

Correlation of innovativeness and impact on sustainability (SDG) at the universities of Europe

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Abstract

The **objective** of the paper is to present the results of secondary research on the connection between the innovativeness of European universities and their impact on the Sustainable Development Goals. The **methodology** is the correlation analysis of the combined data retrieved from publicly available lists.

The **hypotheses**, that for the universities both factors should be in focus, moreover more innovative universities might have stronger contributions to the SDGs, this research was not able to prove. This is not in line with previous research about the correlation of innovation and sustainability. As any diversity, this raised the question of why, for which some answers were found.

As some of the lists the research was based on are self-reporting ones, one of the factors can be, that universities do not yet consider it important to be part of the lists. For the society and for the economy it would be **useful** to have more precise information about the universities' impact on the SDGs, which can be achieved by having more and more accurate data from the universities and/or the creation of more descriptive indicators, which illustrates the relationship of the two factors better, is a possibility.

The **originality** of the research is that to my best knowledge no other research was yet on the relation of these two indicators of the European universities, although because of the limited data, a new analysis was implemented based on Google searches. The results are still not convincing that innovation and sustainability are connected at the universities.

Keywords: Sustainability, SDG, impact, innovation, university, higher-education, Europe, correlation

Introduction

As universities started to develop, we could follow the phases of focus on (1) education, (2) research at the Humboldtian university, and (3) the third mission (Etzkowitz, H., 1983; Etzkowitz, Henry, Webster, Gebhardt, & Terra, 2000; Compagnucci & Spigarelli, 2020) in which the aim is to keep contact with the other actors – mainly within the innovation ecosystem – to contribute to the society. Now we can witness the phase of University 4.0, when the growing importance of sustainability comes to the forefront, which means an even bigger contribution to the society via all the three functions (Lozano et al., 2015; Secundo, Dumay, Schiuma, & Passiante, 2016; Staniškis, 2016). This leads to sustainable entrepreneurial universities, which can educate the sustainable entrepreneurs of the future, which is an important step in the transition to a sustainable economy.

Research on this topic is wide, for example, the table of Giesenbauer & Müller-Christ (2020) on the four phases of the universities summarizes the specifications of the different phases based on the literature (what is in the focus, what is education, research, and the governance, operations and culture like).

As our world is facing challenges not only economically, but environmentally (climate change) and socially, humanity tries to find innovative solutions for the most urging problems. In 2015 during the session of the United Nations (UN) 190 countries signed the resolution on Transforming our world: the 2030 Agenda for Sustainable Development (United Nations, 2015). This document grouped the challenges of sustainability into 17 categories. Since 2019, there is a possibility for the universities to report on these challenges to communicate their performance to society (Impact ranking.2021).

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We know for a long time that there is a connection between innovation and sustainability (Vollenbroek, 2002), even if the available literature is very little, although increasing (Ávila et al., 2017; Wagner, Schaltegger, Hansen, & Fichter, 2021). More to be found in the grey literature (publications of different organisations like the UN or the EUA).

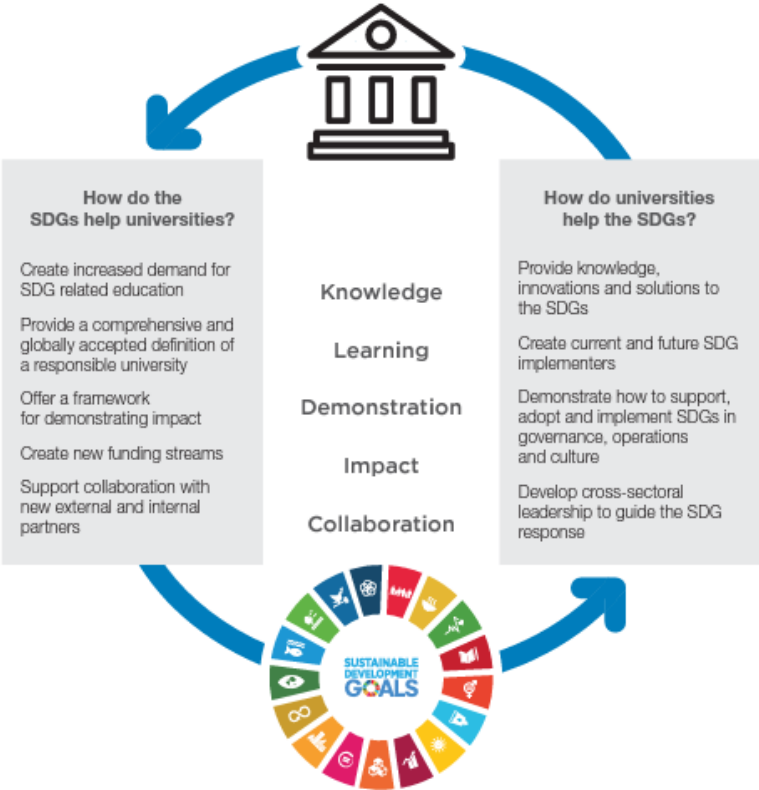
Universities are organized around knowledge. They are the training places of the future’s decision-makers (share of the knowledge), the research is about the creation of the knowledge, while the third mission is about the exploitation of the knowledge (Wallin, 2007). Sustainability is a topic that requires knowledge, too, this is the reason, why universities could become key players in the sustainable innovation ecosystem. Knowledge is the link between innovation and sustainability and the “triple-helix twins” – innovation and sustainability - balance each other (Etzkowitz, Henry & Zhou, 2006; Zhou & Etzkowitz, 2021) or can even strengthen each other (for which the use of the renewables is a good example). Sustainable entrepreneurship is an emerging topic as it becomes evident that being economic and sustainable are not necessarily conflicting objectives (Klofsten et al., 2019). Entrepreneurship is kind of a synonym of innovation at the universities.

Among the firsts (Gerlach, 2003) stated sustainable development as a multi-innovation process, and from this perspective sustainable development is based on successful innovation management.

We also have to deal with the fact that definitions are changing and researchers do not always use the same definitions. In 2011 (Schaltegger & Wagner) the differences of sustainability-oriented entrepreneurship at companies (ecopreneurship, social entrepreneurship, institutional entrepreneurship, and sustainable entrepreneurship) got summarized, which clearly represented the overlapping of the existing definitions.

Even some UN organisations analysed the role of universities in achieving the SDGs (

Figure 1. The case for university engagement in the SDGs



Source: (Kestin et al., 2017)

Based on Figure 1., it is evident that universities are key actors in reaching the sustainable development goals. They provide knowledge, innovations and solutions to the SDGs; they create the current and future implementers of the SDGs; they demonstrate how to support, adopt and implement SDGs in governance, operations and culture, and they develop cross-sectoral leadership to guide the SDG response.

But we cannot forget about the fact that SDGs help the universities, too. SDGs create an increased demand for SDG-related education; provide a comprehensive and globally accepted definition of a responsible university; offer a framework for demonstrating impact; create new funding schemes; support collaboration with new external and internal partners.

The concept of sustainable entrepreneurial ecosystems is an emerging one, while some universities still struggle to be simply an entrepreneurial university. It is a question if universities can find a way to 'skip' the older concept and this way make their entrepreneurial activities (including education, research, and innovation management) more sustainable.

Sustainable innovation is not only an emerging, but also a fragmented topic (Cillo, Petruzzelli, Ardito, & Del Giudice, 2019), which means that there are at least three main perspectives for analysing the topic (performance evaluation, internal-managerial, and external-relational).

The role of universities in sustainability is known for a long time – at least since the Talloires Declaration, which was signed by 500+ university managers since 1990 – and the report and the event titled 'Universities as key contributors to sustainable innovation ecosystems' of the European University Association (EUN) also have to be mentioned as a signal of the recognition of the growing importance of the topic (Kozirog, Lucaci, & Berghmans, 2022). In spite of this, to the best of the author's knowledge, no research was yet implemented if there is a correlation between the level of innovativeness and sustainability of universities. The closest one is a literature review of the business context of the two phenomena (Cordova & Celone, 2019)

In this research, we tried to analyse the correlation of innovativeness as the indicator of entrepreneurship and the impact on SDGs as the indicator of sustainability at the universities of Europe. When we are analyzing the European universities in this research we focus not only on the universities of the European Union but Norway, Switzerland, and Turkey are also included.

The hypothesis of the research is that there is a correlation between the innovativeness and the impact on the sustainability of the European universities, like more innovative universities have a larger impact on sustainability. The root of this assumption is that both innovation and sustainability are based on knowledge.

After this introductory part, the rest of this manuscript is structured like Section 2 presents the method used for the analysis, Section 3 describes the results, while Section 4 summarizes the most important conclusions of the research.

Method

Based on the literature it is clear that the innovativeness of a university represents how entrepreneurial it is (Etzkowitz, Henry, 2016). It is more and more important what impact a university has on the SDGs. The missing point we realized if there is a connection between the innovativeness of a university and its impact on the Sustainability Development Goals of the United Nations (2015), although the nexus of contextualization of entrepreneurship and sustainability was already raised in 2019 in the special issue of the Small Business Economics (Volkman, Fichter, Klofsten, & Audretsch, 2021). In 2021 the European University Association had an event titled 'Universities as key contributors to sustainable innovation ecosystems', which shows that the importance of innovation and sustainability should already be hand-in-hand. The event was based on the publication titled 'Universities as key drivers of sustainable innovation ecosystems' (Kozirog et al., 2022).

That is why this research focuses on the state-of-the-art and the relation between these two factors.

The research covers only the universities of Europe as (1) the US differs from Europe in innovation environment and management (Rybnicek, 2020), (2) Europe and the European Union have declared sustainability among their most important goals in the European Green Deal (A european green deal -

striving to be the first climate-neutral continent.2022).¹⁸ However, we used the data of the most innovative and most impactful US and UK universities as benchmark points in the later part of our analysis.

In this research, we used two publicly available, but not downloadable lists, where data collection was implemented by hand and Google searches to calculate the innovativeness and the impact of the universities.

The Reuters' list of the world's most innovative universities was used as an indicator of the entrepreneurial level of the university. The number of patents and the commercial impact are both important in predicting the innovativeness of a university (Lanjouw, Pakes, & Putnam, 1998; Sweet & Eterovic, 2019).

The Reuters'¹⁹ last available list of the 100 most innovative universities is from 2019 (David M., 2019) and the universities situated in continental Europe (no Irish university was on the list) were selected.

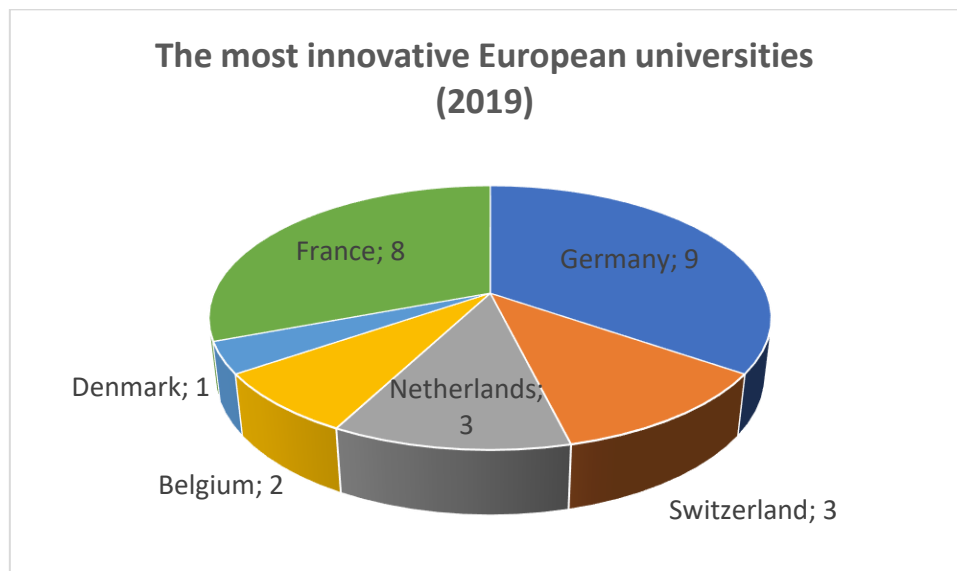
Then The Times Higher Education Impact Ranking on the 17 SDGs was hand-collected for the universities of Europe. We have to note that we finally included Ireland, which in this list means 9 universities, although Ireland is not situated in continental Europe, it is a member of the European Union.

During the research the two datasets were cross-checked and the data of the overlapping 5 universities were analysed by SPSS 22 to find the possible correlations between innovation- and sustainability indicators of the best performing universities. As 5 datasets are too small for a scientific analysis, the datasets were widened. To the data of all the European most innovative and most impactful universities the data of the most innovative and most impactful US and UK universities were added as benchmark points. Even kind of a content analysis was implemented based on Google searches and the analysis of the universities' English webpages. Also the existence of dedicated pages for our topics were studied.

Results

The Reuters'²⁰ last available list of the 100 most innovative universities (David M., 2019) contains 26 universities situated in continental Europe (no Irish university was on the list). 1. Table contains the list and the available data for the most innovative universities in Europe, while Figure shows the distribution of these universities in the European countries.

Figure 2. The most innovative universities in Europe by country (2019)



Source: own work based on the list of the most innovative universities (David M., 2019)

¹⁸ the first European Union Sustainable Development Strategy was formulated in 2001

¹⁹ <https://www.Reuters'.com/innovative-universities-2019>

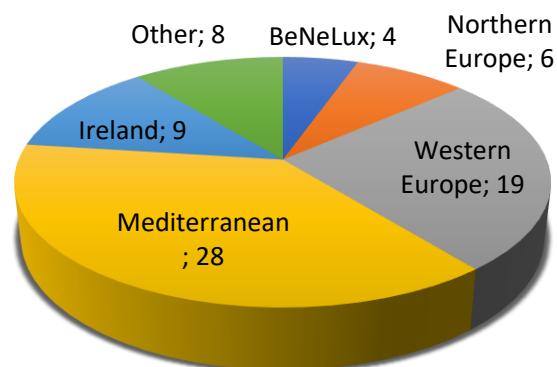
²⁰ <https://www.Reuters'.com/innovative-universities-2019>

Until 2019 there was no official list of the SDG impact of universities. Since then, the Times Higher Education (THE) prepares the annual list parallelly to its rankings. Although the number of the universities that send data is growing (De la Poza, Merello, Barberá, & Celani, 2021), being partly a self-reporting list does not make it possible to compare the universities without doubts.

The list of the Times Higher Education for impact²¹ (Impact ranking.2021) was analysed, where in the first 300 universities 74 were from Europe (hand-collection of data). **Hiba! A hivatkozási forrás nem található.** represents the distribution of the universities of Europe with the greatest reported impact on SDGs.

Figure 3. European universities with impact on SDGs (1-300)

Number of European Universities with impact on SDGs



Source: hand-collected from the list of The Times Higher Education Impact Ranking (2021) (Impact ranking.2021)

After the collection of the data from both the most innovative (26) and the most impactful (74) European universities, a comparison was made. As Table summarizes, only 5 of the most innovative European universities (26) were part of both lists (the Delft University of Technology is extraordinary, as it is not on the impact list although it is the best in SDG9), which even on its own means that this research is not able to justify the relation of innovativeness and sustainability at the universities.

This research has failed in justifying the relation between the innovativeness of a university and its impact on SDGs. This is in line with (Urdari, Farcas, & Tiron-Tudor, 2017), who found that international rankings fail to measure the HEIs success in developing third mission activities.

At that point the decision was made to analyse the data of all the universities together with some benchmarks from the US and the UK. This way data from the THE list (Number of FTE students, Female:Male ratio, Number of students per teacher and the proportion of international students) were collected. Besides, Google searches were implemented to have the data how many hits there are for the „name of the university” + „innovat*” or „sustain*”. The same search was done on the English main websites of each university and it was also analysed if the university has a dedicated page for the innovation and / or for sustainability. For the latter, three options were defined, yes /no / partly, where the latter meant that the keyword was connected to some other topic, most of the times it was research or impact.

It was interesting to see, that innovation still seems more important, as this term was more frequent on the websites of the universities (innovate* was almost twice as much hits as “sustain*”). 13/42 universities do have a dedicated website for innovation, 15/42 has partly (mostly joint with a research website) and 13 do not have any.

For sustainability 9/42 universities have a dedicated website, 5/42 got the label “partly” (mostly it was framed as impact) and 28 universities do not have a dedicated site for sustainability.

²¹ https://www.timeshighereducation.com/rankings/impact/2021/overall#!/page/0/length/-1/sort_by/rank/sort_order/asc/cols/undefined

Only four universities have a dedicated page for innovation and sustainability, two of which are our benchmark points (Oxford and Stanford). From Europe only the Delft University of Technology and the EPFL - Swiss Federal Institute of Technology Lausanne declares innovation and sustainability important enough to have a dedicated page for both.

Table 1. List of the most innovative European universities

Ranking	Name of the University	Country	Overall Ranking	Overall Score	Ranking in the Sustainable Development Goals (SDG) according to the Times Higher Education																	Innovation ranking https://www.reuters.com/innovative-universities-2019	Patents filed 2012-2017	Success rate of filed patents	Commercial Impact score	World ranking 2021	
					1. No poverty	2. Zero hunger	3. Good Health and Wellbeing	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	17. Partnerships for the goals						
1.	KU Leuven	Belgium	101 - 200	77,5 - 85,2	201-300	80	101-200	201-300	201-300	201-300	201-300	101-200	28	101-200	101-200	101-200	101-200	101-200	101-200	101-200	101-200	7.	305	40%	43,3	45	
2.	University of Erlangen Nuremberg	Germany	na																			14.	238	52,10%	51,2	198	
3.	EPFL - Swiss Federal Institute of Technology	Switzerland	na																			17.	235	39,60%	58,1	43	
4.	ETH Zurich	Switzerland	na																			40.	305	29,50%	42,7	14	
5.	University of Montpellier	France	201 - 300	71,0 - 77,4			60	53						201-300		101-200						44.	187	70,60%	27,9	301-350	
6.	Technical University of Munich	Germany	na																			46.	191	40,80%	40,5	41	
7.	Technical University of Denmark	Denmark	na																			48.	379	28,50%	36,4	187	
8.	University of Zurich	Switzerland	na																			51.	167	34,10%	35,8	73	
9.	Sorbonne University	France	201-300	71,0 - 77,4			201-300	401-600				52	201-300			98						56.	383	44,60%	31,7	87	
10.	Ruprecht Karl University Heidelberg	Germany	na																			59.	158	35,40%	34,4	42	
11.	Delft University of Technology	Netherlands	*										101-200			1						60.	147	73,50%	37,6	78	
12.	University of Paris Sud	France	na																			64.	170	54,70%	39,2		
13.	University of Paris Descartes	France	na																			66.	219	32,90%	56,1		
14.	Johannes Gutenberg University	Germany	na																			70.	93	38,70%	33,2	301-350	
15.	Leiden University	Netherlands	na																			71.	73	50,70%	41	70	
16.	University of Munich	Germany	na																			75.	100	40,00%	36,9		
17.	University of Claude Bernard	France	na																			77.	343	59,80%	27,4	501-600	
18.	Dresden University of Technology	Germany	na																			79.	202	57,40%	31,6	152	
19.	University of Bordeaux	France	201-300				101-200	101-201	101-201	201-300			101-200	48	101-200	301-400	81	101-200				80.	205	54,60%	41,4	401-500	
20.	University of Freiburg	Germany	na																			82.	148	53,40%	38,8	83	
21.	RWTH Aachen University	Germany	na																			89.	160	44,40%	37,3	107	
22.	Grenoble Alpes University	France	na																			91.	155	66,50%	24,2	351-400	
23.	Utrecht University	Netherlands	na																			93.	74	41,90%	34,6	75	
24.	Technical University of Berlin	Germany	na																			94.	104	63,50%	38,4	140	
25.	University of Aix-Marseille	France	201 - 300	71,0 - 77,4		88	101-200	101-200	201-300	201-300	201-300	101-200	80	101-200	301-400	101-200	201-300	52	101-200	101-200	101-200	201-300	96.	271	48,00%	30,7	351-400
26.	Ghent University	Belgium	na																			98.	250	42,80%	28,2	103	

* Delft University of Technology seems to have data at only SDG7 and SDG9 - 1st at this

Source: Hand-collected from the Reuters' most innovative universities (2019) list and the Times Higher Education (THE) impact and world university ranking (2021)

Table 2. European Universities ranked among the first 100 innovative universities by Reuters' and among the first 200 in impact (SDG) by the Times Higher Education

Ranking of the 26 most innovative European Universities (2019 Reuters)	Name of the University	Country	Overall Ranking in SDG	Innovation ranking				World ranking 2021
				https://www.reuters.com/innovative-universities-2019	Patents filed 2012-2017	Success rate of filed patents	Commercial Impact score	
1.	KU Leuven	Belgium	101-200	7.	305	40%	43,3	45
5.	University of Montpellier	France	201-300	44.	187	70,60%	27,9	301-350
9.	Sorbonne University	France	201-300	56.	383	44,60%	31,7	87
11.	Delft University of Technology*	Netherlands	na	60.	147	73,50%	37,6	78
19.	University of Bordeaux	France	201-300	80.	205	54,60%	41,4	401-500
25.	University of Aix-Marseille	France	201-300	96.	271	48,00%	30,7	351-400

* Delft University of Technology seems to have data at only SDG7 and SDG9 - 1st at this

Table 3. The results of the correlation analysis 1.

		Correlations					
		SDG ranking (2021)	Innovation ranking (2019)	World ranking (2021)	Patents filed 2012-17	Success rate of filed patents	Commercial impact score
SDG ranking (2021)	Pearson Correlation	1	,807	,668	-,246	,543	-,674
	Sig. (2-tailed)		,099	,218	,691	,344	,212
	Sum of Squares and Cross-products	8000,000	4960,000	19200,000	-3480,000	1156,000	-830,000
	Covariance	2000,000	1240,000	4800,000	-870,000	289,000	-207,500
	N	5	5	5	5	5	5
Innovation ranking (2019)	Pearson Correlation	,807	1	,688	-,194	,155	-,346
	Sig. (2-tailed)	,099		,131	,713	,770	,502
	Sum of Squares and Cross-products	4960,000	4728,833	16685,500	-2588,667	330,683	-332,533
	Covariance	1240,000	945,767	3337,100	-517,733	66,137	-66,507
	N	5	6	6	6	6	6
World ranking (2021)	Pearson Correlation	,668	,688	1	-,339	,152	-,271
	Sig. (2-tailed)	,218	,131		,512	,774	,603
	Sum of Squares and Cross-products	19200,000	16685,500	124419,500	-23204,000	1667,750	-1338,100
	Covariance	4800,000	3337,100	24883,900	-4640,800	333,550	-267,620
	N	5	6	6	6	6	6
Patents filed 2012-17	Pearson Correlation	-,246	-,194	-,339	1	-,864*	-,066
	Sig. (2-tailed)	,691	,713	,512		,026	,901
	Sum of Squares and Cross-products	-3480,000	-2588,667	-23204,000	37757,333	-5225,067	-180,333
	Covariance	-870,000	-517,733	-4640,800	7551,467	-1045,013	-36,067
	N	5	6	6	6	6	6
success rate of filed patents	Pearson Correlation	,543	,155	,152	-,864*	1	-,290
	Sig. (2-tailed)	,344	,770	,774	,026		,578

	Sum of Squares and Cross-products	1156,000	330,683	1667,750	-5225,067	967,648	-125,863
	Covariance	289,000	66,137	333,550	-1045,013	193,530	-25,173
	N	5	6	6	6	6	6
Commercial impact score	Pearson Correlation	-,674	-,346	-,271	-,066	-,290	1
	Sig. (2-tailed)	,212	,502	,603	,901	,578	
	Sum of Squares and Cross-products	-830,000	-332,533	-1338,100	-180,333	-125,863	195,273
	Covariance	-207,500	-66,507	-267,620	-36,067	-25,173	39,055
	N	5	6	6	6	6	6

*. Correlation is significant at the 0.05 level (2-tailed).

Source: SPSS 22

Figure 4. Relation of SDG and innovation rankings at the 6 universities

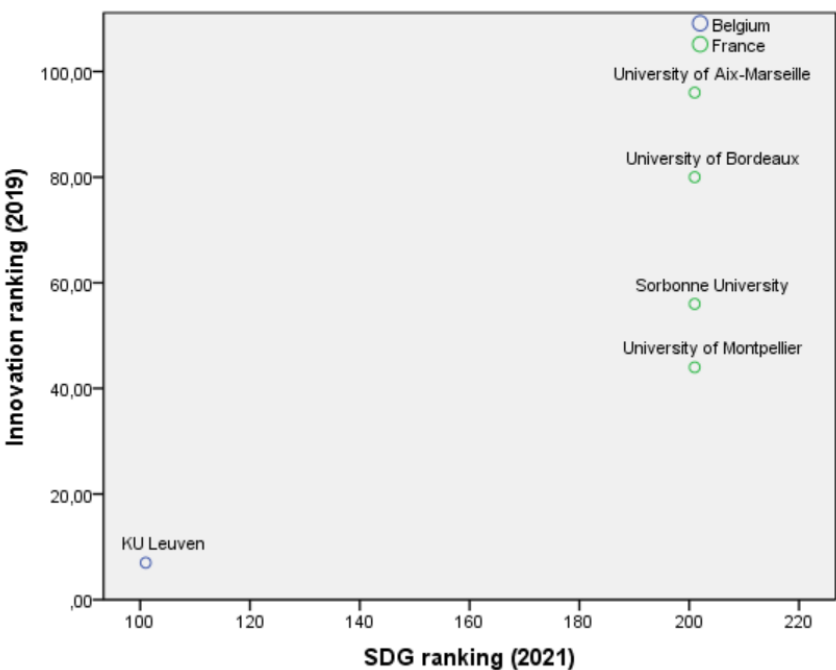


Chart Legend Information

Settings	Value
Color by	Country
Size by	---
Shape by	---
Label by	Name of the university
Fit Lines	---

Legend Settings for the charts that follow. Some settings do not apply to categorical charts.

Table 4. List of the most innovative, best at SDG European universities and the UK and US universities best at these indicators

	Name of the University	Country	SDG Ranking (the times higher)	Innovation ranking (reuter)	World ranking (2021)	Google name of the uni + innovation (3 July 2022)	Google name of the uni + sustainability (3 July 2022)	No of FTE students (2021)	Student Ratio of Females	No. of students per staff	Percentage of International students	Letöltés ideje 2022.07.07.	Innovat	Sustain	Note	Innovat	Sustain	Innovat	Sustain	Impact
1.	Aalborg University	Denmark	6.	na	201 - 250	1 520 000	1 250 000	16519	49/51	12,8	13%	https://www.aau.dk/	3	3	European Consortium	0	13	no	yes	
2.	University College Cork	Ireland	8.	na	301- 350	5 980 000	1 530 000	17397	58/42	20,3	20%	https://www.ucc.ie/en/	4	3	https://www.ucc.ie/en/	21	22	partly	yes	
3.	University of Bologna	Italy	20.	na	167	8 310 000	4 200 000	68370	57/43	24,3	12%	https://www.unibo.it/en/	1	0	https://www.unibo.it/en/	6	0	partly	no	
4.	University of Coimbra	Portugal	21.	na	601 - 800	1 340 000	594 000	21845	57/43	18,4	20%	https://www.ucp.pt/en/	1	0				no	no	
5.	KTH Royal Institute of Technology	Sweden	41.	na	201 - 250	2 020 000	403 000	13422	34/66	16,7	21%	https://www.kth.se/en/	2	1	https://www.kth.se/en/	31	1	yes	no	
6.	Politechnic University of Valencia	Spain	83.	na	801 - 1000	993 000	358 000	22562	42/58	10,8	16%	http://www.upv.es/en/	2	0	https://innovation.upv.es/	10	0	yes	no	
7.	Free University of Berlin	Germany	101 - 200	na	118	40 600 000	23 400 000	27018	61/39	43,2	23%	https://www.fu-berlin.de/	0	4				no	no	
8.	IMT Atlantique	France	101 - 200	na	351 - 400	268 000	67 800	1546	24/76	8,2	39%	https://www.imt-atlantique.com/	7	1	Research/Innovation	6	1	partly	no	
9.	Université Catholique de Louvain	Belgium	101 - 200	na	164	6 460 000	3 850 000	26424	54/46	39,1	20%	https://uclouvain.be/en/	1	0	https://uclouvain.be/en/	33	0	partly	no	
10.	Vrije Universiteit Amsterdam	Netherlands	101 - 200	na	116	8 400 000	10 600 000	25443	58/42	18	13%	https://vu.nl/en/	0	0	https://vu.nl/en/innovation/	0	3	partly	no	
11.	Lappeenranta-Lahti University of Technology	Finland	201 - 300	na	351 - 400	68 800	103 000	4333	31/69	29,6	15%	https://www.lut.fi/en/	0	1	separate pages for innovation services for			yes	no	
12.	University of Latvia	Latvia	201 - 300	na	601 - 800	11 000 000	10 900 000	12007	70/30	31,7	7%	https://www.lu.lv/en/	0	2	https://www.lu.lv/en/innovation/	na	na	yes	no	
13.	University of Pécs	Hungary	201 - 300	na	601 - 800	802 000	632 000	16798	57/43	11,7	24%	https://www.nyit.hu/en/	1	0				no	no	
14.	KU Leuven	Belgium	101 - 200	7.	45	15 300 000	1 290 000	45617	50/50	36,1	15%	https://www.kuleuven.be/	2	0	https://www.kuleuven.be/	2	0	partly	impact	
15.	University of Erlangen Nuremberg	Germany	na	14.	198	1 890 000	769 000	38052	49/51	57,3	12%	https://www.fau.eu/	2	1				no	no	
16.	EPFL - Swiss Federal Institute of Technology	Switzerland	na	17.	43	3 540 000	1 000 000	10942	29/71	12,2	60%	https://www.epfl.ch/en/	8	1	https://www.epfl.ch/	48	46	yes	yes	
17.	ETH Zurich	Switzerland	na	40.	14	29 000 000	23 000 000	19632	32/68	13,1	40%	https://ethz.ch/en.html	0	2	Title - Industry and Kin	na		partly	no	
18.	University of Montpellier	France	201 - 300	44.	301-350	5 540 000	2 250 000	39703	53/47	19,7	15%	https://www.umontpellier.fr/	3	0				no	no	
19.	Technical University of Munich	Germany	na	46.	41	13 400 000	5 430 000	32377	36/64	39,8	31%	https://www.tum.de/en/	6	3	https://www.tum.de/en/	10	0	yes	no	
20.	Technical University of Denmark	Denmark	na	48.	187	36 700 000	14 200 000	9412	31/69	6,7	25%	https://www.dtu.dk/english/	1	6	Innovation is a title, i	43	3	yes	no	
21.	University of Zurich	Switzerland	na	51.	73	21 200 000	8 210 000	22960	57/43	14,8	21%	https://www.uzh.ch/en/ht	0	0	https://www.innovation.uzh.ch/	13	0	yes	no	
22.	Sorbonne University	France	201-300	56.	87	15 700 000	876 000	43585	58/42	12,8	20%	https://www.sorbonne-universite.fr/en/	7	0	https://www.sorbonne-universite.fr/en/innovation/	6	0	partly	no	
23.	Ruprecht Karl University Heidelberg	Germany	na	59.	42	217 000	112 000	20020	54/46	14,5	18%	https://www.uni-heidelberg.de/en/	1	3	https://www.uni-heidelberg.de/en/innovation/	0	10	no	yes	
24.	Delft University of Technology	Netherlands	*	60.	78	8 850 000	6 110 000	19594	30/70	17,4	31%	https://www.tudelft.nl/en/	2	4	https://www.tudelft.nl/en/innovation/	18	2	yes	yes	impact
25.	University of Paris Sud	France	na	64.	na	20 500 000	5 990 000	na	na	na	na	na	na	na	na	na	na	na	na	na
26.	University of Paris Descartes	France	na	66.	na	15 900 000	368 000	na	na	na	na	na	na	na	na	na	na	na	na	na
27.	Johannes Gutenberg University of Mainz	Germany	na	70.	301-350	9 670 000	627 000	31773	59/41	25,7	11%	https://www.uni-mainz.de/	0	1	https://tu-dresden.de/	1	3	partly	no	
28.	Leiden University	Netherlands	na	71.	70	13 400 000	7 190 000	30178	59/41	19	18%	https://www.universiteitleiden.nl/en/	0	0	https://www.universiteitleiden.nl/en/innovation/	16	1	partly	partly	impact
29.	University of Munich	Germany	na	75.	na	15 800 000	8 100 000	34249	61/39	33,6	17%	https://www.lmu.de/en/	1	0	https://www.lmu.de/en/innovation/	1	0	partly	partly	
30.	University of Claude Bernard	France	na	77.	501-600	3 520 000	1 530 000	27490	53/47	13	13%	https://www.univ-lyon1.fr/	1	0				no	no	
31.	Dresden University of Technology	Germany	na	79.	152	5 390 000	950 000	31103	43/57	32,9	15%	https://tu-dresden.de/?se	1	1	https://tu-dresden.de/	1	0	partly	no	
32.	University of Bordeaux	France	201-300	80.	401-500	6 530 000	4 260 000	54812	59/41	22,4	13%	https://www.u-bordeaux.fr/	0	0				no	no	
33.	University of Freiburg	Germany	na	82.	83	9 650 000	2 600 000	14878	54/46	32,5	21%	https://uni-freiburg.de/en/	0	1				no	no	
34.	RWTH Aachen University	Germany	na	89.	107	1 150 000	658 000	45256	32/68	58,4	23%	https://www.rwth-aachen.de/	7	0	https://www.rwth-aachen.de/innovation/	6	0	yes	no	only in Ge
35.	Grenoble Alpes University	France	na	91.	351-400	4 730 000	283 000	40486	53/47	17,1	14%	https://www.univ-grenoble.fr/en/	4	0	https://www.univ-grenoble.fr/en/innovation/	24	1	yes	no	
36.	Utrecht University	Netherlands	na	93.	75	12 400 000	7 320 000	32022	58/42	14	10%	https://www.uu.nl/en/	0	3	https://www.uu.nl/en/innovation/	2	22	no	yes	
37.	Technical University of Berlin	Germany	na	94.	140	45 600 000	21 600 000	22695	34/66	60,8	26%	https://www.tu-berlin/en/	0	0				no	no	
38.	University of Aix-Marseille	France	201 - 300	96.	351-400	837 000	604 000	68841	59/41	16,7	13%	https://www.univ-amu.fr/	0	0	https://www.univ-amu.fr/innovation/	20	2	partly	yes	
39.	Ghent University	Belgium	na	98.	103	10 500 000	4 120 000	37587	56/44	36,1	11%	https://www.ugent.be/en/	1	1	https://www.ugent.be/en/innovation/	1	0	partly	partly	
40.	University of Oxford	UK	na	32.	1	173 000 000	85 300 000	20774	46/54	11,1	41%	https://www.ox.ac.uk/	2	0	https://innovation.ox.ac.uk/	10	22	yes	yes	
41.	Stanford University	US	na	1.	2	77 300 000	22 900 000	16223	44/56	7,4	23%	https://www.stanford.edu/	3	0	"About StanfordA pla	4	16	yes	yes	
42.	Imperial College London	UK	na	10.	11	32 600 000	25 400 000	17176	39/61	11,6	58%	https://www.imperial.ac.uk/	2	0	https://www.imperial.ac.uk/innovation/	4	1	partly	no	
43.	University of Manchester	UK	1.	49.	51	28 400 000	16 800 000	36557	53/47	14,4	41%	https://www.manchester.ac.uk/	4	0	https://www.manchester.ac.uk/innovation/	8	4	no	partly	impact
44.	Arizona State University (Temple)	US	9.	na	184	25 100 000	16 900 000	45827	43/57	19,7	20%	https://www.asu.edu/	3	0	https://www.asu.edu/innovation/	6	1	partly	no	

benchmarks (UK and US bests)
 innovation best Europeans
 SDG best Europeans
 excluded because of lack of data

Source: own collection based on different databases and searches

Table 5. The results of the correlation analysis 2.

		Correlations							
		SDG ranking	Innovation ranking	World ranking	NUmber of FTE students	Students/staff	Percentage of international students	Google search "innovat"	Google search "sustain"
SDG ranking	Pearson Correlation	1	-,231	,363*	,063	-,098	-,122	-,187	-,132
	Sig. (2-tailed)		,141	,018	,690	,538	,440	,235	,405
	N	42	42	42	42	42	42	42	42
Innovation ranking	Pearson Correlation	-,231	1	-,234	,372*	,199	-,175	-,046	-,078
	Sig. (2-tailed)	,141		,135	,015	,206	,269	,773	,624
	N	42	42	42	42	42	42	42	42
World ranking	Pearson Correlation	,363*	-,234	1	-,106	-,140	-,336*	-,339*	-,318*
	Sig. (2-tailed)	,018	,135		,504	,376	,030	,028	,040
	N	42	42	42	42	42	42	42	42
NUmber of FTE students	Pearson Correlation	,063	,372*	-,106	1	,249	-,379*	-,125	-,137
	Sig. (2-tailed)	,690	,015	,504		,112	,013	,429	,388
	N	42	42	42	42	42	42	42	42
Students/staff	Pearson Correlation	-,098	,199	-,140	,249	1	-,255	-,124	-,116
	Sig. (2-tailed)	,538	,206	,376	,112		,104	,436	,465
	N	42	42	42	42	42	42	42	42
Percentage of international students	Pearson Correlation	-,122	-,175	-,336*	-,379*	-,255	1	,353*	,418**
	Sig. (2-tailed)	,440	,269	,030	,013	,104		,022	,006
	N	42	42	42	42	42	42	42	42
Google search "innovat"	Pearson Correlation	-,187	-,046	-,339*	-,125	-,124	,353*	1	,961**
	Sig. (2-tailed)	,235	,773	,028	,429	,436	,022		,000
	N	42	42	42	42	42	42	42	42
Google search "sustain"	Pearson Correlation	-,132	-,078	-,318*	-,137	-,116	,418**	,961**	1
	Sig. (2-tailed)	,405	,624	,040	,388	,465	,006	,000	
	N	42	42	42	42	42	42	42	42

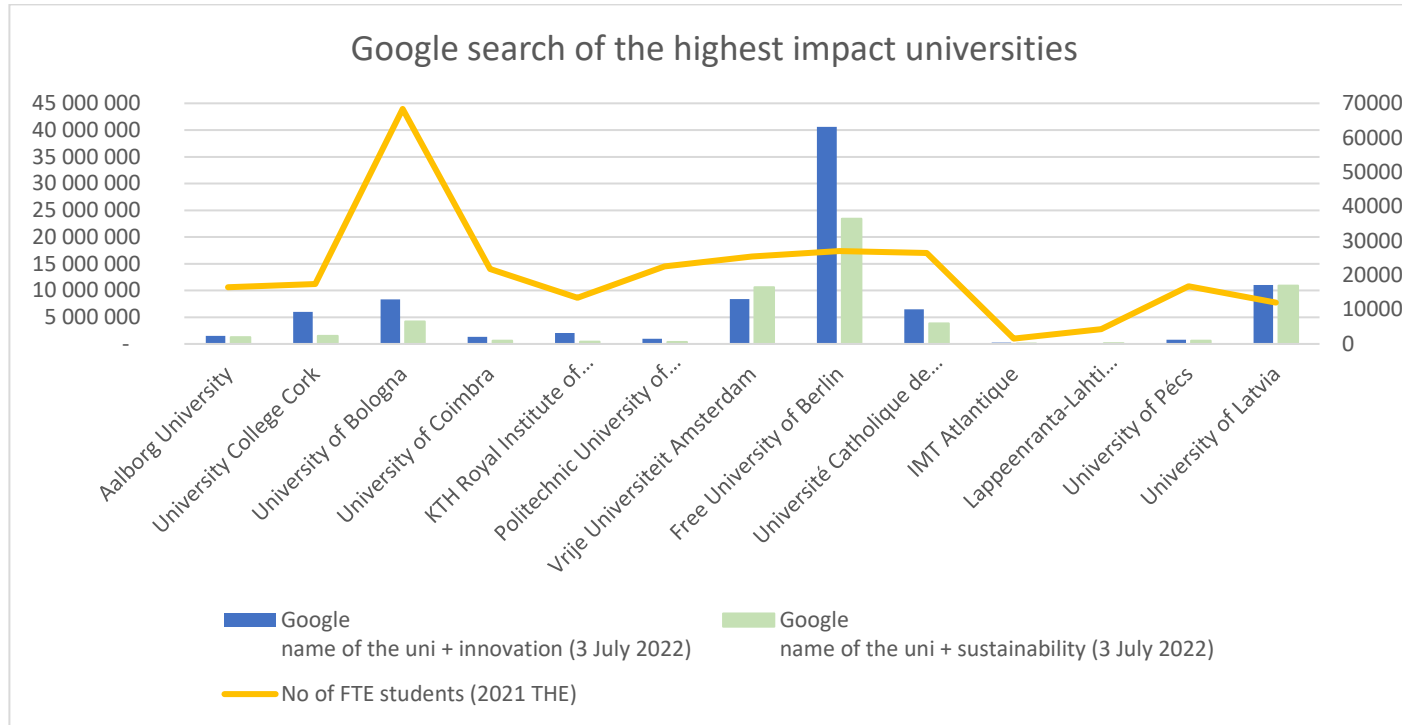
*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

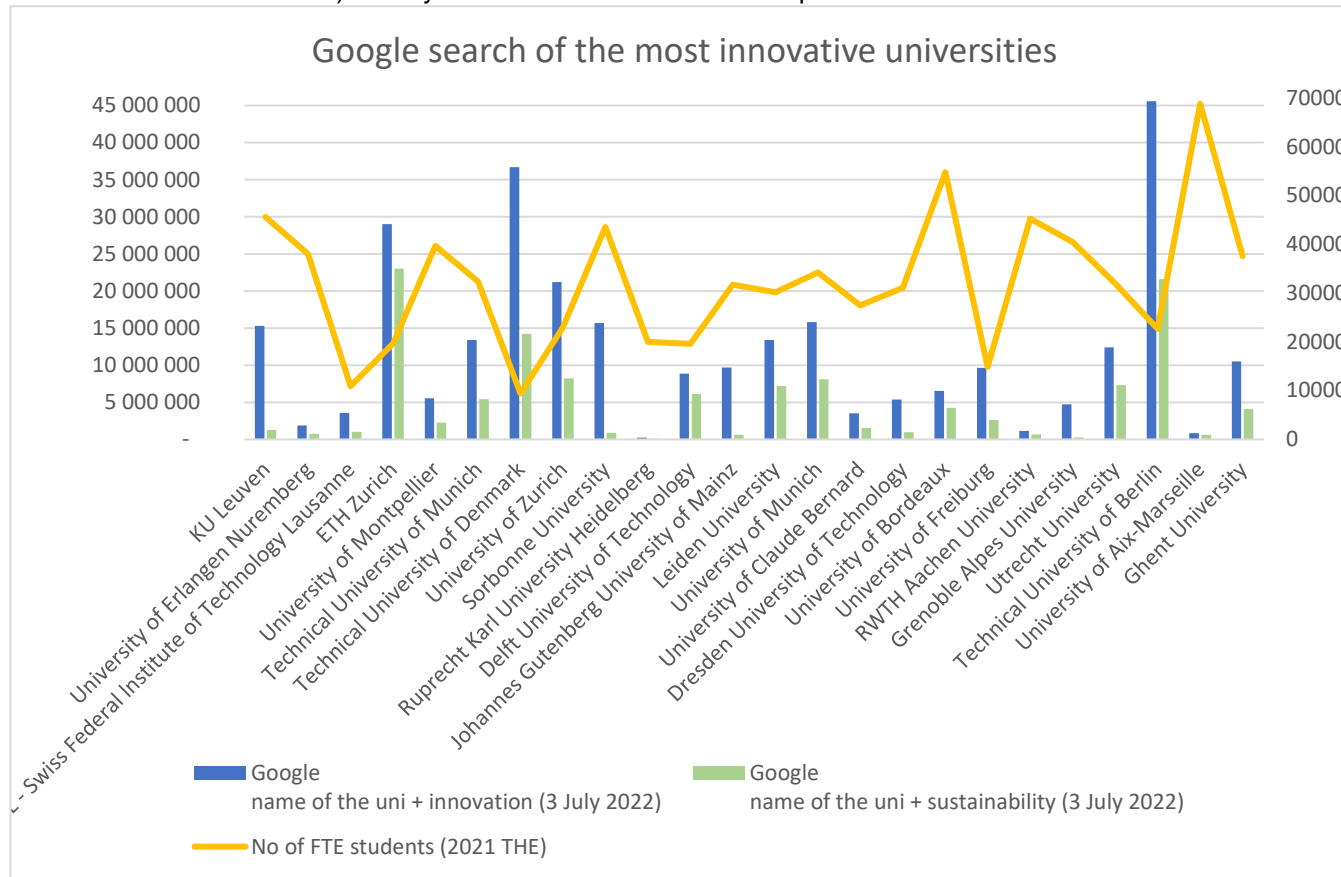
Source: SPSS 22

Figure 5. (a, b, c): Google search of the universities and the size of the universities (Number of FTE students)

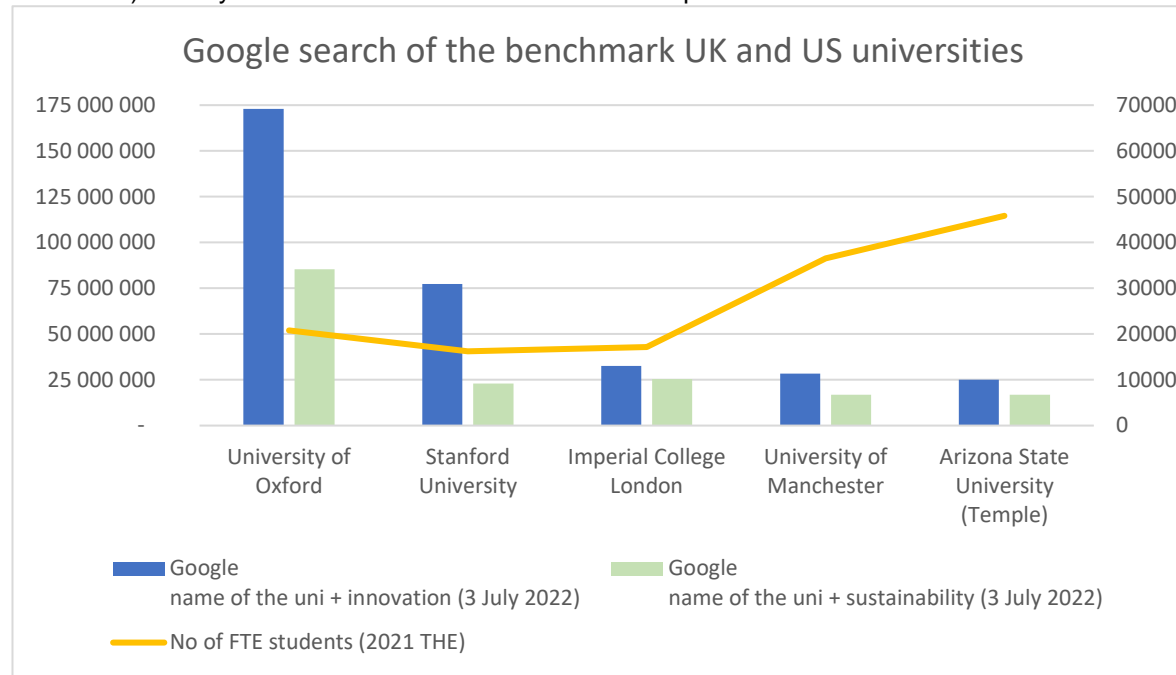
a) Analysis of the European universities highest ranked in impact/SDG



b) Analysis of the most innovative European universities



c) Analysis of the most innovative and most impactful UK and US universities



Source: own work based on the THE data

Our sample is in line with the assumptions of the correlation analysis as the observations are independent and the two variables most probably follow a bivariate normal distribution at the universities (which is the population in this research). **Hiba! A hivatkozási forrás nem található.** shows clearly that the correlation between the different indicators differs.

The research was done by SPSS22 and the used indicators besides the impact on SDG and innovation were the parts of the innovation index - the patents filed in the 5 years between 2012-17, the success rate of the filed patents, and the commercial impact score - and the table also includes the world ranking of the universities by the times higher education list.

We can find weak and stronger linear descending and ascending values, even between indicators that should correlate (like the sub-indicators of the innovation ranking and the innovation ranking itself). For example, the correlation between the SDG and the innovation index is .807, but the number of filed patents and the SDG ranking's correlation is -.246. It is strange as the number of filed patents is part of the innovation index. As the correlations are sometimes positive, other times negative and the strength of the correlation differs, too, no real correlation can be identified. The SPSS did not flag any significant correlations at the .05 level.

Definitely, the low number of the variables has a great role in that, but the differences of the universities working in different parts of the world would also distort the results if we would have tried to use the available data of all the universities.

To come over the problem of the low number of data, then in a new analysis all innovative and good impact universities together with the UK and US universities which are the highest-ranked in these were done. It meant 44 universities altogether, but for two - University of Paris Sud and University of Paris Descartes - data were not available, so 42 universities were ranked. As kind of a simple content analysis, a Google search was implemented ("name of the university" + "innovate*" and then "name of the university" + "sustain*"), the data about the number of FTE students, female:male proportions of the students, number of students / staff and the percentage of international students were included. Moreover the terms "innovate*" and "sustain*" were looked through the main landing pages of the universities and it was also analysed if they have a separate page for innovation and/or sustainability. If they had any – three categories were formed yes/no/partly (where the latter meant that most if the times innovation was connected with research, while sustainability sometimes was translated as impact) – the frequency of the above-mentioned terms was analysed there, too.

In Table it is visible that the only strongly significant correlation (0.961) is between the Google searches for the name of the universities and the terms "innovate*" or "sustain*". A much weaker correlation is justified between the terms and the percentage of the international students (0.418 for sustainability and 0.353 for innovation), with the world ranking the correlation is negative (-0.339 for innovation and -0.318 for sustainability), while world ranking and SDG ranking has a weak positive correlation (0.363). The correlation of the number of FTE students and the innovation ranking is also positive, but weak (0.372).

The regression analysis (4. Figure) was implemented in SPSS 22 to predict the value of sustainability based on the value of innovativeness.

It is visible that 4 of the 5 universities are on the same vertical line, which is caused by the fact that the impact analysis is grouping the universities into groups of 100, so only the first 100 has a real rank. This method of ranking also has an effect on our results.

Based on the Google searches (name of the university + „innovat*” and „sustain*”) it is evident, that there is no correlation among the innovativeness, impact and size (number of FTE students) of the universities. At

Figure 5. (a, b, c): Google search of the universities and the size of the universities (Number of FTE students), it is visible that at figure a) the universities are in the sequence of their impact on SDG and the Free University of Berlin, which is kind of in the middle of this list has the highest numbers in Google searches. Its size is above the modus (21,052.62) of the most impactful universities, but below the average size of all the analysed universities (28,178.69).

The situation is a bit more complex at the most innovative universities, where a German (Technical University of Berlin), a Danish (Technical University of Denmark) and a Swiss (ETH Zurich) are leading the list of the Google searches, which would make one to believe that technical universities have a comparative advantage.

Anyway it is also visible on table c) that the benchmark UK and US universities has much more hits. For innovation it is ten-times of the most impactful universities' average (6,750,908) and 5,56-times of the average of the most innovative universities (12,104.750). Of course, the high number of the University of Oxford (173,000,000) has a role in that, but even the lowest number is twice of the average of the most innovative universities.

At sustainability the averages of the most impactful universities (4,452,908) and the most innovative universities (5,128,708) are closer to each other, although the most innovative universities seems to have more hits for sustainability. The benchmark universities average (33,460,000) is still 6+-times of any of the mentioned values. It was also interesting that these results are not based on the websites of the benchmark universities as they had very few hits on their main webpages for innovation, none for sustainability and they do not have dedicated websites for these topics (at some cases research was the closest topic), while some universities has more dedicated landing pages for these, but their numbers are much lower.

It is also interesting that from the members of the European Consortium of Innovative Universities (ECIU) only one (Aalborg University) was part of this list, with the highest rank in SDG in Europe (6th place worldwide).

Conclusion

The research could not justify the correlation of innovativeness and sustainability in the small sample of the European universities that are both on the list of the world's most innovative universities and are among the first 300 on the impact on SDGs (total). The merged list contained 5 universities and we had special attention on the Delft University of Technology, because of its first place in SDG9 (even if it is not on the overall list as provides data on only 2 SDGs, instead of at least 4 containing SDG17).

As the literature suggests that there is a relation between the two, the result was surprising, and the mapping of the possible reasons started.

As even a simple google search (name of the university + SDG) gives different results at some interesting universities, we can be sure, that the publicly available lists do not fully represent the reality. The efficiency of the self-reporting is also discussed by a new, but very important research (De la Poza et al., 2021), which stated, that universities do not provide data in all the categories, in spite of the fact that the biggest part (39%) of the sample was from European universities, which represents their commitment to sustainability (Asia 32%, North-America 16%, South America 6%, Oceania 3%).

It is caused by many factors some of which can be unequivocal, like the methodology of the lists. There Goodhart's law is a must to mention, according to which "When a measure becomes a target, it ceases to be a good measure".

For example, the world university ranking list contains only universities that publish at least 1,000 papers over a five-year period (at least 150/year), teach undergraduates, and work across a range of subjects (less than 80% of research in one single subject) (THE world university rankings 2021: Methodology.).

At the impact ranking any university that provides data on SDG 17 and at least three other SDGs is included in the overall ranking – this is why the Delft University of Technology is not part of the list, in spite of its 1st place in SDG9 and good position in SDG7 (Impact rankings 2021: Methodology.).

The final score is calculated by the score of SDG17 and the three bests of the other 16 SDGs on the four broad areas of research – for which the data is partly supplied by Elsevier, and partly by the universities. Self-reporting can also be a barrier to retrieving the real data as it seems not important to some universities to be part of the lists, while others use nice rankings as marketing (eg. the University of Manchester which refers to itself as the world's number 1 in impact rankings, which is detailed on their website and on the THE website, as a banner).

But we have to add, that indicators are not perfect. Some indicators based on comparable data are available, but even if innovation indicators are a useful supplement, there are important aspects of the third mission that are

covered by informal and indirect knowledge transfer. As a consequence, using only the direct HEI-industry comparison instruments might miss the target (Urdari et al., 2017).

As (Giesenbauer & Müller-Christ, 2020) stated, Higher-Education Institutions (HEIs) were considered “pivotal agents” of sustainability since the first presence of the term in 1987. One of the causes identified as the reason for the failed efforts to promote it to HEIs is the need for systematic transformation.

Mazon and his fellows mention that despite of the literature – which prefers the participatory approach - in the practice of the sustainability promotion models the top-down manner is the general, which does not support the commitment of the students. (Mazon, Gisele, Ribeiro, de Lima, Carlos Rogerio Montenegro, Castro, & de Andrade, José Baltazar Salgueirinho Osório, 2020).

But when we analysed a broader list of the universities, including the most innovative and the most impactful ones, and as a benchmark the UK and US universities, which are the best in innovation and sustainability were also included the only strong correlation was found at the Google searches for the “name of the university” + “innovate*” and the “name of the university” + “sustain*”. No correlation was found to factors like the size of the university (number of FTE students) or its world ranking.

Implications for universities

Rankings seem not equally important for the universities, although those have an effect on society, media, the decisions of the prospective students, and their parents. These are economic decisions - where we have to raise the attention to the danger of Goodhart’s law, again - and can contribute to regional development (Urdari et al., 2017).

That is why it can be advantageous to the universities to provide information on their contribution to the SDGs and innovativeness besides the education and research perspectives.

It would be more and more important to plan, implement and control their effects on the SDGs as they are key players in the knowledge economy. As the figure from a UN edition at the beginning of this paper showed, they can even profit from that. As for today's and for the next generations sustainability is a must, it can have an effect on their admission rates and other work, like the publications.

That is why it is important to keep up and work on papers important for humanity.

Implications for policy

Governments have a crucial role not only for the public universities. The calls and grants available can change the focus of the research, making sustainability a more important part of life in higher education. Just an example of the transformation from University 3.0 to a sustainable entrepreneurial university - if the government or the EU supports sustainable innovations at the SMEs, it can happen that more cooperation will concentrate on this area. The support of innovative sustainability and/or sustainable innovations can put even more light on the importance of this area. Mazon et al. also stated that “sustainability indicators are not only traditional performance metrics but are also important to support the development of universities” (Mazon, G., Berchin, Soares, & de Andrade Guerra, 2019).

Implications for theory

more comprehensive indicators to measure the topics and their correlations

As some researchers have already failed in founding the correlations among the lists, there are many critics relating to the methods of the lists. Anyway, it was kind of shocking during the research, how few universities from Europe are entitled to be part of the analyzed lists. It clearly shows the difference between the systems. One suggestion can be to have a solely European list, as it is clear that Europe is still the second biggest 'market' in higher education (28% after the 40% of the US).

The Higher Education Market size was valued at USD 13.7 Billion in 2020 and is projected to reach USD 64.2 Billion by 2028, and it is fuelled by the increasing number of students enrollments globally.¹

Research limitations

The research is based on publicly available lists and the data for the universities of Europe was hand-collected and checked. The first limitation is based on the method of secondary research (availability and content of the datasets) and the second is on narrowing the data to only the European universities.

The above-mentioned method has driven to the only 5 universities that were represented on both lists. The number of available data is limited for research. As we collected other data to check the correlation between innovation and sustainability by a simple Google search (name of the university + “sustain*” and name of the university + “innovate*”), which showed the strong correlation on the sample of 42 universities.

Moreover, the reliability and correlation of the indicators should also be checked.

¹ <https://www.verifiedmarketresearch.com/product/global-higher-education-market-size-and-forecast-to-2025/>

Future research possibilities

Future research can focus on other methods to find the connection between innovativeness and impact on SDGs at universities. The content analysis of the webpages of the universities can support this aim or the analysis of the EU projects of the universities, too. It was visible in the correlation analysis (Table), that there is a strong positive correlation between the Google searches of the names of the universities and the terms “innovate*” and “sustain*”, although there was no correlation between the rankings.

The reliability of the indicators is always questioned because of Goodhart’s law, methods (like self-reporting, difficulty of data gathering).

The use of other indicators to measure the innovativeness (Benneworth & Zeeman, 2016) or even the impact on sustainability is a way, too.

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