Towards carbon neutrality through innovation: Empirical insights in European countries

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Abstract: In the current era where innovation and sustainability are at the forefront, businesses need to becomeincreasingly active in implementing environmentally sustainable projects. The aim of this paper is to set initiative-taking activities for small and medium sized enterprises (SMEs) which would increase their level of engagement in innovative and environmentally responsible projects. Achieving environmental goals has never been easy given the fact that SMEs are the biggest polluters of the environment. Therefore, there is an urgent need for the leaders of these businesses to start implementing eco-innovation solutions to respond to these challenges. Our research consists of examining the current situation of the European Union's member states and responding to the objectives which have been set for them, by proposing strategic solutions for SMEs. Research also compares data between Human Development Index and Innovation Index to identify areas where there is room for improvement. These objectives concern the green development of countries, and the achievement of carbon neutrality by 2055. The results of the work points to increased attention for countries with low levels of development capability and refers to the adoption of measures taken by SMEs to help achieve the goals set. Final recommendations will describe how SMEs could implement initiatives in their businesses and where to look for sustainable and green change in their environment. Marked changes need to be made immediately in order for SMEs to adapt to these changes in order to fulfil objectives set by the European Union in a widely discussed program, Fit For 55.

Keywords: sustainability, green projects, innovation, development, SMEs

1. Introduction

The challenge of meeting environmental targets and reducing our carbon footprint is more urgent than ever before. It is therefore necessary for small and medium-sized enterprises (SMEs) to become increasingly focused on this issue. Innovative solutions and the implementation of green projects within their organizational portfolio are ways in which SMEs could be inspired and should implement such solutions to meet environmental targets and thus support the European Union's efforts to achieve carbon neutrality by 2055. Corporate reporting is as essential and important for the long-term sustainability of a business as expanding the project portfolio to include green and sustainable projects.

In this paper we will discuss the issue of innovation and innovative solutions that have an impact on the issue athand with respect to meeting the environmental challenges of today. This paper follows a study (Margarida, etal., 2023), which aims to approach how SMEs should implement green innovation projects and activities in the management of their business.

The study focuses on the development of sustainable and renewable projects to assist SMEs to build a stronger position in the market while meeting the environmental objectives of the European Union. Many other articles focus on the development of innovation in organizations, but very few focus on development linked to the achievement of the European Union's objectives. Our findings are interpreted in the context of the general outlook and the current situation in EU Member States related to the involvement of SMEs in the transformation of sustainable environments.

The following section, literature, overview describes how different business functions define innovation and why is it important to the future scale of companies. It also provides us with an overview of why the activities of SMEs are a crucial factor in the challenge of reaching carbon neutrality by 2055. In the methodology section we describe how we approached our study and what data and resources were used in our analysis. The final two sections discuss the conclusions we have reached, and the gaps identified between EU countries. Lastly, the conclusion section provides an overview of how to implement and suggestions SMEs what to do with their environment to achieve previously set goals from EU by 2055.

2. Literature overview

Innovation in this era is extremely important not only for people as individuals, but also for individual companies whose task it is to advance the development of sustainable environments for society as a whole. (Jeck, 2012). There are many opinions on how to properly define the word "innovation". The definitions that we are familiar

with stem from different industries and therefore it is difficult to define in one sentence what the word "innovation" truly means. When attempting to define it we ask different questions, such as why must something be seen as entirely new to the world to be considered an innovation? For whom does the innovation add value? For the customer or for the company that brought the innovation to market. This is why a clear definition of innovation is exceedingly difficult to process. (Nieminen, 2020) Innovations are found in all industries around us and create value for both people, and various companies. (Pace, 2019)

SMEs have become an integral part of business and national economies. (Belás, et al., 2014) Therefore, it is essential to introduce innovations in the organizational environment that positively affect their prosperity and efficiency. Innovation can help organizations to reduce costs and keep them at a minimum level. (Chris, 2018) Organizational innovation refers to the implementation and use of new work practices and methods in the daily processes of a given firm. (Zgodavova, et al., 2017). In practice, from an environmental perspective, organizational innovation means introducing an environmental audit into the company to examine the areas ofthe company's packaging management, waste management, air protection, and what cost-saving measures the company is implementing to improve the environment. (Alharbi, et al., 2019) The aim of an environmental audit is to analyze the company and propose solutions to achieve a more environmentally friendly operation and reduce its adverse impact on the environment. (RÚZ, 2020) With the introduction of organizational innovation, strategic planning is equally associated. It is a process that uses available information to accurately map the direction of a given enterprise. It is used to set priorities, allocate resources efficiently, and to align stakeholders and all interested parties with the strategic goals of the organization. (Combe, 2014) The strategic goals of an organization have their origin in its mission and outlines the objectives the organization has set out to achieve. (OECD, 2009) The goal must be measurable, and thus its results must be in the form of quantifiable results that can be compared with each other and then evaluated. (De Bruin, 2019).

Organizational innovation can provide insights into how companies in the analyzed countries are embracing sustainability practices, what challenges are they facing during their green transition, and precisely what types of new green innovations they are employing. Knowledge within organizational innovation and the understanding of what types of barriers and drivers, researchers or policymakers are facing can help in the development of new strategies towards carbon neutrality through innovation. Alongside organizational innovation, environmental audit plays an important role in achieving carbon neutrality. Environmental audit is a tool that measures the effectiveness of an organization sustainability activities. The use of external auditors can help businesses identify the areas for improvement available to them. From these results they can decide on new sustainability goals. By combining these two practices within the context of this study, they can provide guidance on how to develop more effective policies, best practices, or how different segments can contribute to each other when achieving successful transition towards carbon neutrality in Europe.

Strategy and strategic objectives are the basis of any organization that aims to achieve predetermined goals within a certain time horizon. (Štefánik et al., 2003) One of the strategic objectives of the European Union is decarbonization, or climate neutrality, by 2050. The European Union has approached this goal by adopting several measures that have been allocated specific time milestones of 2020, 2030 and 2050. Currently, the European Union's main strategic objective for decarbonization is to achieve zero greenhouse gas emissions and thus to achieve climate neutrality in general by 2050. By 2020, the European Union is committed to reducing emissions by 20% compared to 1990 levels, and to increase energy efficiency by at least 20%. The target for 2030 is to reduce these emissions by more than 50% compared to 1990, and to increase the share ofrenewable energy to 32% (European Union, 2020).

The European Union is currently leading the world in the fight against the energy and climate crisis and aims to remain at the forefront of the entire ecological transformation. This whole idea is enshrined in the Fit for 55 legislative documents.

3. Methodology

The main objective of the study is to highlight the importance of innovative projects for organizations to help meet environmental objectives. We examined publicly available data on the EU environment, the share of sustainable projects within EU territory, and the historical development of EU Member States. We conducted our study on 27 EU member states for which this data is publicly available. Based on the datasets selected for our study, individual observations were analyzed and later evaluated. The main purpose of selected datasets was to show how important are innovative projects in EU countries, and what are the drivers in green transition or sustainable development. The data origin is from publicly available statistical data banks such as:

Statista.com, Eurostat, GlobalEconomy.com, DataCube.sk. These statistical data banks provided appropriate datasets for our study including historical records that could help us closely examine the development and progress of each European member state. The study population was focused on Europe, and we picked sample countries that are an adequate member state of European Union. The main purpose of this statistical evaluation was to highlight differences between countries in HDI and the Innovation Index and then compare them against the share of sustainable projects within these countries. We then evaluated the share of renewable energy projects comparing the European Union average to Slovakia alongside the variations in greenhouse gas emissions over time and stating if the increase of renewables had an impact on the decrease of greenhouse gas emissions. This dataset covers a range of ten consecutive years with an annual reporting average from each monitored sample.

The data used in this study pertains to sustainable projects, greenhouse gas emissions, gross domestic product, index of living standards of the population, and the innovation index of the countries where we used Pearson´s correlation coefficient as a main point focus to determine dependencies between chosen datasets. To determine the correlation, corresponding hypotheses are formed. The hypotheses are repeated in the comparative analysis to highlight the correlation in detail. Hypotheses H0 and H1 are represented here.

H0: Question X and question Y are not dependent on each other

H1: Question X and question Y are dependent on each other

The basic formula to calculate Pearson´s correlation coefficient is:

$$r = (\Sigma((X_i - \bar{X})(Y_i - \bar{Y}))) / (\sqrt{(\Sigma((X_i - \bar{X})^2) * \Sigma((Y_i - \bar{Y})^2)})$$

The range in Pearson´s correlation coefficient states that:

- -1 indicates a perfect negative correlation (inverse relationship)
- +1 indicates a perfect positive correlation (direct relationship)
- 0 indicates no correlation between the variables.

For our results in this study to achieve Pearson´s correlation coefficient calculation, we have used Data Analysis software within Microsoft Excel, that helped us calculate these results in more efficient way. This study was conducted in the second quarter of year 2023.

In summary, we looked at twenty-seven member countries of the European Union, and then compared this data between specified countries. For sustainable projects and greenhouse gas emissions, we analyzed data for 2012-2021, and for all other metrics, we analyzed the most recent data available for all countries for one year, 2021. We used a descriptive method to evaluate the statistical data, and all results are recorded and thoroughlyexplained in the study.

4. Results and discussion

Between 2012 and 2021, the share of renewables in the EU increased by 35.63% year-on-year. The curve of the graph in percentages shows a continuous increase in the share of renewables in the EU Member States up until 2020.

The average share of renewables in the European Union is at 18.7% for the period 2012 to 2021. The year-on-year growth rate shows us that almost all countries have managed to maintain the growth in the share of renewables in energy production during the period under review, except Hungary which has seen a decline at -9.11% in the share of renewables. However, its average for the period under review was 14.2%.

When comparing the graphs of the European Union and the Slovak Republic, we can see that the Slovak Republic has not been as consistent over the period under review as the European Union average. Large investments and development of renewable energy sources in the Slovak Republic started to prevail in 2018-2019, where we see a high percentage increase in the share of renewable energy sources. Specifically, it is a jump of 5% between the two years. However, after this high jump from 12% to 17%, the Slovak Republic started to stagnate. This is reflected in the last years 2020, 2021 and, according to current data, we can expect continued stagnation in 2022 as well.

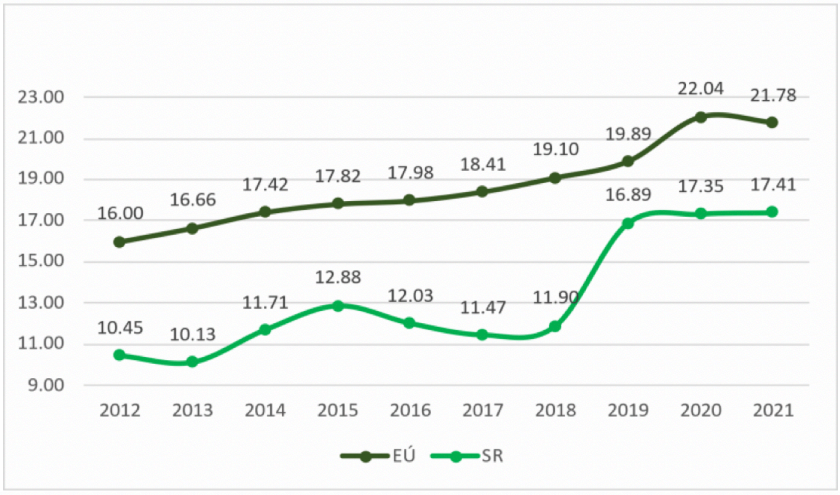

Figure 1: Share of Renewables

Source: Authors

Emissions have plagued the planet for centuries and are an undesirable byproduct that every country must address. The European Union has a target of reducing emissions by at least 55% by 2030. Its plans to achieve this transformation include, increasing the tax burden on energy, making use of the existing emissions trading system, increasing energy efficiency, increasing the production of energy from renewable energy sources, and improving the infrastructure within the European Union for alternative fuels, along with many others. Of these, the most important is the development of renewable energy sources, which are considered key to reducing greenhouse gas emissions.

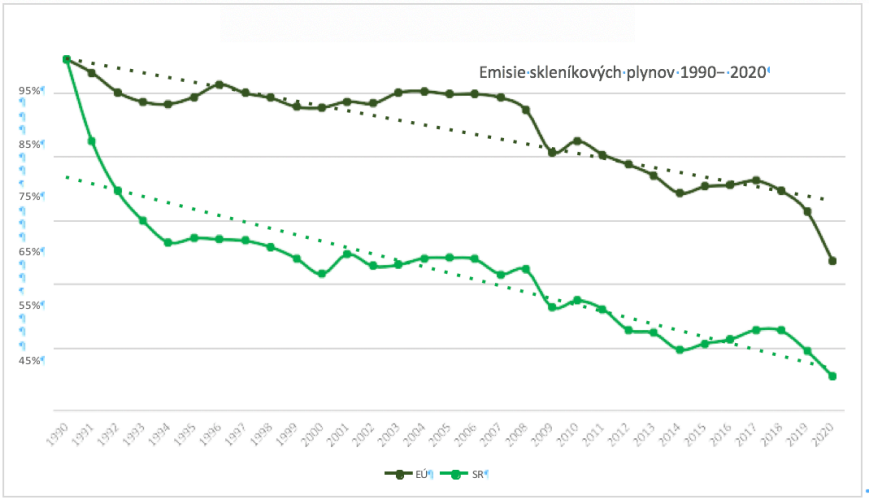

Figure 2: Greenhouse emissions - EU and SK

Source: Authors

From the data for the period 2000-2020 and 2011-2020, we observe a continuous decline in emissions showing that both the European Union and the Slovak Republic are constantly striving to meet the targets set. In 2020, the level of emissions in Slovakia was approximately 37 104 kilotons of CO2. Compared to 1990, this is a decrease of almost 50% in total anthropogenic greenhouse gas emissions. The European Union is following the same trend as the Slovak Republic, and greenhouse gas emissions are gradually decreasing.

The below map of the European Union shows us in color variations how each Member State has performed in terms of emissions. We can clearly see that Germany was the highest emitter of greenhouse gases in 2020, at 742 491kt of CO2.

Figure 3: Map of EU - Emission production

Source: Authors

The development and prosperity of innovative technologies and the implementation of innovative projects depend on a variety of variables centered on the overall quality of the environment. The environment is characterized by a country's capacity to produce and invest in development activities. Factors that influence such developments are, for example, a country's GDP (Gross Domestic Product), HDI (Human Development Index) and EIS (European Innovation Index). According to the values obtained, it is possible to identify which countries are thriving and making progress in innovation-related activities, but conversely, we can identify which countries are falling behind and where more determined measures need to be taken to develop the country further.

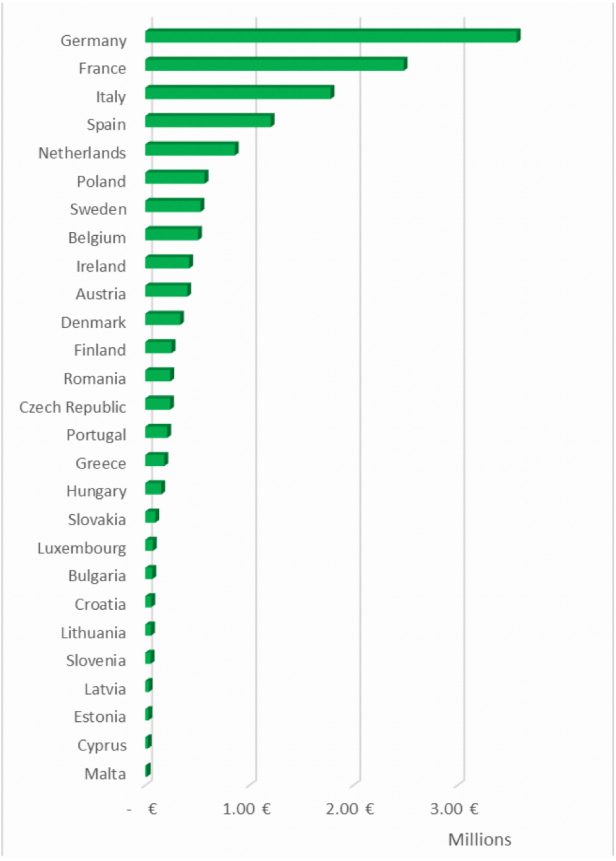

Figure 4: HDI 2021

Source: Authors

The GDP of the EU Member States monitored was €14.45 trillion in 2021. The German economy ranked first and was sovereignly the largest of allEU countries. This high GDP indicates the quality of the country's economic situation and its potential growth in future periods. It also indicates a higher standard of living for the population, higher investment in education, science, and research, but also in health and other areas. Countries with higher GDP onaverage have better quality healthcare andelevated levels of education, which contribute tothe long-term sustainability and quality of life of their population. Quality of life is addressed by the HDI, which represents the standard of living of the population (Baru, 1998).

As part of tracking the information available on national productivity and living standards in the form of a human development index, the study also focused on the innovation index. The innovation index is used to compare the technological and innovative capability of countries in diverse types of sectors and regions.It compares countries' investment intentions andreflects qualitative and quantitative assessmentsin the field of science and research. Based on theinnovation index, a country or sector can respondappropriately and conduct the necessary activities to support the development ofinnovation projects and thus strengthen its position. According to the latest data, the study was dedicated to comparing the innovation indexin the following countries for the year 2022.

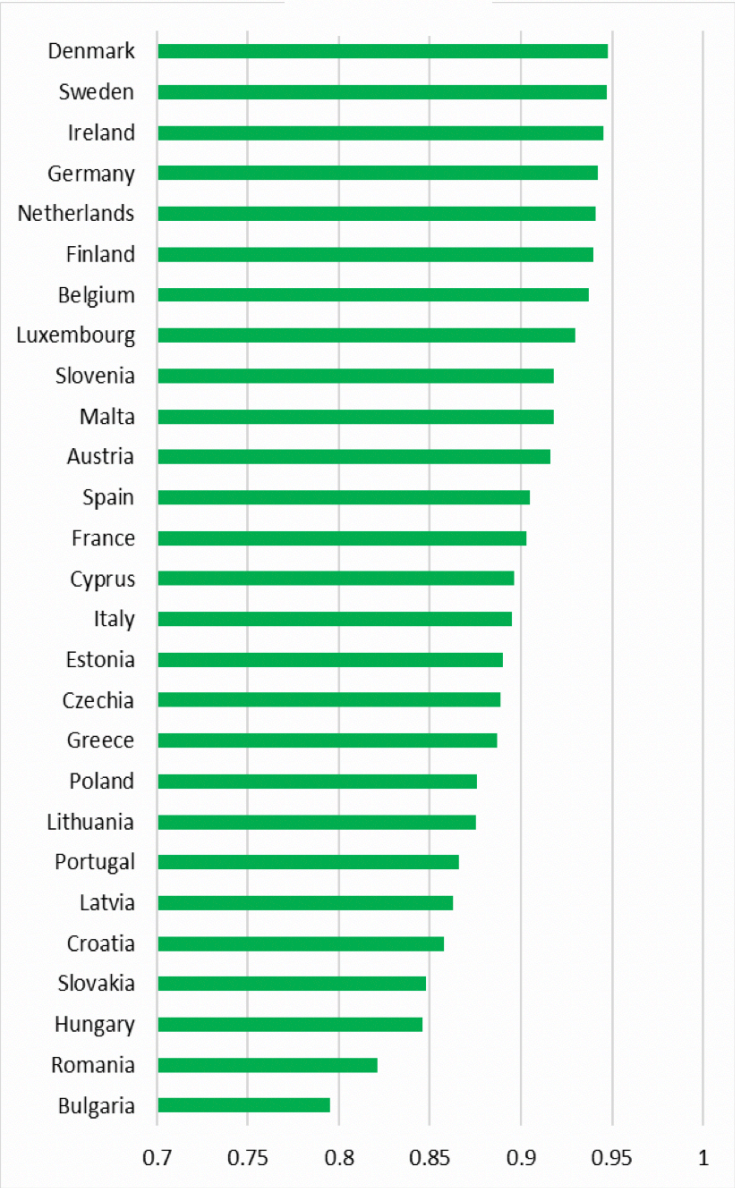

Figure 5: HDI 2021

Source: Authors

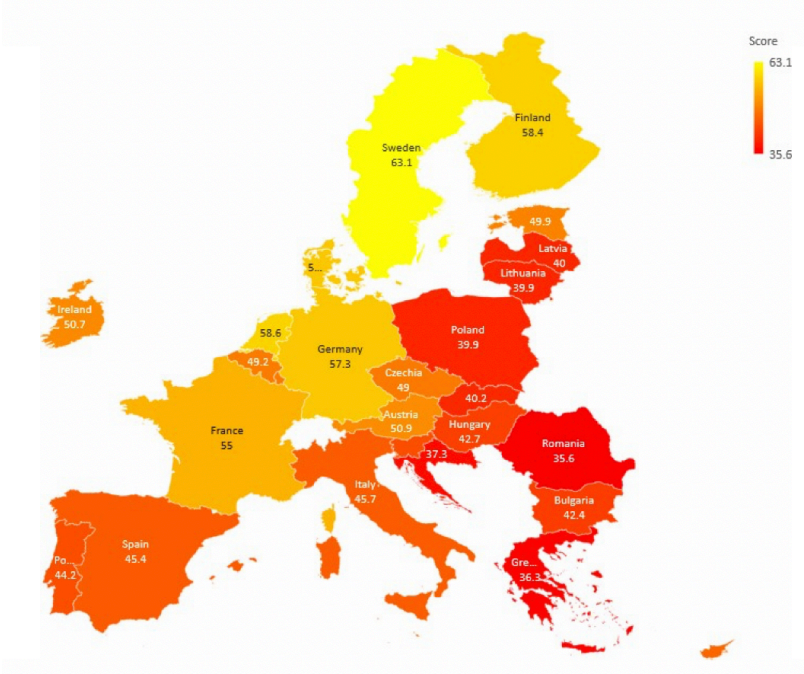

Figure 6: Map of Innovation Index 2021

Source: Authors

The average value of the innovation index of the countries studied was 47.3. The highest value was achieved by Sweden, which reached a value of 63.1 in 2022, and the lowest value was attributed to Romania at 35.6. In general, the Eastern European member countries achieved the lowest values according to the innovation index. This indicates these countries are not prioritizing the development and research of innovation and technological capabilities.

By combining the GDP, HDI and EIS indicators and their values, it is possible to identify which countries have the greatest opportunities to prosper in the field of environmental and renewable innovation, and to improve the general standard of living and development. North-Western Europe is making progress in these areas, while actively contributing to the environmental objectives identified by the EU for the FitFor55 program.

Table 1 compares HDI towards Innovation index, where H0 and H1 are assumed as follows:

H0: There is NO dependency between the HDI and Innovation index by countries

H1: There IS a significant dependency between the HDI and Innovation index by countries

Table 1: Correlation coefficient

	HDI	Innovation index
HDI	1	
Innovation index	0.779342	1

Source: Authors

When examining Pearson correlation coefficient and it´s dependency, we discovered that HDI and Innovation Index have moderately strong dependency among the examined datasets. The value of correlation coefficient is0,77. This number suggests that countries with higher HDI, tend to have also higher Innovation Index and vice versa.

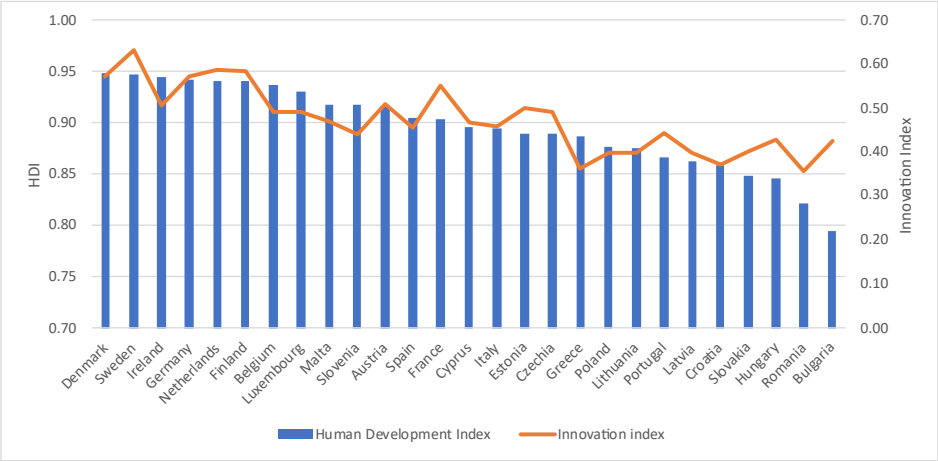

Figure 7: Comparison of HDI and Innovation Index

Source: Authors

In the chart above, the correlation coefficient between the examined datasets shows that countries tend to have higher Innovation index due to higher HDI. The average of the Innovation index is 0.47, and the average of HDI is 0.90. Higher education, and higher living standards, as well as many more factors are responsible for the capability of a country to generate more ideas, use higher and newer technologies, and processes to promote economic growth and its competitiveness.

Returning to the first chart visualizing the Share of Renewables in European union countries, we concluded that in more than 70% of cases, lower HDI and Innovation Index leads countries to use and implement less of renewable energy solutions than those countries with higher evaluations.

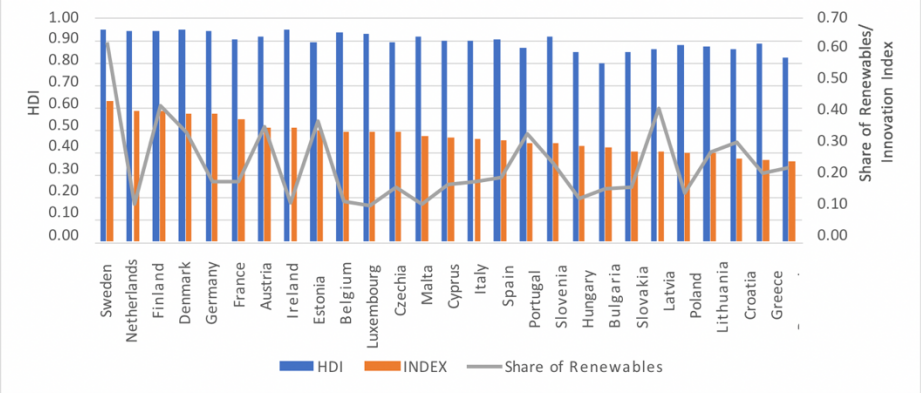

Figure 8: Share of Renewables against HDI & Innovation Index

Source: Authors

From our research perspective, we can confidently say that based on the obtained results, increasing renewable energy sources, and driving general country innovation index upwards has an enormous impact on reducing greenhouse gas emissions. Renewable energy plays a pivotal role in achieving carbon neutrality. Thus, this growth indicates a positive trend towards the adoption of renewable energy sources in the EU member states as they are a key instrument in achieving set of goals by EU. A strong positive correlation between HDI and the Innovation index suggests that countries with higher HDI tend to have higher innovation capabilities and vice versa. This finding is aligned with the observation that countries with higher evaluations in HDI and the Innovation Index tend to implement more renewable energy solutions. Conversely, countries with lower HDI and Innovation Index scores exhibit lower adoption rates of renewable energy. This also supports findings indicating that these countries tend to contribute more toward long-term sustainability and competitiveness. Supporting this evidence is that these indexes and findings are therefore a result of SMEs being highly initiative taking in this environment. They are the drivers that make the country competitive and highlights their interest in sustainability. This evidence indicates that countries separately should support small businesses and make

the processes and activities associated with green development more approachable and easier to implement. Without them a country on its own cannot compete and achieve the specified goals.

Analysis of statistical data shows the need for change in sectors at the organizational and national level, in relation to GHG production or emissions generation. The strategic objectives adopted by the Member States ofthe European Union have committed themselves to achieving these targets in different time horizons. The European Union aims to achieve carbon neutrality by 2050. However, in order to achieve this a change in legislation is needed in the Slovak Republic to better support the development of innovative projects at both national and organizational level. The current situation indicates a poor legislative and procedural environment that needs to be changed to embrace the development of innovative projects in the field of green energy. At the organizational level, it is necessary to make changes or adapt the company's strategy and values according to the draft strategic recommendations that have been developed, which describe how organizations should proceed if they want to continue to integrate environmental projects in their environment.

5. Conclusion

Innovative green energy projects are now crucial for organizations if they want to continue to thrive and add value. In addition to helping individual organizations and increasing their prosperity, innovative projects are important in meeting sustainability goals and protecting the environment. They provide the prerequisites for achieving carbon neutrality, but without their implementation by organizations, this goal is exceedingly difficult to achieve. Projects at the organizational level are unsuccessful due to poorly aligned organizational strategy and values. Unless the core values of the organization are communicated to all stakeholders who influence the growth and management of the organization, it is unlikely that these types of projects will be integrated into the organization’s project portfolio. Environmental projects are becoming more prevalent and desirable by the investment entities that fund today's organizations. They impose various conditions for obtaining funding, including the pursuit of carbon neutrality.

Based on the study, the following points are suggested as they provide useful strategies on how to become greener and more sustainable for the future in the EU region.

The first recommendation is the implementation of ISO standards (Ka et al. 2023) that can provide practical solutions for their businesses and strengthen the market position or create competitive advantage amongst other competitors, with norms such as ISO 14001, ISO 45001, ISO 20400, or ISO 50001.

The second recommendation would be to plan out an action plan that would consist of results from internal and external environmental evaluation. Businesses would then use these data to formulate their strategy and plans (Cote, 2020). It would bring them closer to the formulation of internal company values and what they want to achieve.

The third recommendation is to monitor implement and monitor their KPIs, so the business is more likely to achieve their intended goals within set timeframes. They should be created based on their strategy and planning. The implementation of KPIs in projects should then defined by its importance to business and importance to stakeholders, which could then look like this:

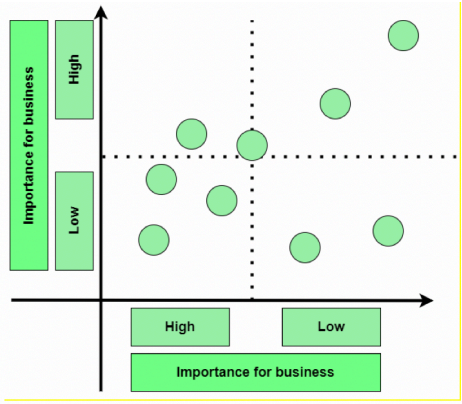

Figure 9: Importance diagram

Source: Authors

The fourth practical recommendation would be for SMEs to lower their consumption of fossil fuels and use sustainable green energy produced from green energy sources. This can be achieved by using local green energy source, or partially depend on their own sustainable green energy source if possible. This would drastically help the environment by reducing dependency on fossil fuels and simultaneously lower the local CO2 emissions. Overall, if majority of SMEs would consider this path, they could globally lower greenhouse gas emissions. On the other hand, businesses would then be able to access so called green financing (Červeňáková, 2023), because they would be considered as a suitable partner for financial institutions to invest in their business. After setting up a proper direction for business, these recommendations would increase relevance of all projects conducted and would help their future growth.

This study brings together valuable information about how the SMEs can influence globally debated question about sustainability and green development. SMEs are the biggest factor that can change the direction of accomplishing EU goals for 2055. However, other researchers may conduct more precise and comprehensive research in this field. For example, data for Slovak republic weren´t that precise and complete in matter of detailed information. In the future, more precise and conducted surveys with larger data samples can be useful to continue this study in more detailed way. In the future, we recommend researchers to split datasets from all countries, and compare results on country level rather than globally. Researchers may focus on different variables than Country Innovation Index which indicates a level of innovation, for example on financial incentives and support mechanisms, regulatory and policy frameworks, environmental and social impacts or on industry collaborations and networks.

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