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The Involvement of Public Higher Education Institutions (HEIs) in Poland in the Promotion of the Sustainable Development Goals (SDGs) in the Age of Social Media

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Abstract: The aim of this paper is to present the involvement of public Higher Education Institutions (HEIs) in Poland in promoting the Sustainable Development Goals (SDGs) in 2021. The reason for undertaking the research was a noticeable lack of studies in the literature on the engagement of universities in the concept of sustainability. The research conducted was mainly qualitative in nature. The aim was realized using three groups of research methods: collection of empirical data, data processing, and the presentation of study outcomes. The study used 16 indicators, constructed from data taken from *SciVal* and *RAD-on* reports. These indicators presented the number of publications promoting each of the SDGs in 2021 per academic staff and other persons carrying out and participating in teaching or research activities. The research was conducted on 57 universities from Poland. Four clusters were distinguished as a result of the cluster analysis that was performed. The first cluster comprised only universities of life sciences. This group had the highest publication productivity for the following goals: SDG2, SDG3, SDG6, SDG11, SDG12, SDG13, SDG14, SDG15, and SDG16. The universities that made up cluster 2 (predominantly universities of technology) specialized in publications related to goals such as SDG7 and SDG9. The highest publication productivity for SDG1, SDG4, SDG5, SDG8, SDG10, and SDG16 belonged to cluster 3 (consisting mainly of universities of economics). The HEIs (mainly universities of physical education) that made up cluster 4 did not have the highest publication productivity in any of the SDGs. Therefore, it can be concluded that, in 2021, there was a correlation between the profile of a public HEI in Poland and the SDGs it was involved in promoting.

Keywords: higher education institution; sustainable development goal; article; productivity

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1. Introduction

There is currently a transformation of the 2nd generation university into a 3rd generation (entrepreneurial) university [1]. Its most important feature is the introduction of the commercialization of research and technology as the third aim of the university, alongside research and teaching. An entrepreneurial university is also one that takes responsibility for its socio-economic environment and adheres to Sustainable Development (SD) guidelines. The role of universities in this process was written down in the document *Copernicus Charta*, which was signed by 326 universities between 1993 and 2005 as a commitment to implementing the principles of SD and providing education that serves this challenge [2]. In 2011, a new version of the document was produced—*Copernicus Charta 2* [2].

A sustainable university, according to Clugston and Calder (2003) [3], is one that empowers students to understand environmental degradation, inspires them to adopt sustainable behaviors, and increases awareness of societal inequalities. They contend that a sustainable higher education institution (HEI): (1) incorporates this commitment into their mission and academic goals; (2) integrates the concept of sustainability into teaching and research; (3) promotes support services for students; (4) encourages students to think critically about environmental issues; (5) promotes sustainable methods that

minimize ecological impact; and (6) creates local and international partnerships to enhance sustainability. In particular, it seems important to promote the Sustainable Development Goals (SDGs) in publications prepared by academic staff and other persons carrying out and participating in teaching or research activities.

It is worth highlighting that sustainable universities should also use modern communication channels (such as social media) to promote their commitment to SD. This allows them to get their information out to a wider range of stakeholders. This includes not only students but also staff, faculty members, outside local community residents, campus administration leaders, and alumni. This makes it possible to raise their awareness of the issue. However, as Carpenter et al. (2016) emphasize, sustainable universities primarily perceive social media platforms as useful for encouraging action and disseminating information but rarely use them to build community around causes and groups.

The author's research showed that the articles published so far have focused on the theoretical aspects of SD in HEIs' activities and on the presentation of solutions applied at the level of individual HEIs (see: Balciunaitiene (2017) [4]; Agbedahin (2019) [5], Amaral et al. (2015) [6]). However, two main research gaps emerge from the author's literature review:

- **Research gap 1 (RG1).** There is a lack of research on the involvement of higher education institutions in Poland in the implementation of SDGs.
- **Research gap 2 (RG2).** There is a lack of quantitative research on the involvement of HEIs in the SDGs.

The indicated research gaps may be due to several reasons. Firstly, there are no legal regulations in Poland that impose an obligation on HEIs to implement the concept of SD, excluding, of course, international obligations such as the "Global Action Programme (GAP) on Education for Sustainable Development". It was launched at the World Conference on Education for Sustainable Development (ESD) in November 2014 in Aichi, Nagoya. It focuses on generating and scaling up ESD action at all levels and in all areas of education, as well as in all SD sectors. Secondly, there was a lack of databases that provided information on, for example, the number of publications correlating with the SDGs. Nevertheless, since 2018, Elsevier, Times Higher Education (THE), and Vertigo Ventures have generated SDG search queries to help researchers and institutions track and demonstrate progress towards the targets of the SDGs. In 2020, Elsevier, through its Science-Metrix group, used a new approach to mapping publications to the SDGs. Taking customer feedback into account, they significantly increased the number of search terms used to define each SDG.

Thus, the author hopes that the considerations undertaken in this article will fill the research gaps identified (RG1, RG2) and inspire further research in this area.

The article consists of five parts. After the Introduction, a review of sustainable development concepts within the literature is made. In the next chapter, the material and research methods are presented. In the next part, the results of the study are presented and interpreted. The last chapter is a summary and presents the conclusions, limitations, and proposals for further research on the subject matter. Thus, the author of this article hopes that the research results presented here will fill the knowledge gap regarding the involvement of HEIs in promoting the SDGs.

2. Literature Review

The idea of SD was created in response to grave worries about how long the Earth's global environment could sustain the impact of anthropo-pressure. The imbalance between economic growth and social development, as well as between socio-economic development and the natural environment, has been targeted for prevention [7]. The concept of SD was introduced to the global lexicon by United Nations (UN) agencies [8]. This term was first widely used in 1972 [9]. It was described as a strategy aiming at development based on the rational utilization of local resources and knowledge gained by farmers in order to satisfy the needs of remote rural areas in less developed countries [10].

The assumptions underlying the idea of SD were reflected in the Millennium Development Goals (MDGs) adopted by the UN. The following goals were included [11]: (1) "Eradicate extreme poverty and hunger"; (2) "Achieve universal primary education"; (3) "Promote gender equality and empower women"; (4) "Reduce child mortality"; (5) "Improve maternal health"; (6) "Combat HIV/AIDS, malaria and other diseases"; (7) "Ensure environmental sustainability"; and (8) "Develop a global partnership for development". The MDGs have become a key point of reference in UN and other international discourse about the progress of development and have been visible to different degrees at a national level in both donor and developing countries.

Based on the success of the MDGs, SDGs have been defined. The SDGs expanded the scope to 17 goals from the initial 8 goals in the MDGs. The following goals were included [12]: (1) "No poverty"; (2) "Zero hunger"; (3) "Good health and well-being"; (4) "Quality education"; (5) "Gender equality"; (6) "Clean water and sanitation"; (7) "Affordable and clean energy"; (8) "Decent work and economic growth"; (9) "Industry, innovation and infrastructure"; (10) "Reduced inequalities"; (11) "Sustainable cities and communities"; (12) "Responsible consumption and production"; (13) "Climate action"; (14) "Life below water"; (15) "Life on land"; (16) "Peace, justice and strong institutions"; and (17) "Partnerships for the goals". Importantly, the SDGs apply to all countries (rich, middle-class, or poor), unlike the MDGs which solely focus on developing countries. The key differences between MDGs and SDGs are presented in Table 1.

Table 1. The key differences between MDGs and SDGs.

Criterion for Comparison	MDGs	SDGS
Number of goals	8	17
Number of targets	18	169
Number of indicators	48	231
Geographic coverage	Developing countries	Entire world (rich and poor countries)
Delivery focus	Narrow: poverty reduction	Broad: global development with and for sustainability
Goal creators	Produced by a group of experts	Result of a consultation process among 193 UN member states, civil society, andother stakeholders
Implementation timeframe	2000–2015	2016–2030

Source: own elaboration based on [13].

Of course, the question arises as to which organizations/institutions should be involved in promoting the concept of SD and achieving the SDGs. In this respect, HEIs have a key role. They are the primary agents of transformation towards SD and increasing people's abilities to turn their visions for society into reality. The role of HEIs can range from primary aims, such as employability, increasing earning capacity, research and experimentation, and seeking and advancing knowledge and wisdom, to more serious secondary aims, such as achieving mental and spiritual development, promoting healthier lifestyles, and expanding scientific outlook [14]. It should be highlighted that this role will increase with further evolutions in technology and globalization. The literature provides examples of HEIs and their practices in relation to SD (Gomes et al. (2021) [15]; Finnveden et al. (2020) [16]; Albert and Uhlig (2022) [17]; Moganadas et al. (2022) [18]).

It is worth noting that most of the initiatives undertaken by HEIs to implement the concept of SD are bottom-up in nature. For example, in Poland, 58 HEIs have signed the "Declaration of University Social Responsibility". The document is a voluntary commitment from universities to promote the idea of SD in research and educational activities, as well as in university management. This regulation obliges HEIs in Poland to commit to actions that involve [19]:

"(1) fostering the ethical values listed, among others, in the *Code of Ethics for Research Staff*; (2) shaping social and civil attitudes of future elites conducive to building community, creativity, openness, along with social sensitivity and work culture; (3) promoting the idea of equality, diversity, tolerance, as well as respecting and protecting human rights in reference to the entire academic community and its environment; (4) expanding curricula to include such issues as ethics and corporate social responsibility, sustainability, and social innovation; (5) realizing projects that implement principles of social responsibility, in particular those concerning diversity management in the workplace, corporate volunteering, promotion of ethics principles, intersectoral cooperation, and cause-related marketing; (6) undertaking scientific research and implementation work that, in the framework of partnership with other academic centers from around the world, enterprises, public administration, and non-governmental organizations, will be able to contribute towards resolving fundamental social problems; (7) developing interinstitutional, national, and international cooperation, enabling the adaptation and strengthening of best practices in the range of university social responsibility; (8) taking care of universities' governance, basing their management on the foundations of social responsibility, both in strategic documents as well as in resulting activities that serve the comprehensive development of the academic community and effective realization of universities' mission; (9) ensuring transparency in the activities conducted by universities through, among others, measuring results, promoting and popularizing achievements, as well as designating a person or team for coordinating these activities; (10) conducting actions/operating in such a manner as to minimalize the negative impact of activities realized by the academic community and its stakeholders on the natural environment, in all its dimensions; (11) conducting dialogue with stakeholders on the priorities of university social responsibility policy and reporting its results; and (12) following the principles of ethics and responsibility in the process of teaching and conducting scientific research, in order to provide stakeholders with optimal conditions for making use of knowledge, intellectual capital, and universities' achievements".

It is worth noting that it is extremely important for HEIs to not only express their willingness to engage in promoting the idea of SD, but also to take real action in this regard. However, this is not an easy task. As many authors point out [20–24], there are numerous barriers that prevent or hinder universities from implementing the indicated activities. The main barriers to the development of SD that influence innovation strategies in HEIs are: (1) the lack of management engagement, human resources, and infrastructure to ensure their development; (2) misunderstandings and ignorance of the concept; (3) the lack of funding; and (4) resistance to change.

Despite the existence of the listed barriers, examples of good practice can be identified among Polish HEIs in the indicated area. Numerous activities for SD have been undertaken by the Centre for Sustainable Development of the University of Gdansk (CZRUG). The center implements eight programs: (1) Research and Projects; (2) International Cooperation; (3) Education for SD; (4) Green University; (5) Internship Program; (6) Culture and SD; (7) Program of Cooperation with Social Environments; and (8) University Conversations on SD [25]. The University of Warsaw, in turn, has launched a master's course on SD. The following faculties of the University of Warsaw took part in the preparation of the new faculty of study: Biology, Chemistry, Physics, Geography and Regional Studies, Geology, Economic Sciences, Law and Administration, and, finally, the Faculty of Management. Subjects in the field of SD were collected in modules and assigned to individual semesters during two-year studies (four semesters). Subjects introduced in the first semester include topics related to SD from the environmental, economic, and socio-legal perspective. In the second semester, students learn about planning and management processes, as well as the use of raw materials and economic analysis, which are used in the implementation of SD goals, both in urban and in rural areas [26]. Another HEI taking an active role in sustainable development is the Gdansk University of Technology. Researchers from the Faculty of Management and Economics are currently working on a project regarding sustainable smart cities (Strengthening Governance Capacity for Smart Sustainable Cities (SSCs)). The aim of the project is to develop and implement new SSC training programs. Furthermore,

Gdansk University of Technology organized a free cycle of courses titled "Open and Smart Government". The courses were intended to shape competences related to SSCs [27].

The success of HEIs' involvement in the concept of SD can be measured by their position in academic rankings in correlation with this topic. The Times Higher Education University Impact Rankings (UIR) are an example. This is the only global performance table that assesses universities against the United Nations' SDGs [28]. Participation in the overall ranking requires HEIs to submit data to at least four SDGs, one of which must be SDG 17—"Partnerships for the goals". The overall score is generated from the score for SDG 17 (worth up to 22% of the overall score) plus the three strongest of the other SDGs for which HEIs provided data (each worth up to 26% of the overall score) [29]. Of course, universities are obliged to provide evidence of engagement with the SDGs. Evidence is evaluated against a set of criteria and decisions are cross-validated where there is uncertainty. Evidence is not required to be exhaustive. UIR are looking for examples that demonstrate best practice at the institutions concerned [29]. Such evidence could be, for example, a post on social media about a conference corresponding to the chosen SDG. HEIs should increase their visibility in relation to sustainability efforts by using available communicators such as Facebook, Instagram, or Twitter. This will make it easier to assess their contribution to the SDGs.

Polish HEIs are also included in the UIR. For example, in 2021, Gdansk University of Technology, Warsaw University, and the Medical University of Warsaw were ranked between 601 and 800; the AGH University of Science and Technology, Lodz University of Technology, Wroclaw University of Technology, Warsaw University of Life Sciences, Adam Mickiewicz University in Poznan, the University of Gdansk, the University of Warmia and Mazury in Olsztyn, and Wroclaw University were ranked between 801 and 1000; and Warsaw University of Technology was ranked 1000+ [30].

3. Aims, Hypotheses, and Research Methods

The main goal of this study is to present the involvement of public HEIs in Poland in promoting the SDGs in 2021. Three research tasks were stated to accomplish this aim: (1) a critical review of the literature on the concept of SD, (2) a presentation of the number of articles published in 2021 by academic staff of public HEIs in Poland and other persons carrying out and participating in teaching or research activities that correlated with the SDGs, and (3) a distribution of public HEIs in Poland in terms of their academic productivity in promoting the SDGs in 2021 (measured by the number of publications per academic staff and other persons carrying out and participating in teaching or research activities).

The study sought answers to the following research questions:

- **Research question 1 (RQ1)**. Is publication productivity, in terms of the SDGs, related to the reputation of Polish HEIs?
- **Research question 2 (RQ2)**. Is the publication intensity of Polish HEIs, in terms of the individual SDGs, related to their profile?

Therefore, two research hypotheses were stated:

- **Hypothesis 1 (H1)**. In 2021, there was a correlation between the publication intensity of universities and their position in the "Perspektywy University Ranking (Poland)".
- **Hypothesis 2 (H2)**. In 2021, there was a correlation between the profile of a public HEI in Poland and the SDGs it was involved in promoting.

Objects for this study were selected based on purposive sampling. They are public HEIs in Poland, for which necessary data were available. Among them, one can distinguish 18 universities, 18 universities of technology, 5 universities of economics, 5 universities of pedagogy, 5 universities of agricultural/life sciences, and 6 universities of physical education. Thus, the population sample consisted of 57 out of the 59 Polish public HEIs. The following HEIs were excluded from the research sample: the Jan and Jedrzej Sniadecki University of Technology in Bydgoszcz and the Christian Theological Academy in Warsaw. The composition of the research sample is shown in Table 2. To simplify the interpretation of the results, HEIs were given codes.

Table 2. HEIs included in the research sample with their codes.

Profile of HEI	Name of HEI	HEI Code
University	University of Warsaw	UW1
University	University of Bialystok	UoB
University	University of Gdansk	UG
University	Adam Mickiewicz University in Poznan	AMU
University	Jagiellonian University in Krakow	JU
University	University of Lodz	UL
University	Maria Curie-Sklodowska University	MCSU
University	Nicolaus Copernicus University in Torun	NCU
University	University of Opole	UO
University	University of Szczecin	USz
University	University of Silesia in Katowice	USK
University	University of Rzeszow	URz
University	University of Warmia and Mazury in Olsztyn	UWM
University	University of Wroclaw	UW2
University	Cardinal Stefan Wyszynski University	CSWU
University	University of Zielona Gora	UZG
University	Kazimierz Wielki University	KWU
University	Jan Kochanowski University in Kielce	JKU
University of technology	West Pomeranian University of Technology	WPUT
University of technology	Warsaw University of Technology	WUT
University of technology	Bialystok University of Technology	BUT
University of technology	University of Bielsko-Biala	UBB
University of technology	Czestochowa University of Technology	CzUT
University of technology	Gdansk University of Technology	GUT
University of technology	Silesian University of Technology	SUT
University of technology	Kielce University of Technology	KUT1
University of technology	Koszalin University of Technology	KUT2
University of technology	Krakow University of Technology	KUT3
University of technology	AGH University of Science and Technology	AGH
University of technology	Lublin University of Technology	LUT1
University of technology	Lodz University of Technology	LUT2
University of technology	Opole University of Technology	OUT
University of technology	Poznan University of Technology	PUT
University of technology	Radom University of Technology	RUT
University of technology	Rzeszow University of Technology	RzUT
University of technology	Wroclaw University of Science and Technology	WUST
University of economics	University of Economics in Katowice	UEK
University of economics	Krakow University of Economics	KUE
University of economics	Poznan University of Economics and Business	PUEB
University of economics	SGH Warsaw School of Economics	SGH
University of economics	Wroclaw University of Economics and Business	WUEB
University of pedagogy	Maria Grzegorzewska University	MGU
University of pedagogy	Jan Dlugosz University in Czestochowa	JDU
University of pedagogy	Pedagogical University of Krakow	PUK
University of pedagogy	Pomeranian University in Slupsk	PUS
University of pedagogy	Siedlce University of Natural Sciences and Humanities	SUNSH
University of life sciences	Warsaw University of Life Sciences	WULS
University of life sciences	University of Agriculture in Krakow	UAK
University of life sciences	University of Life Sciences in Lublin	ULSL
University of life sciences	Poznan University of Life Sciences	PULS
University of life sciences	Wroclaw University of Environmental and Life Sciences	WUELS
University of physical education	Gdansk University of Physical Education and Sport	GUPES
University of physical education	The Jerzy Kukuczka Academy of Physical Education in Katowice	JKAPEK
University of physical education	University of Physical Education in Krakow	UPEK
University of physical education	University School of Physical Education in Poznan	USPEP
University of physical education	Jozef Pilsudski University of Physical Education in Warsaw	JPUPEW
University of physical education	University School of Physical Education in Wroclaw	USPEW

Source: own study, based on [31].

When selecting diagnostic variables, the author used the availability of current data (2021 was the last year for which a complete set of data was available). This study included 16 variables:

- x1—the number of publications promoting the 1st SDG ("No Poverty") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x2—the number of publications promoting the 2nd SDG ("Zero Hunger") per number of academic staff and other persons carrying out and participating in teaching or research activities
- x3—the number of publications promoting the 3rd SDG ("Good Health and Well-being") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x4—the number of publications promoting the 4th SDG ("Quality Education") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x5—the number of publications promoting the 5th SDG ("Gender Equality") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x6—the number of publications promoting the 6th SDG ("Clean Water and Sanitation") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x7—the number of publications promoting the 7th SDG ("Affordable and Clean Energy") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x8—the number of publications promoting the 8th SDG ("Decent Work and Economic Growth") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x9—the number of publications promoting the 9th SDG ("Industry, Innovation and Infrastructure") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x10—the number of publications promoting the 10th SDG ("Reduced Inequalities") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x11—the number of publications promoting the 11th SDG ("Sustainable Cities and Communities") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x12—the number of publications promoting the 12th SDG ("Responsible Consumption and Production") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x13—the number of publications promoting the 13th SDG ("Climate Action") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x14—the number of publications promoting the 14th SDG ("Life Below Water") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x15—the number of publications promoting the 15th SDG ("Life on Land") per number of academic staff and other persons carrying out and participating in teaching or research activities;
- x16—the number of publications promoting the 16th SDG ("Peace, Justice and Strong Institutions") per number of academic staff and other persons carrying out and participating in teaching or research activities.

It is worth bearing in mind that there are no data available in the *SciVal* system regarding the number of publications that correspond to the 17th SDG. Therefore, 16 indicators were used in the survey.

Within this study, three groups of research methods were applied: (1) collection of empirical material, (2) data processing, and (3) presentation of research results.

When collecting research material, the author used the critical literature review method (based on books, journals, and Internet sources) and the documentation method. This manuscript presents results of both domestic and foreign studies focusing on the concept of SD. In addition, a presentation was made on how HEIs are trying to implement the concept in their functioning. In turn, the documentation method consisted of the use of reports produced by *SciVal* (a web-based analytics solution with unparalleled power and flexibility that provides comprehensive access to the research performance of over 20,000 research institutions and their associated researchers from 230 nations worldwide) or *RAD-on* (the system of Information on Science and Higher Education) in order to collect required data.

When processing the research material, the author applied cluster analysis. This is a data mining technique [32]. Generally, the aim of the cluster analysis is to divide data into points based on their features [33]. Clustering may be realized with hierarchical or nonhierarchical methods. The hierarchical methods constitute x classes of y observations. The nonhierarchical methods are based on assigning all observations to the earlier known number of clusters [34]. In this study, the author used the hierarchical method and an agglomerative approach. This approach is known as the bottom to top approach. In this approach, data points set clusters in combination with each other [35].

The distance between the objects (here, selected public HEIs in Poland) was determined based on the Euclidean distance. This distance method uses the Pythagorean theorem and is the distance calculation that is most often used in the process of machine learning [36]. Euclidean distance is used by most clustering algorithms because of its simple and small amount of calculation. Euclidean distance is the result of the square root of the sums of the squares of the differences between the coordinates of the points in each dimension:

$$d_{ij} = \sqrt{\sum_{k=1}^{n} \left(x_{ik} - x_{jk} \right)^2} \quad (1)$$

where:

d_{ij}—similarity calculation distance
n—number of vectors
x_{ik}—input image vector
x_{jk}—comparison image vector.

In turn, to estimate the distance between clusters, the Ward method was used. This method differs from others (such as the single linkage method or complete linkage method) as it uses the analysis of variance approach, i.e., it attempts minimization of the sum of squares of deviations within the clusters. The Ward method is considered to be efficient, although its application leads to the formation of small-sized clusters [37]. This method is said to be the most suitable method for quantitative variables. The analysis provided a dendrogram, constituting a graphical interpretation of obtained results. The results suggest that these methods are useful in typical examples and real data sets. More information on hierarchical agglomeration methods can be found in studies such as Miyamoto (2012) [38], Gülağız and Şahin (2017) [39], and Kacperska et al. (2021) [9].

The following methods were used to present the research results: descriptive, graphical, and tabular. All calculations were made with the use of the *MS Office 365* package and *STATISTICA* software.

4. Research Findings and Discussion

The most obvious and traditional way that HEIs might help to deliver the SDGs is by creating research in relevant topics and preparing articles based on them. It is worth noting at this point that, in 2020, Elsevier, through Science-Metrix, developed a new approach to mapping publications to the SDGs. Taking customer feedback into account, they greatly enhanced the number of search terms used to define each SDG. Those queries were then

complemented by a machine learning model. Here, it is crucial to introduce the ideas of recall and precision. "Recall is the percentage of publications from the specialist journals that are captured by the selected search terms. Precision is the percentage of relevant papers in a random sample of publications in the seed data set. The machine learning model helped increase the recall of publications by approximately 10%" [40].

In 2021, a total of 66,036 articles on the SDGs were published by selected public universities in Poland—Table 3. The largest number of publications, over 15,000, corresponded to the 3rd SDG. In contrast, the fewest correlated with the 1st SDG (less than 530 publications). The leader in terms of publication activity was the JU. In 2021, this university had a 7% share of all publications.

Table 3. Number of publications on the SDGs and the publication leaders in 2021 in Poland.

SDGs	Total Number of Publications in 2021	The HEI with the Highest Number of Publications in 2021 (% Share of Total)
SDG 1: "No poverty"	524	UW1 (18%)
SDG 2: "Zero Hunger"	2099	WULS (12%)
SDG 3: "Good Health and Well-being"	15,569	JU (20%)
SDG 4: "Quality Education"	1434	JU (8%)
SDG 5: "Gender Equality"	761	UW1 (17%)
SDG 6: "Clean Water and Sanitation"	4397	SUT (9%)
SDG 7: "Affordable and Clean Energy"	8029	AGH (10%)
SDG 8: "Decent Work and Economic Growth"	3874	UW1 (6%)
SDG 9: "Industry, Innovation and Infrastructure"	6542	SUT (9%)
SDG 10: "Reduced Inequalities"	1652	UW1 (15%)
SDG 11: "Sustainable Cities and Communities"	6435	KUT3 (6%)
SDG 12: "Responsible Consumption and Production"	4537	WULS (6%)
SDG 13: "Climate Action"	3435	AGH (9%)
SDG 14: "Life Below Water"	1533	UG (15%)
SDG 15: "Life on Land"	3660	WULS (9%)
SDG 16: "Peace, Justice and Strong Institutions"	1555	UW1 (14%)
Total	**66,036**	**JU (7%)**

Source: own elaboration, based on [41].

The publication leaders within each of the SDGs were repeated. There were a total of seven universities: UW1, WULS, JU, SUT, AGH, KUT3, and UG. Therefore, the next step of the study examined whether publication productivity was related to the reputation of the university as measured by its position in the "Perspektywy University Ranking (Poland)" in 2021. This ranking is based on the following criteria: (1) "prestige" (measured by, for example, an institution's position in international rankings in 2021); (2) "graduates on the labor market" (the position of graduates of a given university on the labor market according to a nationwide study of the "Alumni's Economic Situation" carried out by the Ministry of Science and Higher Education); (3) "academic potential" (measured by, for example, the sum of rights to confer a PhD with habilitation degree); (4) "innovation" (measured by, for example, the number of patents and protection rights granted in Poland); (5) "academic effectiveness" (measured by, for example, the ratio of total funding obtained for research from outside to the total number of researchers and research and didactic staff); (6) "teaching and learning" (measured by, for example, the number of valid international accreditations and certificates); and (7) "internationalization" (measured by, for example, the ratio of foreign students to the total number of students). It is worth noting that the criteria in force in 2021 did not include the contribution of university research to the implementation of the SDGs [42]. Hence, there is no duplication of the indicators used in the conducted study and those used to construct the indicated ranking.

Out of more than 100 universities included in the "Perspektywy University Ranking (Poland)" in 2021, the publication leaders took the following positions: JU, 1st place; UW1, 2nd place; AGH, 5th place; SUT, 13th place; UG, 23rd place; WULS, 30th place; KUT3, 35th place. It is, therefore, impossible to conclude that all the universities identified here have

high ranking positions. Thus, H1, stating that "in 2021, there was a correlation between the publication intensity of universities and their position in the *Perspektywy University Ranking (Poland)*", was rejected.

In the next step, a cluster analysis was carried out; however, before starting the cluster analysis, all sixteen variables were standardized. As a first step in the cluster analysis, correlations among the clustering variables were analyzed. It should be mentioned that a strong correlation leads to an overrepresentation of the variables in the final clustering solution [43]. For this reason, the threshold for the correlation coefficient was set at (r* = 0.9) [44]. Due to the low values of coefficients in this study, no variable was eliminated—Table 4.

Table 4. A Pearson correlation matrix for the investigated variables.

Variable	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15	x16
x1	1.00	0.09	−0.22	0.27 *	0.45 *	−0.13	−0.10	0.73 *	0.09	0.86 *	−0.05	0.13	0.05	−0.06	−0.05	0.43 *
x2	0.09	1.00	0.25	−0.08	−0.11	0.55 *	0.14	0.31 *	0.02	−0.00	0.34 *	0.54 *	0.51 *	0.35 *	0.86 *	−0.13
x3	−0.22	0.25	1.00	−0.27 *	−0.04	0.08	−0.08	−0.26	−0.22	−0.12	−0.03	−0.05	0.03	0.05	0.21	−0.13
x4	0.27 *	−0.08	−0.27 *	1.00	0.21	0.15	0.17	0.44 *	0.28 *	0.18	0.29 *	0.30 *	0.13	−0.03	−0.08	0.22
x5	0.45 *	−0.11	−0.04	0.21	1.00	−0.36 *	−0.41 *	0.08	−0.36 *	0.54 *	−0.38 *	−0.29 *	−0.29 *	−0.13	−0.10	0.77 *
x6	−0.13	0.55 *	0.08	0.15	−0.36 *	1.00	0.76 *	0.38 *	0.62 *	−0.23	0.82 *	0.85 *	0.88 *	0.46 *	0.55 *	−0.25
x7	−0.10	0.14	−0.08	0.17	−0.41 *	0.76 *	1.00	0.35 *	0.88 *	−0.21	0.78 *	0.77 *	0.85 *	0.31 *	0.10	−0.33 *
x8	0.73 *	0.31 *	−0.26	0.44 *	0.08	0.38 *	0.35 *	1.00	0.52 *	0.62 *	0.37 *	0.65 *	0.50 *	0.09	0.19	0.13
x9	0.09	0.02	−0.22	0.28 *	−0.36 *	0.62 *	0.88 *	0.52 *	1.00	−0.04	0.73 *	0.75 *	0.73 *	0.17	−0.06	−0.23
x10	0.86 *	−0.00	−0.12	0.18	0.54 *	−0.23	−0.21	0.62 *	−0.04	1.00	−0.16	−0.02	−0.08	−0.10	−0.09	0.49 *
x11	−0.05	0.34 *	−0.03	0.29 *	−0.38 *	0.82 *	0.78 *	0.37 *	0.73 *	−0.16	1.00	0.81 *	0.78 *	0.38 *	0.35 *	−0.22
x12	0.13	0.54 *	−0.05	0.30 *	−0.29 *	0.85 *	0.77 *	0.65 *	0.75 *	−0.02	0.81 *	1.00	0.87 *	0.31 *	0.48 *	−0.24
x13	0.05	0.51 *	0.03	0.13	−0.29 *	0.88 *	0.85 *	0.50 *	0.73 *	−0.08	0.78 *	0.87 *	1.00	0.47 *	0.49 *	−0.23
x14	−0.06	0.35 *	0.05	−0.03	−0.13	0.46 *	0.31 *	0.09	0.17	−0.10	0.38 *	0.31 *	0.47 *	1.00	0.42 *	−0.02
x15	−0.05	0.86 *	0.21	−0.08	−0.10	0.55 *	0.10	0.19	−0.06	−0.09	0.35 *	0.48 *	0.49 *	0.42 *	1.00	−0.06
x16	0.43 *	−0.13	−0.13	0.22	0.77 *	−0.25	−0.33 *	0.13	−0.23	0.49 *	−0.22	−0.24	−0.23	−0.02	−0.06	1.00

* Correlation coefficients are significant with $p < 0.0500$. Source: own study.

The aim of the conducted cluster analysis was to classify the selected public HEIs in Poland into groups that differed by their involvement in promoting SDGs in 2021. The distinguished groups have to meet the criteria of internal cohesion and external isolation [45]. Thus, the aim of the analysis was not to identify the leaders in promoting the idea of SD, but to find HEIs with similar publication activity in the described topic.

The outcome of hierarchical clustering with the Euclidean distance measure is presented in Figure 1. A dendrogram (or tree diagram) is a branching diagram that represents the relationships of similarity among a group of entities. The horizontal axis represents HEIs constituting the study sample, while the vertical axis indicates the distance of the linkage, in this case the Euclidean distance. One of the most important steps in this analysis is to determine the optimal number of clusters. This step is somehow subjective and depends on the method used for measuring similarities and the parameters used for partitioning. To assess the number of clusters, the graph of amalgamation schedule was used, which shows the distance between clusters at the time of their grouping (Figure 2). This is one of the most commonly used methods for indicating the optimal number of clusters (others include the elbow method and silhouette index). It was used, among others, by Czyż et al. (2017) [46], Pietrzak and Pietrzak (2018) [47], and Hamilton et al. (2019) [48]. The cut-off point was established at the point of a sudden increase in the distance of linkage. In the analyzed case, it was between step 53 and 54. Their ordinate corresponds to the distance between linkages amounting to approx. 13. For this reason, it was possible to distinguish four clusters (see the dotted red line in Figure 1). The first cluster includes four universities: (1) PULS; (2) UAK; (3) USLS; and (4) WULS. All of the HEIs listed are classified as life sciences. In other words, PULS, UAK, USLS, and WULS are more similar to each other than they are to other HEIs.

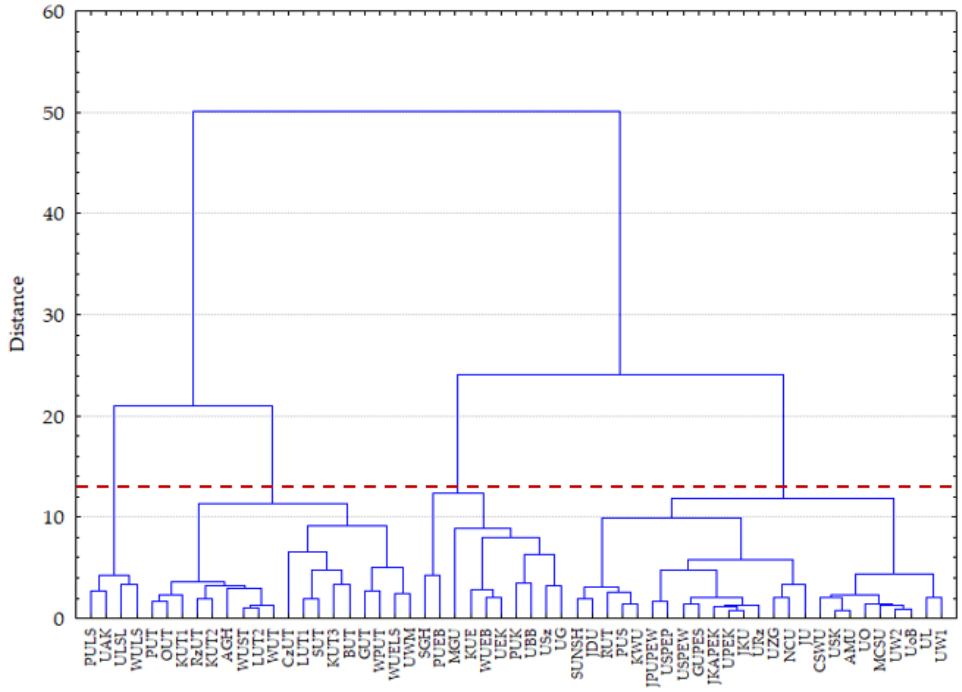

Figure 1. The dendrogram of hierarchical clustering using Ward's method for selected HEIs from Poland. Source: own study.

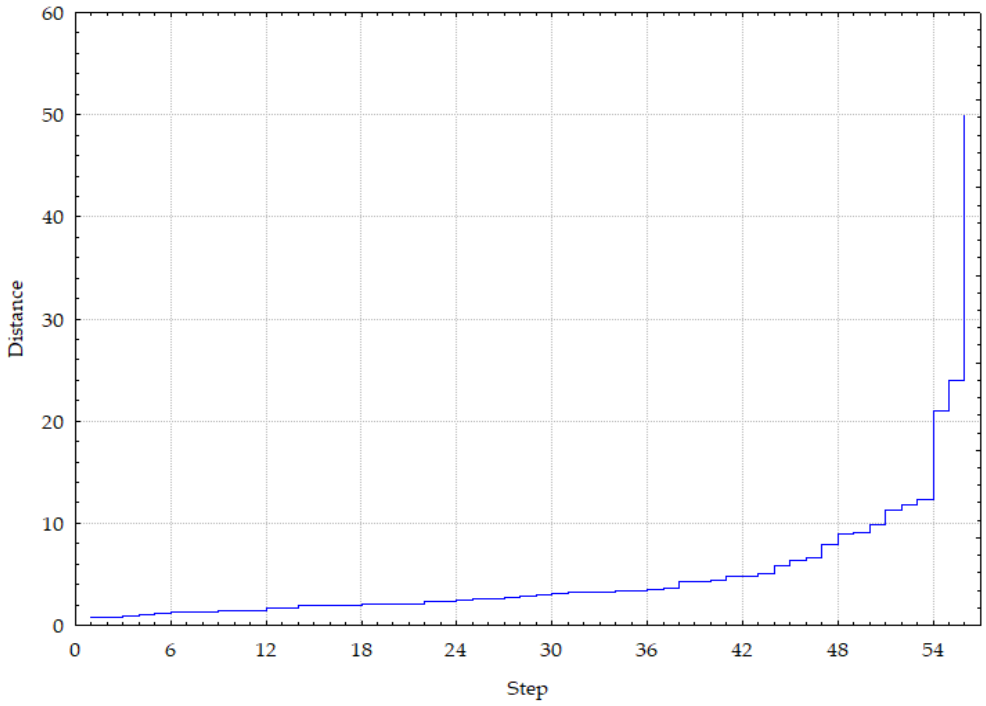

Figure 2. A graph of amalgamation schedule. Source: own study.

The second cluster included 18 HEIs, namely: (1) PUT; (2) OUT; (3) KUT1; (4) RzUT; (5) KUT2; (6) AGH; (7) WUST; (8) LUT2; (9) WUT; (10) CzUT; (11) LUT1; (12) SUT; (13) KUT3; (14) BUT; (15) GUT; (16) WPUT; (17) WUELS; and (18) UWM. As many as 15 of these are categorized as universities of technology. There were 10 HEIs in cluster 3. These included all the universities of economics that entered the research sample: (1) UEK; (2) KUE; (3) PUEB; (4) SGH; and (5) WUEB. In addition to these, the following HEIs were placed: (6) MGU; (7) PUK; (8) UBB; (9) USz; and (10) UG. The largest number of HEIs was in cluster

4. These mostly included universities and physical education universities: (1) SUNSH; (2) JDU; (3) RUT; (4) PUS; (5) KWU; (6) JPUPEW; (7) USPEP; (8) USPEW; (9) GUPES; (10) JKAPEK; (11) UPEK; (12) JKU; (13) URz; (14) UZG; (15) NCU; (16) JU; (17) CSWU; (18) USK; (19) AMU; (20) UO; (21) MCSU; (22) UW2; (23) UoB; (24) UL; and (25) UW1. Based on the results obtained, the author's hypothesis was confirmed. It can be stated that, in 2021, there was a correlation between the profile of a public HEI in Poland and the SDGs which it was involved in promoting.

There was another question whose answer was also of interest, namely, in the promotion of which SDGs (as measured by publication productivity) were individual groups (clusters) of public HEIs in Poland most involved? The following conclusions could be drawn from the results obtained:

- The universities of life sciences, that formed cluster 1, had the highest publication productivity under the following goals: SDG2, SDG3, SDG6, SDG11, SDG12, SDG13, SDG14, SDG15, and SDG16.
- The universities of technology, which made up the majority of cluster 2, had the highest publication productivity for two goals: SDG7 and SDG9.
- The highest publication productivity for SDG1, SDG4, SDG5, SDG8, SDG10, and SDG16 belonged to cluster 3.
- The HEIs that made up cluster 4 did not have the highest publication productivity for any of the SDGs.

On the basis of the results obtained, it is possible to accept H2 which states that "in 2021, there was a correlation between the profile of a public HEI in Poland and the SDGs which it was involved in promoting". Detailed information is provided in Table 5.

Table 5. Cluster characteristics based on average publication productivity in promoting individual SDGs in 2021.

SDGs	SDG Area	Cluster 1	Cluster 2	Cluster 3	Cluster 4
SDG 1: "No poverty"	"People"	0.0063	0.0038	0.0176	0.0053
SDG 2: "Zero Hunger"	"People"	0.1945	0.0247	0.0172	0.0200
SDG 3: "Good Health and Well-being"	"People"	0.2395	0.1532	0.0765	0.2026
SDG 4: "Quality Education"	"People"	0.0167	0.0214	0.0342	0.0140
SDG 5: "Gender Equality"	"People"	0.0051	0.0036	0.0143	0.0102
SDG 6: "Clean Water and Sanitation"	"Planet"	0.1511	0.1055	0.0245	0.0280
SDG 7: "Affordable and Clean Energy"	"Prosperity"	0.1354	0.2125	0.0448	0.0405
SDG 8: "Decent Work and Economic Growth"	"Prosperity"	0.0911	0.0645	0.0992	0.0330
SDG 9: "Industry, Innovation and Infrastructure"	"Prosperity"	0.0851	0.1893	0.0823	0.0363
SDG 10: "Reduced Inequalities"	"Prosperity"	0.0126	0.0103	0.0427	0.0194
SDG 11: "Sustainable Cities and Communities"	"Prosperity"	0.1478	0.1457	0.0574	0.0420
SDG 12: "Responsible Consumption and Production"	"Planet"	0.1622	0.1089	0.0538	0.0316
SDG 13: "Climate Action"	"Planet"	0.0994	0.0715	0.0254	0.0218
SDG 14: "Life Below Water"	"Planet"	0.0329	0.0222	0.0194	0.0120
SDG 15: "Life on Land"	"Planet"	0.2284	0.0288	0.0266	0.0396
SDG 16: "Peace, Justice and Strong Institutions"	"Peace"	0.0104	0.0109	0.0257	0.0177

Source: own elaboration, based on [31,38].

As was mentioned, the involvement of HEIs in Poland in promoting the selected SDGs in 2021 is not accidental. For example, universities of life sciences (cluster 1) had the highest publication productivity within the so-called "planet" goals, e.g., "Climate Action", "Life Below Water", or "Life on Land". Among the articles published in 2021 in this field, one can point out Broda and Hill (2021) [49], Hoffmann et al. (2021) [50], Gołasa et al. (2021) [51], Rokicki et al. (2021) [52], Raza et al. (2021) [53], Sowińska-Świerkosz et al. (2021) [54], and Bownik and Wlodkowic (2021) [55]. In contrast, cluster 2, with a technical profile, had the highest publication productivity in terms of clean energy or infrastructure targets ("prosperity goals"). Examples of publications in this area include Szacherska et al. (2021) [56], Zdarta et al. (2021) [57], Jędrzejczak et al. (2021) [58], Wieszczycka

et al. (2021) [59], Bundschuh et al. (2021) [60], Kasprzyk et al. (2021) [61], and Hejna et al. (2021) [62]. The universities of economics, most of which formed cluster 3, specialized in publications on "prosperity" and "peace" goals. A few selected studies can also be highlighted here: Goczek et al. (2021) [63], De Masi et al. (2021) [64], Czyżewski et al. (2021) [65], Kwiek and Roszka (2021) [66], Szczepankiewicz et al. (2021) [67], Szymańska (2021) [68], and Zarzycka et al. (2021) [69].

Due to the limited volume of the article, it was not possible to cite all articles on the SDGs. The author has referred to those of greatest interest. At the same time, he is aware that he may have omitted many valuable studies in his review.

5. Conclusions

Universities are increasingly taking on the responsibility of promoting the concept of SD. They can do this by, among other things, integrating the concept of sustainability into their research or teaching. However, it seems that the simplest way to promote the SGDs is through the publication activities carried out by academics. The author's analysis shows that there is a lack of research on the publication productivity of universities as measured by the number of publications on the SDGs per academic staff.

Hence, in this article, an attempt was made to present the involvement of public HEIs in Poland in promoting the SDGs in 2021. The following conclusions were formulated as a result of the study:

- The highest publication productivity in 2021 within the individual SDGs was demonstrated by the following universities: UW1, WULS, JU, SUT, AGH, KUT3, and UG.
- Not all of the publication leaders under each of the SDGs held high positions in the "Perspektywy University Ranking (Poland)" in 2021.
- On the basis of publication productivity in 2021, it was possible to identify four clusters of universities.
- The universities of technology, which made up the majority of cluster 2, had the highest publication productivity for two goals: SDG7 and SDG9.
- The highest publication productivity for SDG1, SDG4, SDG5, SDG8, SDG10, and SDG16 belonged to cluster 3.
- The HEIs that made up cluster 4 did not have the highest publication productivity in any of the SDGs.
- In 2021, universities of life sciences (cluster 1) had the highest publication productivity within the so-called "planet" goals, universities of technology (cluster 2) were most involved in "prosperity goals", and universities of economics (cluster 3) specialized in publications on "prosperity", and "peace" goals.

On the basis of the results obtained, it was possible to reject **H1** (stating that "in 2021, there was a correlation between the publication intensity of universities and their position in the Perspektywy University Ranking (Poland)") and accept **H2** (stating that "in 2021, there was a correlation between the profile of a public HEI in Poland and the SDGs which was is involved in promoting". It can also be concluded that the main aim of the study has been met.

On the basis of the study carried out, the author believes that the two research gaps (**RG1**, **RG2**) presented in the introduction have been addressed. With this, this article presents, for the first time, the involvement of public HEIs in Poland in promoting the SDGs on the basis of publication activities. Additionally, the study used bibliometric data, making it quantitative in nature (as opposed to the qualitative studies that dominate the field).

Of course, the author is aware that the obtained results can be criticized from the point of view of the adopted research methodology. In the theoretical part of the article, some studies that could be of importance to some scholars, with regard to the described issues, may have been omitted. The author, when selecting the literature, was guided by availability and the importance of a journal or a scientific publishing house. Several limitations of the agglomerative clustering technique should also be kept in mind. Hierarchical

clustering methods do not require a prior indication of the number of clusters (as required by non-hierarchical methods) but do require a lot of computing power. The clusters are usually not formed on the basis of any theoretical part. The clusters are instead formed at random. Therefore, it is sometimes difficult to find a justification for the cluster structure.

The presented limitations also suggest further research directions. First of all, in the future, research should be carried out on a larger research sample. It would be possible to see what involvement non-public universities have in promoting the SDGs as well. Another idea would be to compare the involvement of Polish HEIs with HEIs from other countries, e.g., both inside and outside the European Union.

Finally, it is worth noting that universities should use social media with greater frequency to showcase their achievements in terms of engagement with the SD concept. This will allow them to get the message out to more stakeholders, thereby raising awareness of the issue.

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