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ECO-INNOVATION DEVELOPMENT IN SELECTED EUROPEAN AND ASIAN COUNTRIES: A COMPARATIVE ANALYSIS

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ABSTRACT: The development of eco-innovation is driven by globalisation processes, technological progress and climate change. It is also directly related to the pursuit of sustainable development, as well as to the reduction of negative impacts on the environment and the efficient use of natural resources. Monitoring progress towards sustainable development requires the systematic measurement of eco-innovation. An important theoretical and practical challenge is to develop methods and indicators to measure eco-innovation. Currently, there are different systems for measuring eco-innovation, which makes international comparative analysis difficult. This article aims to conduct a comparative analysis of the development of eco-innovation in selected European and Asian countries. The study uses a critical literature review as well as a comparative analysis and synthesis method based on the ASEM Eco-Innovation Index. The study provides evidence that there are a number of differences in eco-innovation between European and Asian countries. Measuring eco-innovation is particularly important in planning and implementing instruments to stimulate environmental innovation across countries.

KEYWORDS: eco-innovation, measuring, indicators, ASEM Eco-Innovation Index

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Introduction

The increasing role of sustainable development forces the need to change the current model of socio-economic development to a more sustainable one. These development trends are a priority not only in the activities of the United Nations (UN) or the Organization for Economic Cooperation and Development (OECD, 2012) but also in the politics of other organizations, such as the European Union, Asia Society, African Union.

The implementation of sustainable development is associated with a fundamental change, considering a systemic and integrated interdisciplinary approach (Borys, 2011, Poskrobko, 2013, Famielec and Famielec, 2016). Sustainability efforts require the integration of short and long term economic, social and environmental goals in line with the current global Sustainable Development Goals (SDGs) strategy (United Nations, 2015). These actions are reflected, among other things, in combating climate change and promoting a low-carbon and resource-efficient economy. In the face of current global challenges, it is necessary to take action for sustainable development, especially in terms of sustainable economic development, social progress and environmental protection.

Eco-innovation plays a particularly important role in supporting sustainable development, which are seen not only as a catalyst for facilitating these changes, but also as a key element of policies and activities for sustainable development (Cai and Li, 2018, Akiner et al., 2019). The overall objective of eco-innovation is to reduce negative environmental impacts, to create new market opportunities, products, services or processes focused on improving environmental performance (e.g. saving energy and other resources and reducing pollution and waste) (OECD, 2009). Green innovation is a type of innovation that can not only benefit consumers and businesses, but also significantly reduce negative environmental impacts. Eco-innovation is defined as the introduction of any new or significantly improved product, process, organizational change or marketing solution that reduces the consumption of natural resources (including materials, energy, water and soil) and reduces emissions of harmful substances throughout its life cycle (Donis et al., 2021, Díaz-García et al., 2015). In all cases, the producer and the consumer play an important role in the successful diffusion of eco-innovation.

Eco-innovation is, therefore, an important area of business competitiveness and directly affects financial returns; however, its scale and implementation depend on, among other things, the industry, legislation and standards, as well as consumer sensitivity and environmental awareness (Horbach et al., 2012, Triguero et al., 2013, Urbaniec, 2016). Their implementation aims not only to reduce negative environmental impacts but also to decrease material and energy costs to increase competitiveness (Porter and Van der Linde, 1995). Despite the numerous and varied definitions found in the literature, eco-innovation can also be defined as innovation that leads to an improvement in environmental quality and has been implemented to increase the environmental performance of enterprises (Díaz-García et al., 2015).

Despite growing interest in eco-innovation, it is still a relatively under-researched area. Above all, it lacks a widely accepted definition and a coherent theoretical concept (Urbaniec et al., 2021, Türkeli and Kemp, 2018). Furthermore, there is no standard approach to measuring the effects of eco-innovation. In turn, the availability and quality of environmental data vary from country to country and region to region. Considering eco-innovation at the macroeconomic level, it should be pointed out that in practice and the literature, there are different theoretical approaches for measuring and analyzing eco-innovation, e.g. for European countries and for Asian countries. This is also linked to countries' efforts to achieve sustainable development, as well as to reduce negative environmental impacts and use natural resources efficiently. Monitoring progress towards sustainable development requires the systematic measurement of eco-innovation (Park et al., 2017). Therefore, an important theoretical and practical challenge is to develop methods and indicators to measure and analyse eco-innovation at the macroeconomic and microeconomic levels.

The aim of this article is to conduct a comparative analysis of the development of eco-innovation in selected European and Asian countries. The main research question is what difficulties or advances in eco-innovation exist in selected European and Asian countries? The method used was a critical literature review as well as a comparative analysis and synthesis method based on the ASEM Eco-Innovation Index. This analysis provides a comprehensive overview of the developments of eco-innovation development based on the same methodology. The study contributes to the literature on measuring eco-innovation performance by analysing the determinants of eco-innovation in different countries.

The paper is organized as follows: The next section presents the analytical framework for measuring eco-innovation. Section 3 deals with the research methodology, including data collection and analysis methods. Subsequently, the research analysis results are presented, focusing on the eco-innovation progress of Asian economies based on the indicators of the ASEM Eco-Innovation Index. The final section summarizes the main results of the analysis, provides a discussion and identifies directions for future research.

Literature review

Eco-innovation is the subject of various theoretical approaches. There is no single universally accepted definition of eco-innovation in the literature, and existing concepts differ in their research scope (Türkeli and Kemp, 2018). Eco-innovation is characterised by much greater variation than traditional innovation, as they are often based on technical processes (environmental technologies), and their effects are usually unpredictable. Many definitions of eco-innovation in literature and economic practice vary in scope and degree of detail. Generally, they are concerned about innovations that bring benefits to the environment.

Eco-innovation first became the subject of research already in the late 1970s (Urbaniec, 2015). A broader definition of eco-innovation was formulated in the second half of the 1990s and includes "all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which; develop new ideas, behavior, products and processes, apply or introduce them and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets" (Rennings, 2000). Eco-innovation is not limited to innovations in products, processes and marketing methods but also includes innovations in social and institutional structures. Eco-innovation is, therefore, not necessarily a global novelty or the result of a deliberate business activity or strategy (Arundel and Kemp, 2009). It can therefore be argued that any innovation that contributes to environmental benefits over relevant alternatives is an eco-innovation (e.g. environmental technologies, organisational innovations, product and service innovations and green system innovations) (Arundel and Kemp, 2009, Türkeli and Kemp, 2018, OECD, 2009). A similar definition has been used for the Eco-Innovation Scoreboard (Eco-IS) developed by the Eco-Innovation Observatory (EIO) in the European Union. According to the EIO, eco-innovation is defined as any form of innovation aiming at significant and demonstrable progress towards the goal of sustainable development, either by reducing environmental impacts or achieving more efficient and responsible use of resources, including both intended and unintended environmental consequences of innovation, as well as not only environmental technologies but processes, systems and services (EIO, 2013).

The Eco-innovation Scoreboard (Eco-IS) provides an overview of EU Member States' eco-innovation performance. It aims to measure different aspects of eco-innovation by using 16 indicators grouped into five dimensions: eco-innovation input, eco-innovation activities, eco-innovation output, resource efficiency outcomes and socio-economic performance (Arundel and Kemp, 2009, Bernard et al., 2020, Colombo et al., 2019). The Eco-IS score enables the identification of the strengths and weaknesses of eco-innovation in each EU country. By promoting a holistic view of economic, environmental and social performance, the Eco-IS complements other approaches to measuring country innovation, such as the Global Innovation Index (Bernard et al., 2020).

Regarding the growing role of eco-innovation, especially in the context of the global SDGs, various organisations are making efforts to measure eco-innovation. While measurement of eco-innovation at the OECD and EU levels are rather frequently explored (Colombo et al., 2019, Wegrzyn, 2013, Pakulska, 2018), however, methodologies developed for Asian countries are relatively rarely examined (Park et al., 2017). Given the different existing methodologies, there are difficulties in comparing European and Asian countries.

Therefore, this study focus on analysing indicators for European and Asian countries based on the ASEM Eco-Innovation Index (ASEI), which was developed by the ASEM SMEs Eco-Innovation Center in the Republic of Korea (Park et al., 2017, Jang et al., 2015, Jo et al., 2015). The ASEM Eco-Innovation Index shows how well individual countries are performing in the various dimensions of eco-innovation and enables analysis of their strengths and weaknesses (Park et al., 2017). The ASEM Eco-Innovation Index aims to promote a holistic view of economic, environmental, and social performance. However, ASEI has limitations in measuring indicators due to limited data availability in Asian countries.

The development of a research methodology to measure eco-innovation has been the focus of many researchers (Triebswetter and Wackerbauer, 2008, Arundel and Kemp, 2009, Horbach, 2016). This contributes to the search for new measurement tools in economic practice. However, few studies have examined eco-innovation at the national level, but most have been conducted in developed countries (i.e. European countries), excluding Asian countries (Jo et al., 2015). Considering this research gap, focusing on eco-innovation based on the methodology used in the ASEM Eco-Innovation Index may provide an opportunity to compare the level of eco-innovation in Europe and Asia.

Eco-innovation plays a particularly important role in supporting sustainable development, which are seen not only as a catalyst for facilitating these changes (Urbaniec, 2015, Smol et al., 2017, Colombo et al., 2019), but also as a key element of Asian countries' policies for sustainable development (Cai and Li, 2018, Akiner et al., 2019). Although many countries are taking various steps to achieve the 17 SDGs by 2030, overall progress in Asian countries is rather slow. There has been relatively little progress in reducing inequality, promoting responsible consumption and production or achieving peace, justice and strong institutions. Advances on gender equality and building sustainable cities and communities are also insufficient. Therefore, greater support is needed to significantly accelerate progress or reverse trends on most of the 2030 Agenda's environmental targets (UN ESCAP, 2020). Asian countries have already taken significant steps in some areas. For example, the region's total renewable electricity capacity has increased nearly fivefold since 2000, faster than any other region in the world. In addition, there are specific conditions in each country resulting from the applied economic instruments used and the historical path of industrial development.

The literature review on the theoretical approaches to measuring and analysing the effects of eco-innovation shows that there is no uniform method of measurement and indicators. The specificity of the methods and the level of detail require appropriate adaptation to the particular case. However, it should ensure comparability of the results of eco-innovation activities. The difficulty of measuring eco-innovation effects lies additionally in the fact that they are associated with uncertainty in eco-innovation effects. By measuring eco-innovation at the national level, comparisons between countries can be made, and environmental policies can be fostered. This is particularly important in planning and implementing instruments to stimulate eco-innovation across countries (Donis et al., 2021). Measuring eco-innovation also contributes to a better understanding of overall sustainability trends and raises public awareness of environmental management.

Research methods

This study focuses on conducting a comparative analysis of the development of eco-innovation in selected European and Asian countries. The research made it possible to answer the research question: what difficulties or advances in eco-innovation exist in selected European and Asian countries? For this study, annual data for 2016-2018 were used that describe the ASEM Eco-Innovation Index. The ASEM Eco-Innovation Index covers both ecological, economic and social aspects. Therefore, a comprehensive tool for measuring eco-innovation in ASEM member states was constructed. In addition, the ASEM Eco-Innovation Index includes input-based indicators measuring the outlays of innovative processes and output-based indicators that test the results of innovative activities (Albino et al., 2014). It is equally important to include the impact of eco-innovation in the ASEM Eco-Innovation Index (Park et al., 2017). The ASEM Eco-Innovation Index includes a total of 19 different indicators, which have been grouped into 4 components (ASEIC, 2018):

- Eco-innovation Capacity,
- Eco-innovation Supporting Environment,

- Eco-innovation Activities,
- Eco-innovation Performance.

All these indicators are measured by different indicators on social, economic and environmental issues (table 1).

Table 1. Components and indicators of ASEM Eco-Innovation Index

Component	Indicators
Eco-innovation Capacity	1. Potential to improve national competitiveness 2. General innovation capacity of nation 3. R&D Capacity for Environmental Science 4. Number of Researchers in Environmental Science 5. Awareness level of company`s sustainable management
Eco-innovation Supporting Environment	1. Government expenditure on green R&D 2. Impacts of environmental regulations on corporate competitiveness 3. Corporate priority level of sustainable development 4. Generation Capacity of Renewable Energy
Eco-innovation Activities	1. Number of companies with green technology 2. Participation level in environmental management 3. Industry-academic cooperation on environmental R&D 4. Share of Green patents 5. Level of renewable energy distribution
Eco-innovation Performance	1. Quality of life related to environmental impacts 2. Greenhouse gas emission intensity 3. Environmental sustainability level 4. Employment rate in green technology industry 5. Green Industry Trade Market Size

Source: ASEIC (2018).

Components will be discussed in the next section. However, it is worth noting that these four components highlight the complexity of eco-innovation as they describe the inputs, outputs and impacts of eco-innovation (Park et al., 2017).

The data for the analysis concerns the five Asian countries and five European countries that are members of ASEM (Asia-Europe Meeting), which is an intergovernmental partnership of member countries from Asia and Europe. The analysis covers the following countries: Japan, New Zealand[1], Singapore, Australia, the Republic of Korea, Norway, Denmark, Sweden, Switzerland and Germany. These are leading European and Asian countries in eco-innovation. The research timeframe was selected due to the availability of the data. The ASEM Eco-Innovation Index has been continuously developed since 2012, but not all ASEM member countries were included initially.

[1] Australia and New Zealand belong to the geographical region of Oceania, while under ASEM they are classified as Asian countries.

Hence, when comparing the eco-innovation level in European and Asian economies, data for 2016-2018 based on the ASEM Eco-Innovation Index was used.

The study employed the following research methods: a literature analysis and critique, comparative analysis method and synthesis method. Through the use of comparative analysis, the study offers a qualitative perspective on the current achievements in the implementation of eco-innovation. It contributes to the debate on eco-innovation in Asian countries. Based on the ASEM Eco-innovation Index data, the analysis provides a comprehensive overview of changes in the development of eco-innovation in selected Asian countries. In order to assess the quality of the research, the choice of research methods in the article was determined by meeting two research criteria: reliability and validity. These criteria were provided using publicly available secondary data on the eco-innovation index for Asian countries.

Results of the research

A comparative analysis of the main components based on the ASEM Eco-Innovation Index will be conducted to investigate the strengths and weaknesses of eco-innovation development in selected European and Asian countries. At the first stage, the Eco-innovation Capacity component was analysed in 2016-2018 in Norway, Denmark, Sweden, Switzerland, Germany, Japan, New Zealand, Singapore, Australia and the Republic of Korea. Based on the figure below, it can be observed that this component has higher values in European countries compared to the Asian countries included in the analysis. Germany is an exception, although the share of the potential to improve national competitiveness (measured by WEF Global Competitiveness Index) and the general innovation capacity of nation (measured by INSEAD Global Innovation Index) was relatively high (Schwab, 2018, Dutta et al., 2019). Switzerland's position, in turn, is a result of its high position in terms of both indicators mentioned above. It is also indicated that Switzerland should be considered as the country with the highest eco-innovation capacity among ASEM Member States (Becker et al., 2021). In the case of Asian countries, the leading position of Australia can be observed, even though it ranks relatively low in terms of both the potential to improve the country's competitiveness and the general innovation capacity. The measurement of this component is hampered by the other three indicators and the scoring method adopted for them. Moreover, it is worth noting that in previous years other indicators were also used to measure Eco-innovation Capacity. It is therefore difficult to clearly assess the difficulties and progress of the analysed countries with regard to the first component.

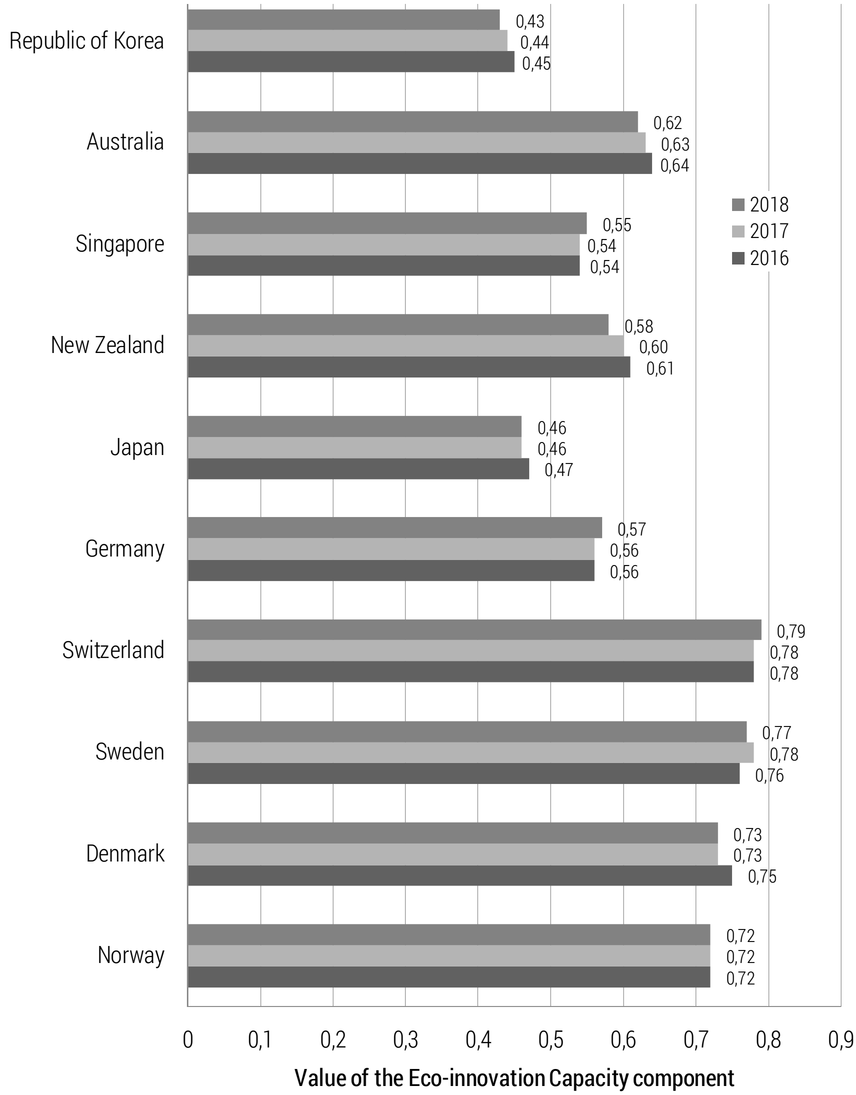

Figure 1. Eco-innovation Capacity component in selected countries in years 2016-2018
Source: author's work based (ASEIC, 2018).

Similar difficulties are encountered in assessing the Eco-innovation Supporting Environment component, which focuses more on institutional factors. The impact of environmental regulations on the competitiveness of enterprises and the corporate priority level of sustainable development indicators was adopted as the scoring method for the IMD survey index value. The lack of an up-to-date ASEIC database makes it difficult to both track progress and country-specific difficulties in implementing this component. From

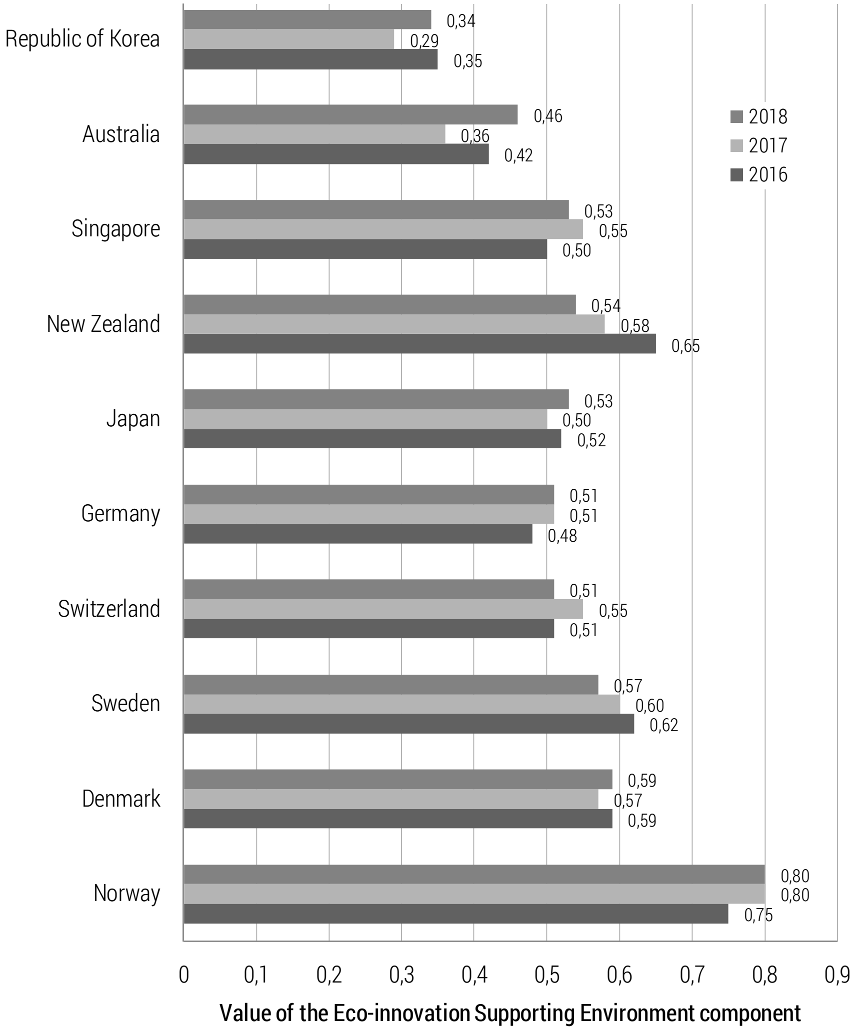

Figure 2. Eco-innovation Supporting Environment component in selected countries in years 2016-2018

Source: author's work based (ASEIC, 2018).

the countries analysed, it appears that the Eco-innovation Supporting Environment component achieved the highest values in 2016-2018 in Norway, followed by New Zealand (figure 2). Norway's high performance was influenced by its renewable energy policy as well as the high share of the generation capacity of renewable energy indicators (Egging and Tomasgard, 2018). New Zealand has also taken a number of steps to transform the energy sector and develop renewable energy to achieve ambitious goals in this regard (Verma et al., 2018).

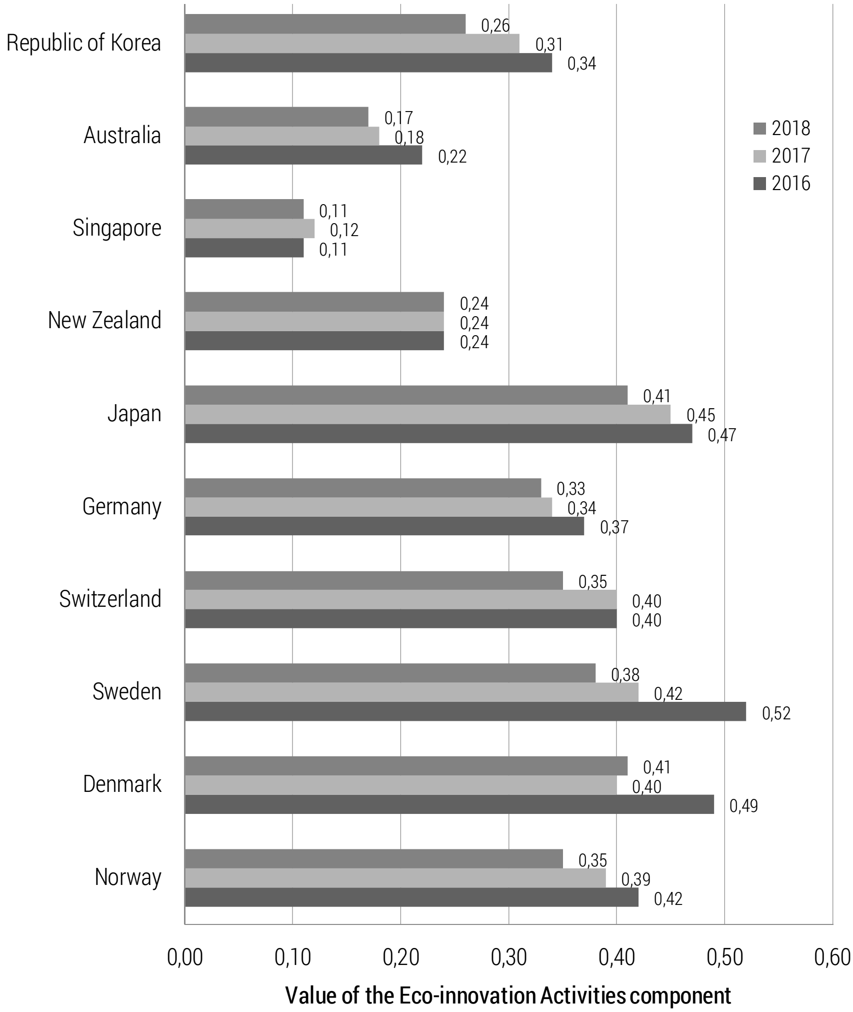

Figure 3. Eco-innovation Activities component in selected countries in years 2016-2018
Source: author's work based (ASEIC, 2018).

All the analysed countries achieved the lowest values in the Eco-innovation Activities component among all 4 components of the ASEM Eco-Innovation Index. The highest values in 2018 were recorded by Japan and Denmark (figure 3). Japan's leading position was due to the relatively high share of participation level in the environmental management indicator (World Bank, 2021). Japan also has a very good result in the number of companies with green technology indicators, measured as the number of companies with patent applications for the past five years (WIPO, 2018). In addition, Japan, along with the United States, China, the Republic of Korea and Germany, is among

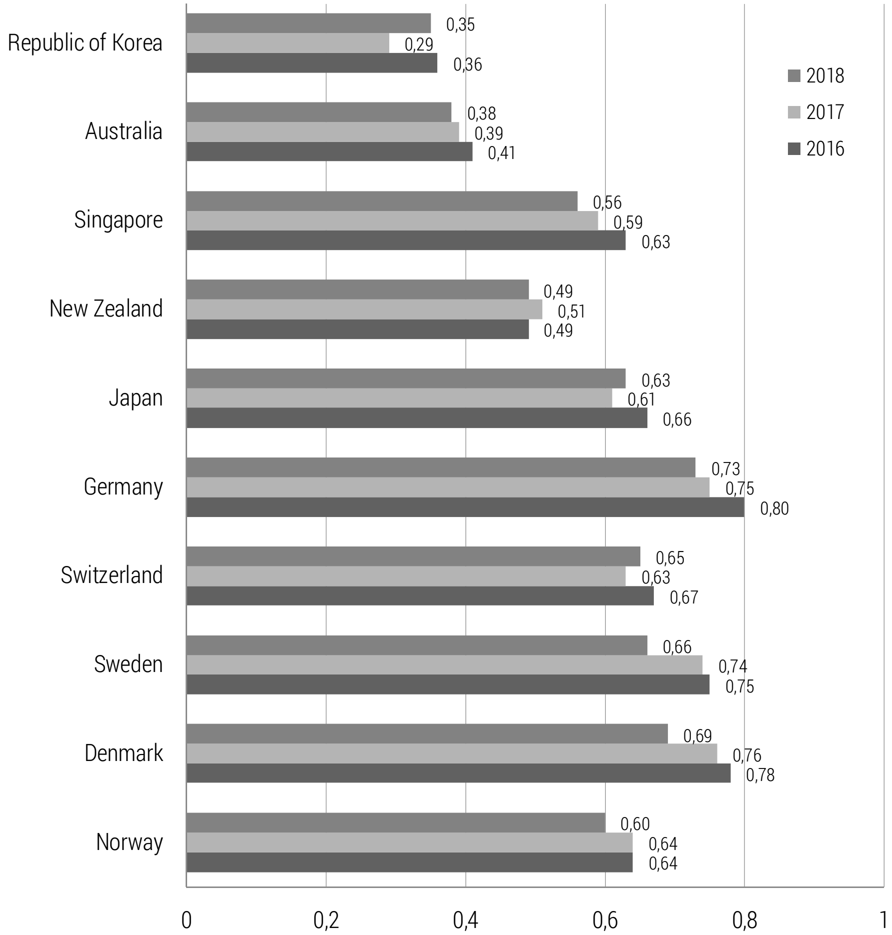

Figure 4. Eco-innovation Performance component in selected countries in years 2016-2018
Source: author's work based (ASEIC, 2018).

the countries with the highest number of green patents (Urbaniec et al., 2021). Denmark also boasts a very good result in the level of renewable energy distribution indicator and participation level in environmental management indicator (The World Bank, 2021).

The discrepancy between the analysed Asian countries and the European countries can be noticed again in the case of the Eco-innovation Performance component. European countries achieved higher values of individual indicators assigned to this component. The exceptions are Japan and Singapore, which obtained similar results to Norway and Switzerland (figure 4). Asian countries achieved weaker results in the Quality of Life Index in relation to the European countries included in the analysis (Numbeo, 2021). European countries also score better on the environmental sustainability indicator (EPI, 2018). Therefore, Asian countries should pay more attention to these indicators to improve their performance than European countries.

The presented components of the ASEM Eco-innovation Index allow for the assessment of the level of eco-innovation, as well as the identification of strengths and weaknesses in development eco-innovation in selected European and Asian countries. The weakest point of the analysed Asian and European economies was found to be the Eco-innovation Activities component, which requires the implementation of green technologies, as well as developing cooperation at different levels and building a platform for dialogue between industry and science. The best results were achieved in Eco-innovation Capacity, which is influenced by the continuous improvement of competitiveness and focus on innovation development.

Based on the average values for all components in the countries analysed, it can be observed that European countries perform better in terms of eco-innovation (figure 5).

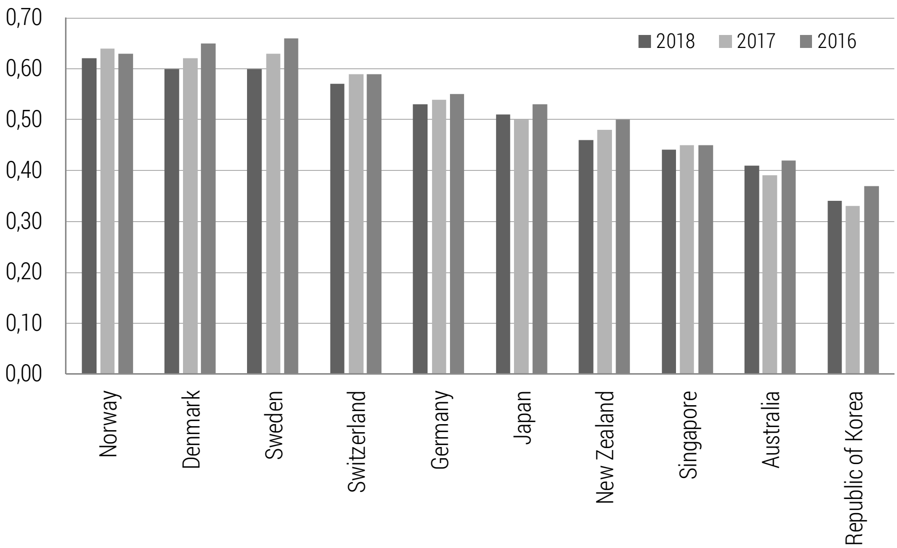

Figure 5. ASEM Eco-Innovation Index in selected countries in years 2016-2018

Source: author's work based (ASEIC, 2018).

However, this is not a fully quantifiable picture of the potential for developing eco-innovation and sustainable development. This is due to changes in the indicators describing the components that make up the ASEM Eco-Innovation Index. Furthermore, the lack of a database of up-to-date data for all ASEM member countries makes it difficult to track changes in eco-innovation. It is also a challenge to determine the progress and difficulties of individual countries in achieving particular indicators due to limited access to comparative data.

Conclusions

The research analysis showed that the ASEI index has a great potential to measure eco-innovation. The findings provide insights into the key areas, objectives and applications of the eco-innovation index indicators for European and Asian countries based on ASEM Eco-innovation Index. This research facilitates the comparative analysis of selected economies in the area of eco-innovation. The index results can contribute to the development of eco-innovation strategies at the national level and by relevant actors. At the same time, our analysis showed that the level of eco-innovation development in individual European and Asian economies belonging to ASEM varies greatly. One of the factors that seem to have a decisive influence is the different level of socio-economic development of these countries.

The main contribution of this study is to benchmark and assess developments in eco-innovation in selected European and Asian economies. Another added value of the analysis carried out is that it broadens the knowledge of research on the measurement of eco-innovation by including the ASEA Eco-innovation Index indicators, which is rarely examined in the literature. In addition, the research analysis showed that the ASEI index has a strong potential to contribute to the Sustainable Development Goals (SDGs), especially in relation to the SDGs on sustainable industrialisation and sustainable consumption and production.

Like any scientific article, this one is not without limitations. An important limitation was the access to complete and up-to-date data, which conditioned the temporal scope of the analysis to 2015-2018. Furthermore, although the ASEM Eco-Innovation index was first published in 2012, it does not cover all ASEM member countries. In addition, the analysis covered selected European and Asian countries belonging to ASEM. However, it is worth noting that these countries have different levels of socio-economic development and face various economic, social and environmental challenges that determine the development of eco-innovation (Jo et al., 2015, Park et al., 2017).

Given the future directions of the study, the temporal scope of the analysis should be extended. This would significantly deepen the knowledge of measuring eco-innovation in European and Asian countries. An interesting research area would also be an analysis for all Asian countries, which could reveal differences and progress in the implementation of eco-innovation.

It will certainly also be important to consider the impact of the COVID-19 pandemic on levels of eco-innovation, as the pandemic affects many aspects of economic, political and social life. Therefore, it is worth examining how the pandemic is affecting the development and implementation of eco-innovation not only in Asian economies but also in other countries around the world.

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The contribution of the authors

Justyna Tomala: conception – 50%, literature review – 50%, writing 30%, analysis and interpretation of data – 70%

Maria Urbaniec: conception – 50%, literature review – 50%, writing – 70%, analysis and interpretation of data – 30%

References

Akiner, S., Hay, J. & Tideman, S., 2019. Sustainable Development in Central Asia, New York, Routledge.

Albino, V., Ardito, L., Dangelico, R. M. & Messeni Petruzzelli, A., 2014. Understanding the development trends of low-carbon energy technologies: A patent analysis. Applied Energy, 135, 836-854.

Arundel, A. & Kemp, R., 2009. Measuring eco-innovation. Working Paper Series. UNU-MERIT.

ASEIC, 2018. 2018 ASEM Eco-Innovation Index. ASEM SMEs Eco-Innovation Center (ASEIC).

Becker, W., Domínguez-Torreiro, M., Neves, A. R., Tacão Moura, C. & Saisana, M., 2021. Exploring the link between Asia and Europe connectivity and sustainable development. Research in Globalization, 3, 100045.

Bernard, H., Spaini, C., Markianidou, P. & Doranova, A., 2020. EU Eco-Innovation Index: 2019 version. Technical note., Technopolis Group.

Borys, T., 2011. Sustainable Development – How to Recognize Integrated Order. Problemy Ekorozwoju, 6, 75-81.

Cai, W. & Li, G., 2018. The drivers of eco-innovation and its impact on performance: Evidence from China. Journal of Cleaner Production, 176, 110-118.

Colombo, L., Pansera, M. & Owen, R., 2019. The discourse of eco-innovation in the European Union: An analysis of the Eco-Innovation Action Plan and Horizon 2020. Journal of Cleaner Production, 214, 653-665.

Donis, S., Gomez, J. & Salazar, I., 2021. The determinants of eco-innovation at the country level. An analysis for OECD countries. Academy of Management Proceedings, 2021, 16562.

Dutta, S., Lanvin, B. & Wunsch-Vincent, S. (eds.), 2019. The Global Innovation Index 2019: Creating Healthy Lives – The Future of Medical Innovation, Ithaca, Fontainebleau, Geneva: Cornell University, INSEAD, and the World Intellectual Property Organization.

Díaz-García, C., González-Moreno, Á. & Sáez-Martínez, F. J., 2015. Eco-innovation: insights from a literature review. Innovation, 17, 6-23.

Egging, R. & Tomasgard, A., 2018. Norway's role in the European energy transition. Energy Strategy Reviews, 20, 99-101.

EIO, 2013. Europe in transition: Paving the way to a green economy through eco-innovation, Brussels, Eco-Innovation Observatory. Funded by the European Commission, DG Environment.

EPI, 2018. 2018 Environmental Performance Index, New Haven, Yale University, Columbia University, World Economic Forum.

Famielec, J. & Famielec, S., 2016. Integracja nauk ekonomicznych, technicznych i chemicznych na rzecz rozwoju zrównoważonego. Ekonomia i Środowisko, 58, 47-61.

Horbach, J., 2016. Empirical determinants of eco-innovation in European countries using the community innovation survey. Environmental Innovation and Societal Transitions, 19, 1-14.

Horbach, J., Rammer, C. & Rennings, K., 2012. Determinants of eco-innovations by type of environmental impact – The role of regulatory push/pull, technology push and market pull. Ecological Economics, 78, 112-122.

Jang, E. K., Park, M. S., Roh, T. W. & Han, K. J., 2015. Policy Instruments for Eco-Innovation in Asian Countries. Sustainability, 7, 1-29.

Jo, J.-H., Roh, T. W., Kim, S., Youn, Y.-C., Park, M. S., Han, K. J. & Jang, E. K., 2015. Eco-Innovation for Sustainability: Evidence from 49 Countries in Asia and Europe. Sustainability, 7, 1-16.

NUMBEO, 2021. Quality of Life Index by Country 2018. Available: https://www.numbeo.com/quality-of-life/rankings_by_country.jsp?title=2018 [17.08.2021].

OECD, 2009. The Bioeconomy to 2030: Designing a Policy Agenda, Paris, OECD.

OECD, 2012. OECD Environmental Outlook to 2050: The Consequences of Inaction, Paris, OECD.

Pakulska, J., 2018. Wskaźniki innowacji ekologicznych dla Polski w latach 2010–2017. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, 237-247.

Park, M. S., Bleischwitz, R., Han, K. J., Jang, E. K. & Joo, J. H., 2017. Eco-Innovation Indices as Tools for Measuring Eco-Innovation. Sustainability, 9, 1-28.

Porter, M. E. & Van Der Linde, C., 1995. Toward a new conception of the environment: Competitiveness relationship. Journal of Economic Perspectives, 9, 97-118.

Poskrobko, B., 2013. Paradygmat zrównoważonego rozwoju jako wiodący kanon w badaniu nowych obszarów ekonomii. Ekonomia i Środowisko, 3, 10-24.

Rennings, K., 2000. Redefining innovation – eco-innovation research and the contribution from ecological economics. Ecological economics, 32, 319-332.

Schwab, K. (Ed.), 2018. The Global Competitiveness Report 2018, Cologny/Geneva: World Economic Forum.

Smol, M., Kulczycka, J. & Avdiushchenko, A., 2017. Circular economy indicators in relation to eco-innovation in European regions. Clean Technologies and Environmental Policy, 19, 669-678.

The World Bank, 2021. ISO 14001 environmental certificates.

Triebswetter, U. & Wackerbauer, J., 2008. Integrated environmental product innovation in the region of Munich and its impact on company competitiveness. Journal of Cleaner Production, 16, 1484-1493.

Triguero, A., Moreno-Mondéjar, L. & Davia, M. A., 2013. Drivers of different types of eco-innovation in European SMEs. Ecological Economics, 92, 25-33.

Türkeli, S. & Kemp, R., 2018. Changing Patterns in Eco-Innovation Research: A Bibliometric Analysis. In: Horbach, J. & Reif, C. (Eds.) New Developments in Eco-Innovation Research. Cham: Springer International Publishing.

UN ESCAP, 2020. Asia and the Pacific SDG Progress Report 2020, Bangkok, United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP).

United Nations, 2015. Transforming our world: the 2030 Agenda for Sustainable Development, New York, United Nations.

Urbaniec, M., 2015. Towards Sustainable Development through Eco-innovations: Drivers and Barriers in Poland. Economics & Sociology, 8, 179-190.

Urbaniec, M., 2016. Sustainable competitiveness. Opportunities and challenges for Poland's economy. Ekonomia i Środowisko, 59, 34-51.

Urbaniec, M., Tomala, J. & Martinez, S., 2021. Measurements and Trends in Technological Eco-Innovation: Evidence from Environment-Related Patents. Resources, 10, 1-17.

Verma, P., Patel, N., Nair, N.-K. C. & Brent, A. C., 2018. Improving the energy efficiency of the New Zealand economy: A policy comparison with other renewable-rich countries. Energy Policy, 122, 506-517.

Wegrzyn, G., 2013. Ekoinnowacje w Polsce na tle krajów Unii Europejskiej. Ekonomia i Środowisko, 46.

WIPO, 2018. Patents. Available: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2018-chapter2.pdf [17.08.2021].