policy makers and businesses alike have a very special responsibility: the natural environment must be preserved and protected for future generations. This creates an obligation to implement the basic principle of sustainable development as comprehensively as possible in the extraction and use of minerals, in the design, production and use of goods, as well as in the recycling of reusable materials in waste management systems (Petrie et al., 2007; Straka et al., 2018; Straka et al., 2020b). Therefore, quality information on raw material reserves is a prerequisite for production planning. Mineral resources are distributed relatively evenly across all continents, but the resource potential expressed by reserves depends mainly on geological exploration and interpretation of results.

However, Europe is clearly lagging behind in investment in exploration for the last 30-40 years. Recent exploration has been conducted mainly in the Nordic countries, the Iberian Peninsula, Ireland and, to some extent of Central Europe and the Balkans (Tiess, 2010).

Geological exploration of minerals is taking place across the EU, although there are significant differences between Member States. However, the EU's mineral potential remains insufficiently explored. The EU uses the UN methodology as the only universal international classification system for energy and mineral resources (UNFC) to compare raw material reserves (Cehlár et al., 2011).

In addition to the above, however, it is necessary to look for other, new, non-traditional solutions. For example, mining waste is rich in some critical raw materials, so it could be re-explored to create new economic activity in existing or former mining sites, which in turn presupposes improving the environment. Unfortunately, it is currently not possible to assess the raw material potential in secondary sources, as there is no complete information on the amount of raw materials contained in products, extractive waste or landfills. In the long run, however, they represent great potential and hope of the innovations as an opportunity to solve the above-mentioned problems (Rajbhandari et al. 2022). Innovation is seen globally as a key tool for growth, competitiveness (Ključnikov et al., 2021; Civelek et al., 2021a; Gavurova et al., 2021a) and high performance (Žufan et al., 2020; Civelek et al., 2021b). Innovation is also a link between science, technology and industrial policy (Yuan et al., 2021), therefore, innovative tools provide effective solutions for economic, legislative, social and environmental problems (Belas et al., 2020; Ključnikov et al, 2020a; Ključnikov et al., 2020b; Hussain et al., 2021; Molnár, 2003; Molnár, 2008; Rosova et al., 2020; Gavurova et al., 2020) including the increasing performance of industries. It is the realization that knowledge plays a key role in innovative improvements in socio-economic systems and that it is at the heart of the knowledge-based economy (Caballero-Morales et al., 2020). Because of the fierce competition, new solutions and alternative approaches become in existence (Kelić et al., 2020; Straka et al., 2020a). Thus, many companies consider only ground breaking inventions and results to be real innovations, leaving aside smaller but no less useful ideas (Estéliyová, 2007). Raw materials for production and construction also help build and sustain air transport infrastructure (Kelemen et al. 2020), which is important for the national economy, while respecting the praxeological requirement to select stable, trustworthy, and secure suppliers (Kelemen et al. 2021). The solution to the problem has implementation potential for various sectors of the national economy.

In our research, we focused on the innovation capacities of OECD countries in connection with Construction materials which make up a large part of the EU's use of raw materials (on a mass basis) (EC, 2021). The extraction of Construction minerals, especially aggregates (crushed rocks, gravel, sand), is the largest sub-sector of non-energy extraction in the EU in terms of value and volume (Regueiro, 2021). Potential sources of Construction minerals are abundant in all Member States and mining is carried out in large quantities, around 3 billion tons. However, the amount extracted varies greatly from country to country, with most Construction minerals are mined in Germany, France, Italy, Spain and the United Kingdom (Eurostat, 2021).

Aggregates have a wide range of uses, including the construction of buildings, roads and railways. The demand for aggregates is therefore closely linked to the level of construction of new buildings, the maintenance and repair of existing buildings and the scope of civil engineering projects. It is estimated that around 22,000 sites are currently mined across the EU, many of which are close to construction sites (EC, 2011). By resource type, non-metallic minerals, which include construction materials, will see the highest growth both total and per capita, what is in line with the expected expansion of infrastructure and housing needed for a growing world population and life standards. The only resource type that sees slowing growth is fossil fuels, reflecting the global push to move towards a low-carbon society (EC, 2021) (see Figure 1). The bulk of the price of aggregates is made up of transport costs, which means that most markets are local or regional in nature and international trade is relatively small. Aggregate mining requires an adequate network of surface mines and quarries in order to shorten transport distances, reduce associated costs and reduce environmental impact.

The ever-increasing prices of Construction Minerals are also declaring the exceptional topicality of the issues being processed. At the same time, this area is relatively interesting in terms of circular economy, as construction waste is a pioneer in the field of circularity. Construction and demolition waste is the largest waste flow (in mass) in the EU. Though the revised Waste Framework Directive requires EU Member States to take measures to achieve the re-use, recycling and other material recovery, EU Member States' data are not sufficiently comparable regarding backfilling to allow conclusions. Overall domestic extraction of non-metallic minerals, which contain construction materials and industrial minerals, is much larger (about 55%) than imports (only 6%) of these materials. While they are the biggest contributor by mass to societal stocks and recycling, they are also the largest part of landfilled waste, what make a great opportunities for increasing circularity of these materials exist (EC, 2021).

Materials and Methods

The primary focus of the research is to evaluate the connection between the innovation activities of selected OECD countries and the area of Construction minerals. The chosen goal was predominantly fulfilled through the application of regression analyzes. On the one hand, these analyzes verified the statistical significance and also pointed out the direction of the assessed effects. For a more comprehensive view, a cluster analysis was also applied in the conclusion, which was processed on the basis of the outputs of the evaluation of innovation activities and the outputs of construction materials. The sample consisted of selected Organization for Economic Co-operation and Development (OECD) countries, which were available in the OECD database for the selected time period (2010-2019) (Australia, Canada, Chile, Israel, Japan, Korea, Mexico, New Zealand, United States has been excluded as selected indicators are not reported by Construction minerals in the OECD period). The sample was predominantly located in Europe. Columbia was excluded from the sample due to its short membership in the OECD.

The sample consisted of 27 countries: Austria (AUS), Belgium (BEL), Czech Republic (CZE), Denmark (DEU), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Iceland (ICL), Ireland (IRL), Italy (ITA), Latvia (LVA), Lithuania (LTU), Luxembourg (LUX), Netherlands (NDL), Norway (NOR), Poland (POL), Portugal (POR), Slovak Republic (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE), Switzerland (CHE), United Kingdom (GBR), Turkey (TUR).

Innovation data were obtained from the final reports of Cornell University, INSEAD, & WIPO (2020) and Construction minerals were obtained from OECD databases (2021). Innovation activities present the individual pillars of Global Innovation Index (GII): Institutions (GII Institutions), Human Capital Research (GII HR&RAD), Infrastructure (GII Infrastructure), Market sophistication (GII Market sophistic), Business sophistication (GII Business sophistic), Knowledge technology (GII Know Tech), Creative outputs (GII Creative Outputs). GII data were collected from reports with a postponed year of publication, i.e. 2011 - 2020. OECD (2020) defines Construction minerals as non-metallic Construction minerals whether primary or processed. They comprise marble, granite, sandstone, porphyry, basalt, other ornamental or building stone (excluding slate); chalk and dolomite; sand and gravel; clays and kaolin; limestone and gypsum. This area has been concentrated in three specific perspectives: Domestic material consumption (CM Consumption) – refers to the amount of materials directly used in an economy, which refers to the *apparent consumption* of materials (computed as Domestic extraction used minus exports plus imports, Domestic material input (CM Input) is computed as Domestic extraction used plus imports, Domestic extraction used (CM Extraction) – refers to the flows of raw materials extracted or harvested from the environment and that physically enter the economic system for further processing or direct consumption (they are used by the economy as material factor inputs). The stated consumption variables of Construction minerals were used in metric millions of tons per country.

From the point of view of analytical processes, descriptive analysis procedures were used (mean, sd (standard deviation), median, trimmed (trimmed mean 0.1), min, max, skew, kurtosis). In the next step, regression models were applied, namely Ordinary Least Squares regression (OLS) and Panel regression model (PLM).

Among the conditions applied in the decision-making process when choosing a model, the verification of multicollinearity was included in the first model – Variance Inflation Factor (VIF), significant presence of heteroscedasticity was verified by Breush Pagan test. Hausman Test for Panel Models was used to decide between Within and Random models. Robust estimation methods were used to estimate both OLS and PLM coefficients (OLS – HC3; PLM – White 2). The Cluster Analysis application was implemented through Partitioning Around Medoids and Manhattan distances. The estimation of the number of factors was performed by using the Silhouette method. The inputs to the Cluster analysis consisted of standardized variables from 0 to 1, where 1 presents the highest average value (arithmetic average for individual years) in the group of countries. These standardized variables were averaged and two new variables were created, namely GII (average rating of innovation), CM (average rating of Construction minerals).

Results

The procedures applied in order to fulfill the intention stated in the previous section were divided into 3 areas. Descriptive analysis approximates the investigated variables and the multiple regression analysis assessed the significance of the links between innovation and the Construction minerals variables. Finally, the cluster analysis shows the position of specific countries in the connection between the evaluation of innovation and the evaluation of the Construction minerals variables (further only CM)

Tab. 1. Descriptive analysis

Variable	n	mean	sd	median	trimmed	min	max	skew	kurtosis
CM Consumption	263	116.88	142.26	61.24	87.37	-6.26	580.64	1.74	2.1
CM Input	263	123.84	147.25	69.32	93.04	2.83	616.01	1.77	2.29
CM Extraction	263	117.94	145.07	58.76	87.49	0.46	593.1	1.75	2.19
GII Institutions	270	80.28	9.2	80.75	80.86	50	95.8	-0.67	0.5
GII HR&RAD	270	50.45	9.43	49.95	50.64	29.8	69.8	-0.12	-0.92
GII Infrastructure	270	53.78	8.52	54.6	54.37	27.5	69.9	-0.59	0.00
GII Market sophistic	270	55.31	8.94	54.05	54.85	32.3	84.6	0.47	0.07
GII Business sophistic	270	46.67	10.15	46.7	46.54	25.4	74	0.09	-0.71
GII Know Tech	270	41.81	11.57	40.7	41.24	18.9	74.9	0.43	-0.37
GII Creative Outputs	270	46.94	9.15	46.55	46.57	23.8	73.7	0.33	-0.07

Table 1 presents the basic outputs of descriptive statistics, while the Construction minerals variables indicate missing values (n = 7). The values of the central tendency suggest that there are no major differences between the Construction minerals variables. On the contrary, the differences in the average value, or in the median value, are more pronounced between the innovation indicators (dominantly GII Institutions). Based on skewness and spikedness, slight differences from the normal distribution were identified in the Construction minerals variables.

The following parts of the analysis were devoted to the presentation of regression models.

In the first step of assessing the conditions, VIF analysis was applied, the outputs of which do not indicate unacceptable levels of multicollinearity (GII Institutions = 3.58, GII HR&RAD = 2.52, GII Infrastructure = 1.53, GII Market sophistic = 2.28, GII Business sophistic = 5.02, GII Know Tech = 4.19, GII Creative Outputs = 4.19). Certain discrepancies were detected by the checking the variability of residue invariability (Model: CM Consumption = BP = 76.3, p-value = 7.807e-14; CM Input = BP = 77.543, p-value = 4.361e-14; CM Extraction = BP = 79.036, p-value = 2.166e-14), thus, a robust estimation method was used to estimate the coefficients.

Tab. 2. Regression model OLS

OLS HC3	CM Consumption		CM Input		CM Extraction	
Statistic	Coef.	p value	Coef.	p value	Coef.	p value
(Intercept)	668.76	<0.0001	667.10	<0.0001	667.38	<0.0001
GII Institutions	-13.78	<0.0001	-13.96	<0.0001	-13.89	<0.0001
GII HR&RAD	5.20	0.0002	5.38	0.0002	5.40	0.0001
GII Infrastructure	0.00	0.9960	0.20	0.8411	0.25	0.7978
GII Market sophistic	4.71	<0.0001	4.90	<0.0001	4.91	<0.0001
GII Business sophistic	0.13	0.9291	0.04	0.9774	-0.17	0.9058
GII Know Tech	1.21	0.3267	1.19	0.3591	1.08	0.3935
GII Creative Outputs	-0.27	0.7617	-0.31	0.7321	-0.35	0.6939
R2	0.3215		0.3089		0.3219	
R2 adjusted	0.3028		0.2899		0.3033	

Table 2 provides a result of OLS regression models with three dependent variables (CM Consumption, CM Input, CM Extraction). The significance of the effects was verified by the p value, which was in several cases lower than 0.05. In the model with dependent variable CM Consumption, a significant effect was identified in the case GII Institutions (β = -13.78), GII HR&RAD (β = 5.20), GII Market sophistic (β = 4.71). For models with a dependent variable CM Input and CM Extraction identical areas of innovation were evaluated as significant. The only negative significant effect was evaluated the GII Institutions effect. The negative trajectory can be interpreted in such a way that a decreasing output of GII Institutions can be associated with a higher output of innovation activities. Positive β coefficients can be perceived as the output in the area of Construction minerals also increases with the increasing value of the innovation output.

The first step in applying regression models was to select the most appropriate model based on the Hausman Test output. This test did not reach a value lower than 0.05 in either case (CM Consumption: chisq = 6.6582, p-value = 0.4653; CM Input: chisq = 6.0994, p-value = 0.5282; CM Extraction: chisq = 5.3432, p-value = 0.6182), so a random effect model with a White 2 estimator was used to estimate all models.

Tab. 3. Regression model PLM

PLS Random	CM Consumption		CM Input		CM Extraction	
Statistic	Coef.	p value	Coef.	p value	Coef.	p value
(Intercept)	381.73	<0.0001	391.49	<0.0001	376.17	<0.0001
GII Institutions	-2.78	<0.0001	-2.76	<0.0001	-2.71	<0.0001
GII HR&RAD	-0.11	0.7003	-0.15	0.5916	-0.07	0.8517
GII Infrastructure	-0.40	0.0930	-0.37	0.1197	-0.34	0.1158
GII Market sophistic	-0.62	0.0861	-0.61	0.0865	-0.62	0.0926
GII Business sophistic	1.54	0.0002	1.52	0.0003	1.49	0.0006
GII Know Tech	-0.91	0.0032	-0.90	0.0035	-0.90	0.0048
GII Creative Outputs	-0.15	0.5284	-0.22	0.3342	-0.20	0.4914
R2	0.2150		0.2158		0.2167	
R2 adjusted	0.1934		0.1934		0.1943	

Table 3 shows the outputs of the panel regression model. Significant effects were observed in all 3 models (CM Consumption, CM Input, CM Extraction). Negative significant effects were seen with the independent variable GII Institutions (CM Consumption: β = -2.78, pvalue = <0.0001; CM Input: β = -2.76, pvalue = <0.0001; CM Extraction: β = -2.71, pvalue = <0.0001) and at the variable GII Know Tech (CM Consumption: β = -0.91, pvalue = 0.0032; CM Input: β = -0.90, pvalue = 0.0035; CM Extraction: β = -0.90, pvalue = 0.0048). A significant positive effect was observed for only one independent variable, GII Business sophistic (CM Consumption: β = -1.54, pvalue = 0.0002; CM Input: β = 1.52, pvalue = 0.0003; CM Extraction: β = 1.49, pvalue = 0.0006). Based on the above, it was possible to obtain knowledge that the individual models do not show significant differences. The negative effect rate indicates that highly innovative countries have lower rate of consumption levels of Construction minerals.

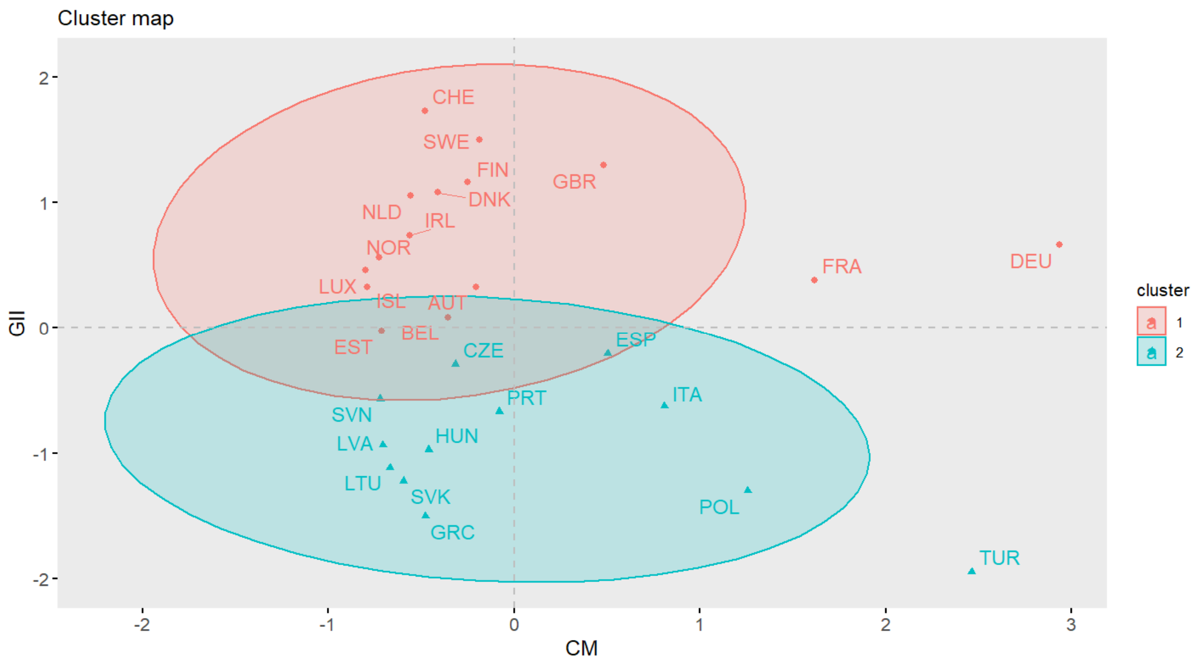

Fig. 2. Cluster map – GII and CM: all variables

Data were entered into the Cluster analysis presented in Figure 2 without taking into account the results of the regression analysis, so no variables were excluded. The number of clusters was estimated by using the Silhouette method. The individual axes present the recalculated value, whereby the higher the value, thereby higher the value entering these standardized variables. Most countries are placed in lower CM values, but it was in GII it was possible to observe an interesting distribution of individual countries (countries were concentrated relatively proportionally over the length of the GII rating scale). Cluster 2 presents countries with lower outputs in both assessed dimensions, where Greece, Slovakia, Lithuania or Latvia can be included among the countries with the lowest output. Cluster 1, on the other hand, presents countries with higher output (especially in the area of GII evaluation) and there dominated countries as Switzerland, Sweden and the United Kingdom. Countries such as Turkey with a very low GII score but a high CM differed significantly, while France and Germany showed slightly higher GII but very high CMs.

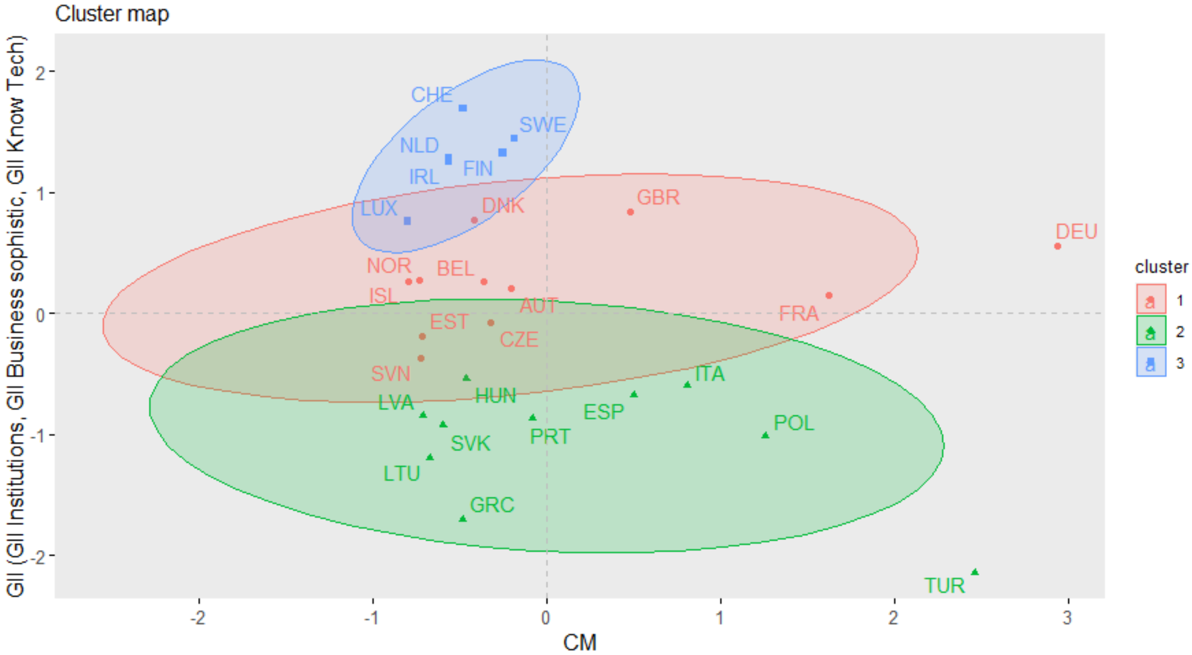

Fig. 3. Cluster map – GII (GII Institutions, GII Business sophistic, GII Know Tech) and CM

The Cluster analysis presented in Figure 3 included data taking into account the results of the panel regression analysis. Based on the PLM results, the GII assessment variables were thus made up of variables that showed a significant effect on Construction minerals. The number of clusters was estimated by using the Silhouette method. In this case, the Cluster analysis revealed 3 clusters, where 2 clusters highlighted countries with a high degree of innovation and a relatively low degree of consumption of Construction minerals. The second cluster (red colour) highlighted countries with a rate of innovation that fluctuates around averages. Here, Germany presents itself as a significantly different country in the CM rating variable. Countries with a lower degree of innovation were covered by the second cluster (green colour). And even in this case, Turkey appears to be an excellent country for Construction minerals.

Conclusion

The development of non-traditional forms of using strategic as well as traditional raw materials, together with a more realistic assessment of their raw material potential, can be considered a top priority for several decades. Although the production of non-metallic and construction raw materials cover in significant extent domestic consumption in the monitored OECD countries. In the context of the self-sufficiency in minerals, which is declared by EU, it is also desirable to innovate significantly the traditional use of building materials (building stone, gravel, quartz sand and brick clay) and related raw materials (perlite, meta kaolin, basalt and gypsum). These are raw materials whose extraction is the least demanding in terms of secondary effects on the environment and its pollution. But it is innovation that creates the space for continuous improvement of all processes of the whole value chain of the mineral life cycle. New approaches can reduce energy consumption and carbon dioxide contamination in the processing of these raw materials. In addition, it is possible to focus on prefabricated and lightweight building elements with high thermal and sound insulation parameters, thermally treated aggregates for the production of mixed, low-energy eco-cements, innovative concrete and renovation mortar. Significantly diversify the traditional use of the most important carbonate and silicate raw materials in non-traditional directions, their application to the domestic market and export, and thus reduce the risk and disadvantage of the current narrow range of raw materials. This applies mainly to limestone with too one-sided focus on the production of cement or lime, but also to different degrees of urgency for dolomite, talc, bentonite, zeolite and gypsum. Innovation in this area is also necessary because construction is the largest producer of waste right behind industrial production.

The analysis processed in the article confirmed the interesting fact and the fact that some countries with a high degree of innovation show a lower degree of CM consumption. To these clusters highlighted countries with a high degree of innovation and a relatively low degree of consumption of Construction minerals include countries such as Sweden, Finland, Ireland, the Netherlands, Switzerland. These are countries with a high standard of living, as well as innovative capacities, which apparently manage to use the available alternatives of individual materials. This is confirmed by the fact that they are the leaders in green growth and progress, and they are at the forefront of circularity within EU. This is an extremely positive phenomenon, as innovation should be the basis and bearer of increasing recycling rates as well as the efficient and rational use of non-renewable earth resources. These facts represent a high hope for the future for the preservation of non-renewable raw materials for future generations in accordance with the principles of sustainable development.

Other countries, such as Belgium, Norway, Iceland and Austria, are among the countries with innovation rates fluctuating around the mean values due to the analysis performed. A group of countries such as Slovakia, Hungary and Greece are among the countries with a lower degree of innovation potential as well as lower CM consumption.

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