Prevalence of the Sustainable Cities and Communities Goal (SDG-11) in the Research Activity of V4 Countries

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ABSTRACT

The UN General Assembly accepted the "Agenda 2030" UN resolution in 2015. The document specified seventeen so-called Sustainable Development Goals (SDGs) for countries to follow. It is widely accepted that Universities as scientific hubs should participate in facilitating the knowledge generation and implementation of the strategy. This study analyzed the prevalence of the "Sustainable cities and communities" (SDG-11) goal in academic publications from 2017 to 2021 in Europe, focusing on V4 countries. We analyzed the number of research papers and their impact based on the SciVal and the World Economic Forum's Times Higher Education (THE) university impact ranking databases. Luxembourg leads the ranking of European countries in SDG-11 publications per capita, while less-developed countries tend to be at the bottom of the line. For the V4 countries, not the lower interest in SDG-11 is the main problem, but the weaker interest in SDG-related research in general. Also, there is little overlap between the sub-topics in V4 countries which can hinder possible synergies. To celebrate the few existing sub-topic overlaps between V4 institutions, we introduced a "connection map" that may facilitate stronger collaborations amongst V4 universities.

CCS CONCEPTS

• **Sustainability**; • **Sociology**; • **Database views**;

KEYWORDS

Sustainability Goals, SDG-11, Sustainable Cities and Communities, Impact University Ranking, THE Ranking

1 INTRODUCTION

The 2015 United Nations General Assembly (UNGA) on sustainability organized its programme according to the Post-2015 Development Agenda framework [1]. The Framework is based on balanced social development, sustained economic growth and environmental protection. The negotiations have been finalised in creating the so-called Agenda 2030 UNGA resolution. To implement the Agenda's strategy, world leaders identified Sustainable Development Goals (SDGs) in 17 interrelated areas, ranging from decent work and economic growth to sustainable cities and communities and responsible consumption and production. A significant number of the goals are to be achieved by 2030, while no deadline is set for others. The 2030 Agenda recognises that a critical pillar of sustainability dilemmas is the problems of cities and their communities [2]. This is reinforced by the scientific findings whose message is that "cities are critical drivers of global change" [3]. The paradigm is supported by a wealth of current data today. They show that the world's cities account for more than 50% of the world's population, which could reach 70% by 2050. By then, cities will produce 80% of the world's GDP (world economic output), consume 2/3 of global resources and energy, and be responsible for 70% of greenhouse gas emissions [4, 5]. In line with the United Nations' strategy, the European Union is also committed to the sustainable development of cities and their communities. In this context, the so-called Sustainable and Smart Mobility Strategy [6] was developed in 2020, which also serves as a basis for the implementation of three sustainability goals: "Industry, innovation and infrastructure" (SDG-9), "Sustainable cities and communities" (SDG-11) and "Responsible consumption and production" (SDG-12).

In this study, we examine the relationship of academic publications in higher education institutions to the theme of Sustainable Cities and Communities. Considering the above, we have assumed that the intellectual and active contribution of universities in their respective cities is essential to achieve the relevant goals locally. Policies give universities a key role in developing sustainability concepts, disseminating a culture of sustainability and promoting sustainable ideas. Our approach utilizes the definition of academia that is: "universities are institutions embedded in regional and international networks that are composed of a broader range of stakeholders, including civil society organizations or citizens, and are engaged in the science of sustainability" [7, p.77] Universities contribute to the sustainability goals of global, national, and regional and local communities in a variety of ways and a variety of areas, such as education, research, and governance participation

in government [7]. There are previous studies utilizing the same concept to elaborate on the SDG related commitment of higher education institutions. Pakkan et al. [8] used the Scopus database and the so called "THE ranking" architecture to examine the publications on the SDGs of the BRICS (Brazil, Russia, India, China and South Africa) countries from 2015 to 2019, focusing on India's role and contribution to the SDGs research. Their work aimed to identify existing SDG research areas at the international level among BRICS countries. To do this, they examined the impact of the 16 SDGs on each other using Spearman's rank correlation. Their results contribute to strengthening cooperation and networking between universities around the world in both research and education. As mentioned above, the referred authors analyzed sixteen SDGs out of the total seventeen. The reason behind it is that the 17th SDG, called partnerships is a particular category regarding the classification process. The performance in SDG-17 is a precondition for being involved in the THE Impact ranking and SCOPUS databases and not an assessment measure. Suppose an institution meets the criteria regarding its SDG–17 performance and gets listed on the mentioned databases. In that case, SDG 17th is no longer a performance indicator in the THE Impact ranking system by definition. We will also use this method for our analysis (considering the sixteen SDG goals from the seventeen).

In the present study, we analyzed the relationship between higher education institutions and the sustainability goal of SDG 11 in Europe, with a particular focus on the Visegrad Group countries (Hungary, Poland, the Czech Republic and Slovakia). The main scope of the analysis was to study the research directions of higher education institutions in the respective countries. We took into account the period ranging from 2017 to 2021. Our results provide a picture of the engagement of researchers, particularly in the V4 countries with sustainability issues. The joint analysis of the corresponding patterns of higher education sectors in V4 is well-justified by their relatedness. The so-called post-socialist countries have several standard features in their higher education systems, mainly because they started from a similar basis and moved to Western systems in the same period and under the same conditions. The main features of this were the development of the non-state sector, the introduction of tuition fees, the emergence of per capita funding and, later, the segmentation of the education system [9]. Some scholars argue that, from particular perspectives, the coherence of the development path of the V4 higher education systems is weakened because of somewhat different pathways and the final results of the transition. There are also conflicting results regarding the ex-post assessment of the achievements of those systematic changes [10]. With all of those considerations, the V4 higher education systems have a lot of shared features. Universities in the V4 continue to be characterised by the importance of state ownership and the government's decisive influence/control role. At the same time, it is valid for every country that academic research activity is crucial for stimulating sustainability-related innovation. The process requires the integration of sustainable development goals into all university activities [11]. After all, we consider it a meaningful and relevant research question to what extent sustainability-based research goals are reflected in the academic publications of the studied country group. Accordingly, our investigation focuses on the relevance of publications referring to a given SDG goal. In the following, we

analyse the emergence of the "Sustainable cities and communities" goal in academic publications from V4 countries.

2 OBJECTIVES AND METHODOLOGY

In the following, we will present our research objectives by their structure, the methodological construction of the databases used, the analytical procedures we applied for data processing, and the results revealed. According to the United Nations system, incorporated into the 17 Sustainable Development Goals, there are 169 sub-goals. To indicate how nations perform in achieving the mentioned goals, 231 indicators have been assigned. Utilizing scientific achievement-related indicators, we answer three main research questions in this study:

- I. How popular is the SDG-11 research topic in the European Union and the V4 countries?
- II. Which V4 universities are involved in SDG-11 research with what quantity and quality of output?
- III. What is the extent of overlaps between SDG-11 sub-topics, and what are the specific connections between individual universities?

Question I. was measured in three steps:

- (1) we examined the number of SDG-11 publications in the member countries between 2017 and 2021 (which also shows the respective country ranking);
- (2) we measured the position of SDG-11 topic within the SDG family of themes in each country;
- (3) we compared the V4 data to other European countries' achievements.

Answering question II., we identified the V4 Universities involved in SDG-11 topics according to the "THE impact ranking" criteria. The evaluation was based on publication numbers and quality (impact). Based on the number and performance of the scientific outcomes, typification group were formed to demonstrate our results.

For question III., the specific links between V4 universities were identified, and we were able to introduce a "connection map" that representatively shows all SDG-11 sub-group linkages between V4 universities (that fulfil the "THE impact ranking" criteria).

The proper classification based on the SciVal database was used to establish a scientific publication's appropriateness for the SDG-11 topic group for classification and analysis. Scopus represents a large portion of academic publications, containing 20.54 million open-access articles, it's share in some European countries exceeding 80% of total publications [12]. Also, the so-called Times Higher Education (THE) impact rankings, including metrics for research outputs, evaluate how well universities achieved the SDGs. While determining the institutions involved in SDG-11 themes, we prefiltered the universities with THE impact ranking methodology, if applicable, for further analysis.

The World Economic Forum's Times Higher Education (THE) university impact ranking is the first in the world to look beyond research and teaching at the impact of universities on society. Universities are scored and ranked for their activities concerning each SDG for which they provide data. The related data collection covers all registered universities in the world. Any university that conducts teaching activities at the undergraduate or postgraduate level can be included in the ranking. The ranking is designed to allow as

many universities as possible to make a list; there is no minimum research performance requirement for participation, although the research activity is part of the methodology. Universities must provide data for at least four SDGs to qualify for the overall ranking, one of which must be SDG 17, Partnership for Achieving the Goals (22% of the overall score). If data is provided for over three other SDGs, the approach of THE system will consider the three areas where the university has performed best (26-26-26% of the overall score). The scores for each SDG are based on a set of indicators [13].

The ranking for 2022 includes 1401 universities from 107 countries, with the highest number of universities from Russia (94), Japan (76) and Pakistan (63). There are 24 countries with one university on the list. The list includes 24 of the 27 countries of the European Union. The 24 countries are represented by 217 institutions. The effectiveness of the universities is assessed regarding each objective. However, not every university provides data for all the SDG goals since the types of SDGs for which universities submit data are defined by the possibilities of the Academies. The institution's success concerning each sustainable development goal is measured using a set of measures. Metrics for each SDG are divided into three groups: evidence-based metrics, continuing metrics, and research metrics. The rankings are based on the five years between 2016 and 2020, just like the World University Rankings.

In our study, Elsevier data are used to develop research metrics according to the scientific research directions of V4 universities. In the Elsevier database, each sustainable development goal has its unique query, which limits the metric's search results to pertinent publications. Gained data is also supplemented with publications proposed by artificial intelligence. Each of the sustainable development goals has a different set of bibliometric indices. At least two metrics are applied in every specific case [13]. In the case of SDG-11, the Impact Rankings database examines the institution's sustainability research, its role as a custodian of art and heritage, and its internal approach to sustainability.

The eligibility of a scientific publication to be classified as SDG-11 was assessed according to the relevant classification in the SciVal database. SciVal associates publications with specific SDG goals (if the criteria are met) based on the content analysis of the studies. As a result of our analysis, member countries can be ranked according to the number of scientific outputs they have classified under SDG-11.

Metrics applied for SDG-11 in the Impact Rankings database:

- Research on sustainable cities and communities
- Support of arts and heritage
- Expenditure on arts and heritage
- Sustainable practices
- SDG-11 is a priority sustainability element for 56 institutions in the EU-24 group.

3 RESEARCH RESULTS

3.1 Country-level Results for Visegrad Group and Other EU Countries

Our analysis is based on sustainability data for universities from the THE impact ranking system. First, we show the data assessed on country levels, later we analyze the particular universities in

V4 involved in SDG-11 research. The THE ranking methodology assigns each university's three most relevant sustainability goals. The list includes 217 institutions from 24 countries in the European Union. (Therefore, it is referred here as EU-24) Thirty-four institutions from the V4 countries are included in the database. The Impact's international ranking includes fifteen universities from Poland, eight from Hungary, six from the Czech Republic, and five from Slovakia.

Following our research question scheme, firstly, we will demonstrate how popular SDG-11 is as a research topic in the European Union, especially in the V4 countries. The ranking mechanism uses SciVal absolute figures basically (number of publications). Still, we have also constructed an indicator so that the ranking is not affected by differences in the size of the member countries. Accordingly, the number of scientific publications per 1 million inhabitants was considered (Figure 1, left axis). According to our findings, Luxembourg had the highest number of SDG-11 publications per capita among the 27 Member States (746 publications per million inhabitants), and Bulgaria had the lowest (126 publications per million inhabitants). Among the V4 countries, the Czech Republic had the highest SDG-11 articles per capita and Hungary the lowest. The latter ranks 24th – not very high – in the list of 27 EU Member States, ahead of France, Romania and Bulgaria.

For the next step, we also identified the relative popularity of the SDG-11 theme for each member country. Relative popularity was determined by ranking the SDG-based research topics (by the number of related publications). This also determined the position of SDG-11 in one country's sustainability-related research portfolio. Our results indicate that SDG-11 works are prominent among SDG-related publications in most EU countries. The topic of sustainable cities and communities is typically ranked in the top five of the seventeen SDG categories. However, it has been ranked at least eighth in any EU country. In the V4 countries, SDG-11 is ranked fourth to fifth among the SDG areas, which aligns with the EU "average".

The number of SDG-11 publications by one million inhabitants in the EU countries and the relative popularity of the SDG-11 topic are shown together in Figure 1 for comparability. The measure for the former is shown on the left axis of Figure 1 with the respective values depicted on bar charts, and the measure for the latter is shown on the right axis, where square dots show the corresponding values. Visegrad countries have been distinguished by blank coloring. The abbreviations in the figure are as follows: Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (EL), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE).

Looking at the numbers, the assumption that countries' SDG-11 publication position and the position of the research topic within the country are in close relationship is not fulfilled. However, countries with a high absolute number of SDG-11 publications (such as Luxembourg, Cyprus or Portugal) also have a solid SDG-11 relative position. The consistency of the two dimensions is also unclear for the V4 countries. Another important finding for the V4 is that, the universities operating in the region pay relatively less attention
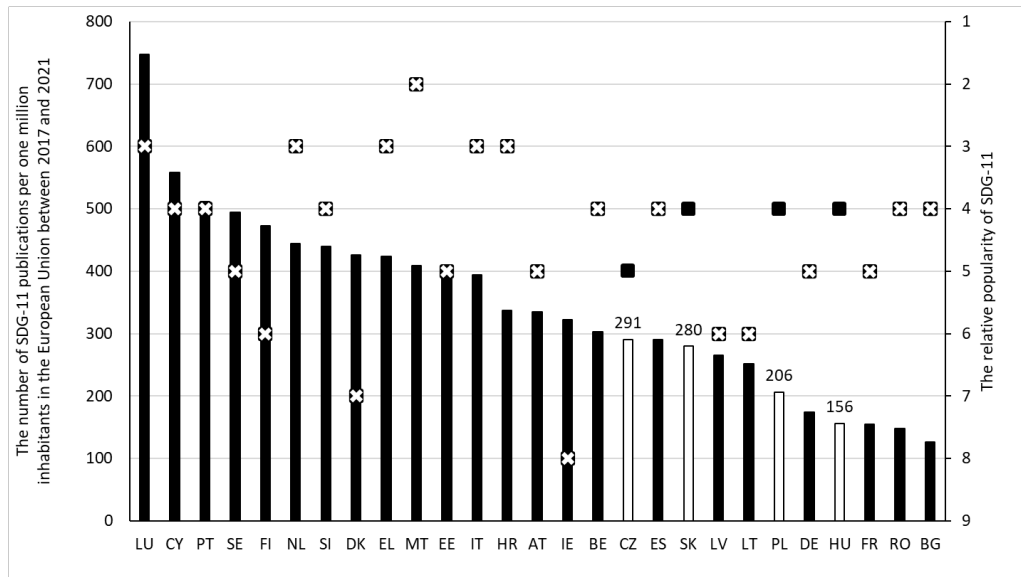
Figure 1: The number of SDG-11 publications per one million inhabitants in the European Union between 2017 and 2021 and the relative popularity of SDG-11 (edited by the authors based on SciVal databases)

to the problems of developing sustainable cities and communities than the EU average suggests.

3.2 Results for Visegrad Group on the University Level

In the rest of our study, we will focus on universities in the V4 countries active in SDG-11 research. A total of ten universities in the Visegrad Group countries have published papers on the topic of "Sustainable Cities and Communities" between 2017 and 2021.

These institutions are, by name:

- Gdańsk University of Technology (Poland)
- Wrocław University of Science and Technology (Poland)
- University of Gdańsk (Poland)
- Wrocław University of Environmental and Life Sciences (Poland)
- Széchenyi István University (Hungary)
- University of Debrecen (Hungary)
- University of Szeged (Hungary)
- VSB – Technical University of Ostrava (Czech Republic)
- Palacký University Olomouc (Czech Republic)
- Slovak University of Technology in Bratislava (Slovakia)

We examined the number and relevance of publications related to the SDG-11 goals for the listed higher education institutions. One widely accepted measure of the importance of scientific publications is the impact of publications on the scientific community. The number of subsequent citations usually measures this impact on a given publication, which indicates the use of the publication's results by others. (It should be noted that the number of citations may also be influenced by other factors, such as the number of new publications in the field, the number of years since the publication was published, the prominence of the authors, etc.) The number of citations (such as the number of publications) was obtained from

the SciVal database (which method also functions as a quality filter). Our analysis, therefore, looked at studies published in journals of internationally recognised quality (and their impacts on academic works of similar quality). We measured the number of citations using the so-called FWCI indicator.

Based on the results of the dichotomous analysis (pertaining to the number and quality of publications), we identified three typification group from the data of the ten studied universities:

- Low/medium number of publications – High impact
- Low number of publications – Medium impact
- High number of publications – Low/medium impact

The typification groups were formulated by the own perceptions of the authors based on outlying numeric distances between numerical values (no statistical cluster formation methods were used for this simple problem with a low number of elements sample). The results are shown in Figure 2. Universities from the same countries are shown in similar shades of colour. A significant finding concerning the characteristics of the groups obtained is that the number of publications and the scientific importance of the publications are basically inversely related. Excluding the Hungarian universities in group II, which have deficient publications, the inverse pattern is clearly visible in Figure 2.

- Groups I and III have four institutions involved, and Group II has two. About the national composition within the groups, we can say that both members of groups II are Hungarian universities, while the other two groups are explicitly international (Slovakia is represented by one university "only"). We can say that, institutions' nationality is not a precise predictor of the scientific interest of higher educations in SDG-11 goal amongst V4 countries (based on the data of Elsevier publication database). Furthermore, only Hungary has institutions with few publications and medium impact
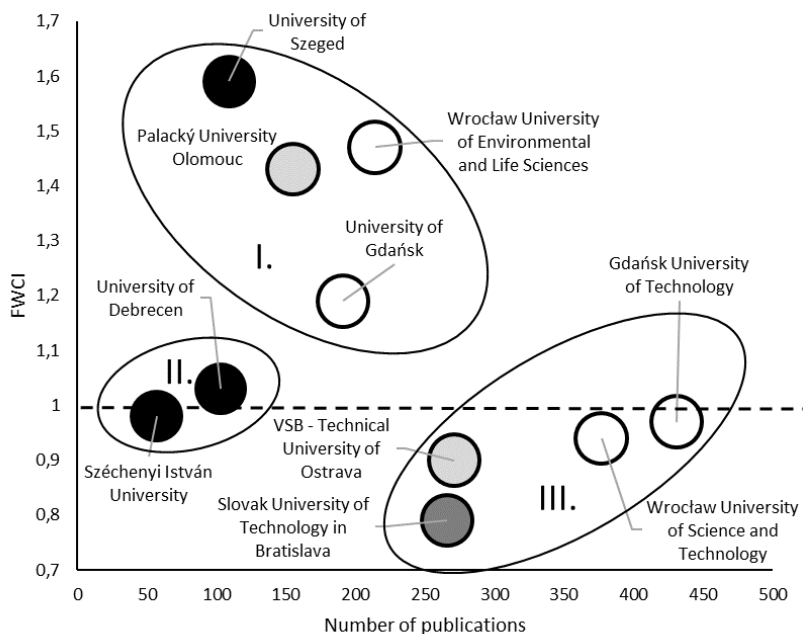
Figure 2: SDG-11 related publications in V4 universities (edited by the authors based on SciVal databases)

(which is not a qualitative differentiator on its own). At the same time, Hungary has the highest impact university on SDG-11 theme, the University of Szeged, a science university in a countryside city. However, it is also true that regarding the number of publications, the combined output of Hungarian universities is the lowest between V4 countries (as shown in Figure 1). The Czech universities characterized by a medium number of publications with varying scientific impact. Polish universities have high and medium number of publications, with a high and medium impact. One university from Slovakia (the Slovak University of Technology in Bratislava) was included on the utilized impact ranking list with a medium publication number (and the lowest impact).

- Next, the sub-topics within the SDG-11 themes of the publications were examined to determine the relationship between the occurrences of more specific themes across the V4 universities. The 2,175 SDG-11 publications published by the ten universities studied between 2017 and 2021 are classified into 898 subtopics by SciVal. As shown in Figure 3, 71% of the subtopics (639 subtopics) are cultivated at only one university, 18% (162 subtopics) at two universities and 6% (56 subtopics) at three universities. There are only around 20 sub-topics that are simultaneously researched by a significant number of universities (5-9). Most of the topics are studied solely by specific research groups.

These results also suggest that there is weak cooperation even between regional universities researching the topic of "sustainable cities and communities". The strengthening of cooperations would presumably require greater research flexibility, conscious coordination, and active mediation. However, the results show that within

the SDG-11 theme, the sub-themes are quite diversified and cover many segments of the SDG-11 topic. In some respect, this can be regarded a positive sign about the scientific coverage pattern of the field.

- To facilitate the aggregation of related scientific outputs and future collaborations, we examined how sub-topics of SDG-11-based publications link regional universities. The relevant results are presented in Figure 4. The number of links cannot be considered high given the large number of sub-topics. We could identify some university relations where several links are present, however, those relations exist typically between institutions located in the same city (such as Gdansk and Wroclaw in Poland) or the same region (such as Szeged and Debrecen in Eastern Hungary). The impact of geographical distance on the overlap between themes is evident at the national level. On a country level, national policies and domestic academic networks may also play a role in the formation of thematic linkages). Even so, it is striking that intra-country overlaps are remarkably higher than international overlaps: about one-sixth (twelve) of the total sixty-nine overlaps are between universities in different countries (this can be added to the fact that Slovakia is represented by one university so that no intra-country overlap could be identified in that relation). Also, universities are typically linked to only one or two universities in a foreign country (except for the Czech Republic). The Czech Republic has the highest number of international links (connections with all three foreign countries) and the highest number of international links (in ten subcategories). There are seven cases where Polish universities' scientific outputs on sustainable

Figure 3: Similarities in SDG-11 research sub-topics in V4 countries (edited by the authors based on SciVal databases)

Figure 4: Linkages of SDG-11 research sub-topics between V4 universities (edited by the authors based on SciVal databases)

cities coincide with relevant themes in other V4 countries. In Slovakia, the corresponding number is four universities, and in Hungary, three. Hungary's only SDG-11 publication sub-topic match exists with the Palacký University Olomouc operating in the Czech Republic.

4 CONCLUSIONS

Our study analyzed the prevalence of the Sustainable Cities and Communities sustainability goal (SDG-11) in European academic publications focusing on V4 countries. The studied period was the 2017-2021 years. By doing so, we also measured the contribution of researchers (and their institutions) to the field of the mentioned sustainability goal. We studied the topic's prevalence by analyzing the number of research papers and their impact (which signals the quality and proliferation of the related academic publications). We

analyzed the data also by countries and by institutions. The prevalence of the SDG-11 theme in academic research portfolios was interpreted as a measure of popularity amongst academic researchers. Based on this, we compared SDG-11 data with the relevant measures of other SDG goals in our focus group (V4 countries) using the relative position of SDG-11 to describe its popularity. Given that different research topics can contribute to a specific SDG goal, we extended our investigation into the analysis of sub-groups of publication topics in the field of Sustainable cities and communities. With this, we could identify the extent of similarities in SDG-11 research topics at V4 universities. Visegrad Group members Hungary, Poland, the Czech Republic, and Slovakia are four nations that are geographically close to one another and have similar higher education systems. The so-called Times Higher Education (THE) impact rankings assess how well universities reached different sustainable development goals, containing indicators regarding research outputs. We used the THE impact ranking system's results as a

pre-filtering function when identifying the institutions involved in SDG-11 topics. The international rating system of the THE impact contains a total of 34 institutions from the V4 nations that participated in SDG-11 research during the examined period. This includes 15 universities from Poland, eight from Hungary, six from the Czech Republic, and five from Slovakia. For the methods of classification and analysis, a scientific publication's suitability for the SDG-11 field category and its sub-groups was determined according to the appropriate classification supported by the SciVal database. Run by the well-known Elsevier b.v. company, SciVal and Scopus contain a significant portion of academic publications worldwide and also represent a quality filter. With all of this, we acknowledge that our analysis was based on one segment of published journals, and our conclusions are limited and should be interpreted accordingly. According to our results about the European countries, Luxembourg (the richest of the 27 Member States) has the most significant number of SDG-11 articles per capita (746 publications per one million inhabitants), and Bulgaria has the lowest (126 publications per one million inhabitants) during the investigation period. On the institutional level, around ten per cent of European universities prioritize SDG-11 as a focus theme. In the consideration period, 56 universities in EU-27 countries published articles on the topic. SDG-11 category works are prominent among SDG-related publications in most EU countries compared to other SDG topics. The issue of SDG-11 is typically ranked in the top five of the seventeen SDG categories but has not been ranked lower than eighth in any EU country The Visegrad nations have fewer publications on sustainable cities and community topics than the EU average. The Czech Republic and Hungary had the most prominent and lowest percentages of SDG-11 papers, respectively. In the V4 countries, SDG-11 is ranked fourth to fifth among the SDG areas, which aligns with the EU. In the Visegrad Group countries, ten universities published papers on "Sustainable Cities and Communities" between 2017 and 2021 that also fit the criteria of the THE impact criteria system (and its unique SDG topic-selection mechanism described above). Regarding quality and reach, Hungary has the highest impact university, even though Hungarian universities publish less than the V4 average.

The 2,175 SDG-11-related papers produced by the ten universities can be classified into 898 sub-topics according to the official SciVal scientific data system. We concluded that from the 898 sub-topics, there are only 20 or so sub-topics that numerous universities are researching concurrently in the V4 countries. Furthermore, most subjects are only studied by one research institution. To facilitate the aggregation of related scientific outputs and hopeful collaborations, we examined how universities in the region are linked by sub-topics of SDG-11-based publications. The number of links cannot be considered high considering the large number of sub-topics. There are some university relations where overlaps can be found, but these are typically between institutions located in the same region. The impact of geographical distance on the overlap between themes is also evident at the national level. In addition to distance, country characteristics and standard academic networks may also play a role in the emergence of theme-based links. Intra-country overlaps are remarkably higher than international overlaps: about one-sixth (twelve) of the total sixty-nine overlaps are between universities in different countries. These findings also

imply that regional universities researching cities and communities do not coordinate their efforts satisfactorily (or at all). In order to step forward, research groups across V4 countries would presumably require greater research flexibility and conscious coordination (with active mediation) to find common ground, add up resources, develop new synergies and produce more excellent scientific added value for the region. On the other hand, the fact that the research results cover a wide variety of themes in the SDG-11 topic may be viewed as a positive sign, given this can facilitate the field's scientific coverage and enhance the sustainability goal in various ways. A further research task could be to identify the country/group of countries to which the results of the publications under discussion apply. A significant number of studies on countries in the region would strengthen the complementarity of the results and justify region-specific synthesis work. Given the common academic history and similar economic development of the group of countries as detailed above, there may also be a valuable contribution to be made by aggregating results by region for publications that focus solely on the country concerned. We have yet to have the opportunity to do so within the scope of this paper (but we are open to collaborating with colleagues from universities in the region on this topic).

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