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Original Research

Relationship between GDP and Productivity of G7 and BRICS Countries in Solid Waste Management Research Literature

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Abstracts

The primary aim of this study is to analyze whether developed (G7) or developing (BRICS) countries concentrate on Solid Waste Management (SWM) research. It also intends to associate and compare the productivity with the economic development of G7 and BRICS countries, productivity with world share performance, and measure the research profile of countries, which aids in strengthening the research areas' fund distribution and articulating suitable policy strategies. To examine this statement, the plain text files are exported to the software Bibexcel and MS Excel to determine the growth productivity of G7 and BRICS countries in SWM research, and scientometrics indicators such as activity index, relative specialization index are exploited to analyze the performance of the countries Mapping and visualization software like VOS viewer were utilized to identify the impact and contribution of top organizations. To analyze GDP and GDP per capita, the World Bank report has been involved. GDP and productivity of G7 and BRICS countries were compared and found an optimistic association between them with a 76% correlation. It reveals that both G7 and BRICS follow a linear growth model, and their performance is more remarkable than the average level with 0.98 of value. BRICS countries show a growing trend in publications compared to G7 countries, and the most prolific organizations are from China, which has the highest number of publications. It also received an excellent citation value of 44312, with the highest link strength of 18683 and a minimum of 4 cluster levels. The study concludes that developing countries focus more on SWM research than developed countries. Hence, developed countries can concentrate on SWM research, which aid to upsurge scientific production in upcoming years to progress the world's socio-economic development.

Keywords: Solid Waste Recycling, Activity Index, Relative Specialization Index, G7, BRICS, Research Productivity.

Introduction

Solid Waste Management (SWM) has become a noteworthy study due to an upsurge in population, rapid societal progression, and global industrialization (Hazra & Goel, 2009). Waste can be classified based on materials such as paper, plastic, glass, metal, organic waste, household hazardous waste, construction and demolition debris, industrial or commercial

waste, used electronic equipment, used oil, and waste tires. SWM is a process of reducing and removing contrary influences of waste materials, which aid in maintaining human well-being, preserving the environment,t and enhancing economic growth. Inept management of waste materials serves as a background for disease vectors, creates worldwide climate change through methane generation, and can cause serious health issues for humans and the environment (Taweesan, Koottatep & Polprasert, 2017). According to the United Nations Environment Programme Report (2013), approximately 11.2 billion tons of solid waste were collected, and more waste streams were produced in the electrical and electronic equipment. It generates multifaceted environmental hazards, and it is a big challenge for both developed and developing countries. Recycling is the only way to protect the environment and to save sustainable resources. Moreover, recycling creates more employment opportunities. In Brazil, China, and the United States, 12 million employment opportunities were created. It also plans to access the Sustainable Development Goals (SDGs), also known as the Global Goals, which is adopted by the United Nations (UNDP, 2015) as a worldwide call to action and to conclude poverty, defend the planet from various hazards, and to ensure that by 2030 all people enjoy peace and prosperity.

According to the WHO 2020 report, the world produced 2.24 billion tonnes of solid waste, expected to increase to 3.88 billion by 2050. When comparing developed nations with developing countries, urban areas are severely affected by indefensibly managed waste, and 90% of waste is disposed of in unregulated ways or burned publicly examined solid wastes from households and communities that are not managed appropriately, which produces a serious health danger and threat that leads to the dissemination of transmittable diseases. Due to a lack of monetary resources, suitable technologies, and directive implementation, the SWM problems have become more inspiring, causing unsanitary and unhygienic conditions (Sharholy, Ahmad, Mahmood & Trivedi, 2008; Guerrero, Maas & Hogland, 2013; Moh & Abd Manaf, 2014). According to the World Economic Forum (2017), Germany has the best recycling rate of 52% -56% globally. Germany has managed its municipal waste through its policies, and producers are responsible for recycling packing materials, while consumers are responsible for disposing of packing materials. Canada and the USA also concentrate on the recycling scheme, which has three categories: compost, recycle, and landfill. BRICS countries (Brazil, Russia, India, China, and South Africa) are some of the significant countries in terms of population and size. The United States Environmental Protection Agency Guide Brazil established the Brazilian National Policy on Solid Waste in August 2010, which aims to better incorporate and involve unceremonious sector workers in the recycling process.

Even though many researchers, programs, and organizations are concentrating much on solid waste management and numerous studies (Sharholy et al., 2008; Asian Development Bank, 2013; Chaerul, Fahruroji & Fujiwara, 2014; Linzner & Salhofer, 2014; Moh & Abd Manaf, 2014; United Nations Environment Programme Report (2013) have been commenced to regulate noteworthy factors affecting SWM practices. In-depth analysis of whether the developed countries or developing countries are more concentrating on this particular research and focusing on their environment to implicit the global distribution of research, identifying potential opportunities for collaboration, and informing policies and investments in research and development and also aid the policymakers and funding agencies to generate policies, as well as help researchers and institutions to identify areas for future research is essential. However, none of the studies compare the SWM research productivity of developing and developed

countries; hence, this study involves scientometric analysis to examine the scientific production and various characteristics of academic communication in a particular field.

Literature Review

Gyedu, Heng, Ntarmah, He, and Frimppong (2021) aimed to explore the impact of advancement on economic growth among the G7 and BRICS countries and exposed that research and development, patent, and trademark as the determinants of innovation have a noteworthy collision on GDP per capita also as a determinant of economic growth among G7 and BRICS countries. Biswas, Majumder, and Dawn (2022) examined the relationship between the socio-economic development (SED) and resilience of the countries and represented that the SED of a country does not directly enhance pliability to COVID-19. Zainab, Wani, and Bhat (2018) assessed the research output in the field of Science and Technology S&T of the countries India and China and analyzed the association between Gross Domestic Product (GDP) and the proportion of same inverted in Research and Development (R&D) which reveals that GDP investment in R&D assists the development of S&T. Laverde-Rojas and Correa (2019) found that scientific productivity in fundamental sciences and engineering has initiated a critical constructive effect on the economic complexity of countries—the university-industry-government potential interacts to inspire and generate advancement and strategies for economic growth of firms. Yang, Chen, Liu, Gong, Yu and Wang (2013) resolute a prominent growth trend in publication outputs, along with more contributions from countries. The G7 countries published popular world articles, while other countries signified by BRIC countries were restoring their article share. Research dynamics on solid waste landfilling based on bibliometric analysis and interpretation about scientific production, prolific authors, institutions, journals, countries, keywords,s and progressive evolution of solid wastes (Naqvi, Ali & Atabani, 2021). Scientometric and social network analysis to measure the international scientific collaboration of All India Institute of Medical Sciences revealed that India has made more effort to enhance the excellence of research by encompassing and encouraging the cooperation between institutions and industries at the global level (Nishavathi & Jeyshankar, 2020). The impact of GDP, spending on research and development with publications in pharmacological sciences in Middle Eastern countries found that there is no association between the GDP and research outcomes and also depicts that the countries which are allotting more funds to research and development have a more significant number of universities and ISI indexed journals (Meo, Usmani, Vohra & Bukhari, 2013).

Objectives of the Study

The main aim of this study is to compare the scientific productivity of solid waste management research in developing (BRICS) countries and developed countries (G7) to determine the countries' presentation to achieve the following objectives (Zainab et al., 2018).

- To determine and compare the productivity of G7 and BRICS countries in SWM research with world share;
- To investigate the socio-economic analysis of G7 and BRICS countries in SWM;
- To analyze the performance and productivity of G7 and BRICS countries on SWM with its impact on the environment and
- To evaluate the most prolific organizations of SWM research from 2007 to 2021 and identify those top institutions belonging to G7 or BRICS countries.

Hypotheses of the Study

The following hypotheses framed testing the solid waste management research in developing countries (BRICS) and developed countries (G7), and the hypotheses are allied with the works of Zainab et al. (2018), Vinkler (2008), and Şenel (2019).

Hypothesis 1: There exists a positive correlation between GDP and SWM research publications of G7 and BRICS countries and

Hypothesis 2: A positive correlation exists between GDP per capita and SWM research publications of G7 and BRICS countries.

Materials and Methods

The scientometric analysis produces a more balanced and less biased result when used solitarily, as it is genuine without any individual's perception; this study précises and synthesizes the research piloted over the last 15 years of 2007-2021. Abundant documents have been published on the particular subject, and selecting the most perfect database is vigorous. This study downloaded data from the Web of Science by utilizing the search strings "*Solid Waste Management," "Solid Waste,"* and *"Solid Waste Recycling."* With limited publication year from 2007 to 2021 and gathered 10664 documents. Data from the database was exported in plain text format and analyzed with a suitable software tool. The science mapping and visualization were created using Vos-Viewer and Bibexcel. To determine the growth in SWM research output and to compare with world productivity MS-Excel is used to analyze GDP and GDP per capita, which aids in assessing a country's level of scientific and technological development in this particular field, the report from the World Bank has been engaged—the tool SPSS was used to analyse the correlation between GDP, GDP per capita and research productivity. The scientometric indicators, such as activity index and relative specialization indexes, are mainly used to gauge the research performance of the countries' productivity, and the impact of this research literature can be identified.

Results

Data analysis is a significant step in quantitative research (Leech & Onwuegbuzie, 2007), which involves and supports researchers in making sense of their retrieved data. Table 1 represents the longitudinal world share of publications of G7 and BRICS countries.

G7 Countries: The productivity of all the block periods of 2007 -2021 is augmenting SWM research. Even though a constant increase was found in G7 country's productivity, it fluctuated compared to world productivity share. The USA and Canada show a spontaneous fall in world share productivity, and other countries in the G7 depict a fluctuating trend. In G7 countries, the UK and Germany picked up their growth in the last block period. Germany also fortified the best recycling rate in the world in 2021, with more than 56% managing municipal waste (Source: World Economic Forum).

BRICS Countries: BRICS countries follow an up-surging trend in productivity, and while comparing it with world productivity, it also shows an increasing trend throughout the block periods of 2007-2021. Compared with world productivity, BRIC countries are also making much effort to publish more publications on SWM research. The country China secured the highest publication with 1859 documents, and the least production of BRICS countries was produced by Russia with only 51 documents. Whereas associating productivity with world share except China, all the other BRICS countries track an unstable trend in growth.

Table 1 reveals that in the earlier blocks, production of G7 countries is high when compared with BRICS countries, but 2016-2021 BRICS countries show an ever-increasing trend. Hence, it reveals that BRICS countries (China, India, and Brazil) are concentrating on solid waste management research to keep their environment from the contaminated effects of inorganic and recyclable elements and are concerned about the well-being of society.

Table 1
Longitudinal world share of publications of G7 and BRICS countries

Countries		Productivity						Growth Curve	World Share %						World Share Growth curve
		2007-2009	2010-2012	2013-2015	2016-2018	2019-2021	2007-2021	2007-2021	2007-2009	2010-2012	2013-2015	2016-2018	2019-2021	2007-2021	2007-2021
G7 Countries	USA	133	158	203	267	452	1213		14.33	12.55	11.99	10.68	10.55	11.37	
	Italy	68	67	148	179	295	757		7.33	5.32	8.74	7.16	6.89	7.10	
	United Kingdom	49	73	87	141	267	617		5.28	5.80	5.14	5.64	6.23	5.79	
	Canada	105	101	100	115	192	613		11.31	8.02	5.91	4.60	4.48	5.75	
	Germany	25	31	36	82	149	323		2.69	2.46	2.13	3.28	3.48	3.03	
	Japan	27	55	52	74	112	320		2.91	4.37	3.07	2.96	2.61	3.00	
	France	25	36	41	62	99	263		2.69	2.86	2.42	2.48	2.31	2.47	
BRICS	China	132	175	238	444	870	1859		14.22	13.90	14.06	17.75	20.31	17.43	
	India	54	91	102	220	428	895		5.82	7.23	6.02	8.80	9.99	8.39	
	Brazil	24	57	83	179	288	631		2.59	4.53	4.90	7.16	6.72	5.92	
	South Africa	5	16	13	33	90	157		0.54	1.27	0.77	1.32	2.10	1.47	
	Russia	3	3	4	15	26	51		0.32	0.24	0.24	0.60	0.61	0.48	

The goodness of fit is verified through regression analysis with year of production as the independent variable and output as a dependent variable, depicted in Figure 1. The growth of SWM in G7 countries with the linear R^2 value of 0.3353 and exponential curve provides the R^2 value of 0.2719, which indicates that linear is 33% and exponential is 27% of the variance in the growth. The coefficient of determination (R^2) of linear growth is more incredible than exponential growth; hence, the growth model followed by G7 countries is linear.

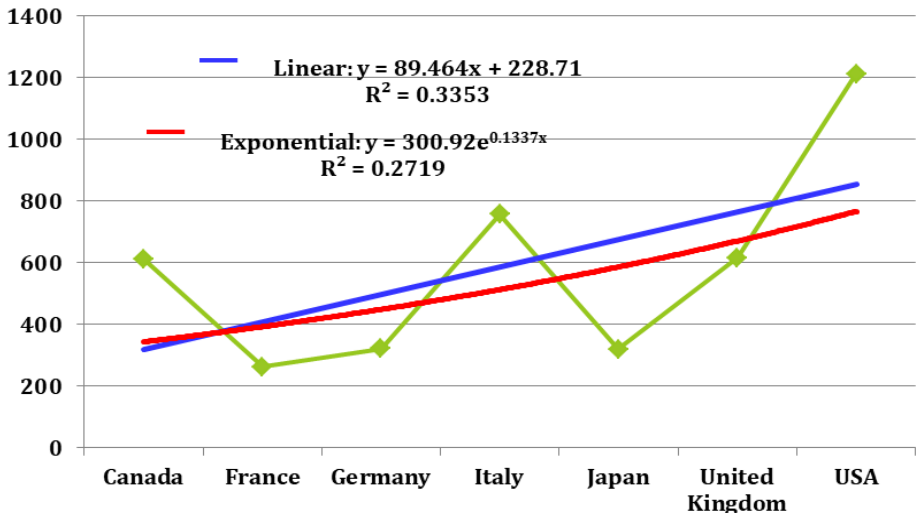

Figure 1: Research growth trends in solid waste management in G7 countries

Figure 2 portrays the development of SWM in BRICS countries with a linear R2 value of 0.0352 and an exponential curve delivering an R^2 value of 0.008, which designates that linear growth accounts for 3% and exponential growth for 0.8% of the variance in the

evolution. The coefficient of determination (R^2) of linear growth is better than exponential growth; hence, the growth model tailed by BRICS countries is linear.

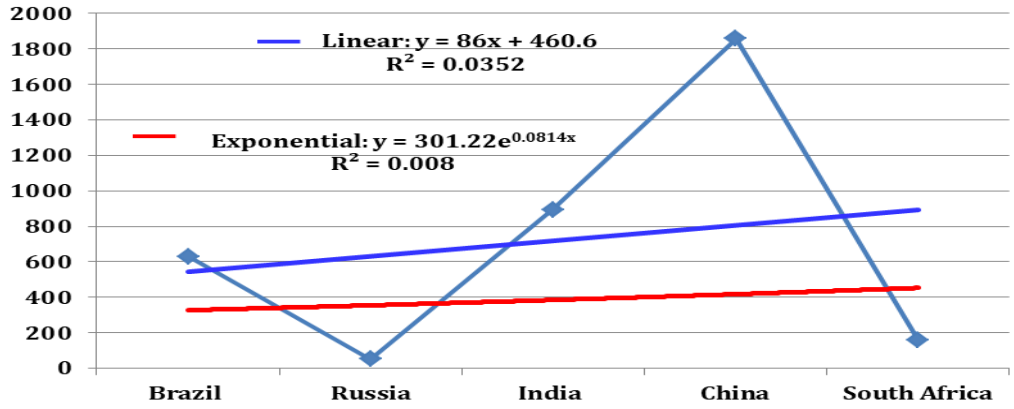

Figure 2: Research growth trends in solid waste management in BRICS countries

The research growth trends of SWM through regression line, which is most commonly used to best fit the data on the scatter plot. It is inferred that the research output of both G7 (R^2= 0.3353) and BRICS (R^2= 0.0352) countries follows a linear growth pattern rather than an exponential growth pattern as the R squared value of linear is higher than exponential. In those G7 countries, the linear value is higher than that of the BRICS countries. Hence, G7 countries' progression in SWM research increased by a constant difference.

Figure 3 illustrates the SWM research output of G7 and BRICS countries in block periods. The productivity of G7 countries was high in four block periods (2007-2009) to (2016-2018). In the last block period, 2019-2021, productivity was diminished, which specifies that not as much attention was taken on SWM research.

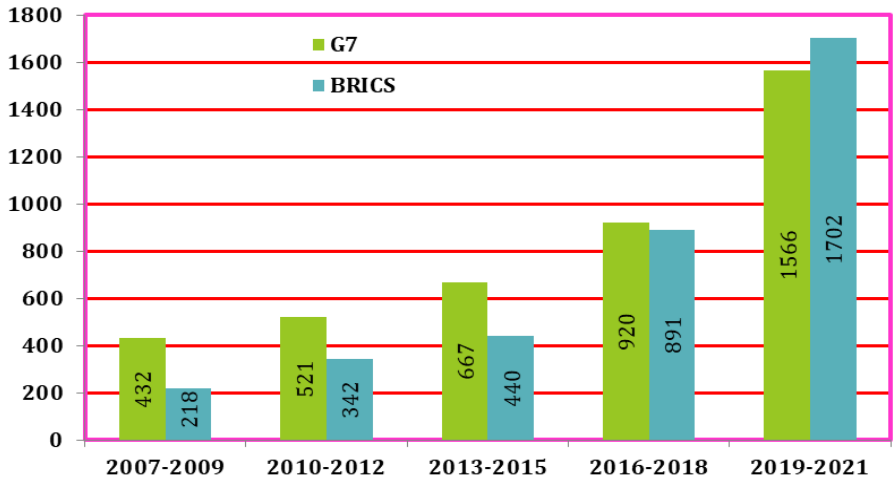

Figure 3: Productivity of G7 and BRICS countries in block period

The research output of BRICS countries is stumpy in the commencement block periods. Still, it attained its peak in the latter block of 2019-2021 with 1702 documents, which shows that developing countries are making much effort to protect countries from the effects of pollution which is caused by solid waste.

The G7 countries are focused on managing solid waste in the initial period, and BRICS are attentive in the latter period. Research output indicates that developing countries are more aware of pollution than developed countries. Hence, developed countries may focus more on this particular field to enhance the research. If the collaboration persists among G7 and BRICS countries, it will avert the world from contamination of the environment.

Figure 4 defines the GDP versus total productivity of the G7 countries in SWM. The linear regression line of G7 countries was identified through the SPSS statistical analysis tool, which found the regression value of R^2=0.58, which shows the best-fitting line. The countries disseminated around the trend line demonstrate that the G7 countries were equally proportionate to their economic size. Italy is the only country where productivity is directly proportional to economic size.

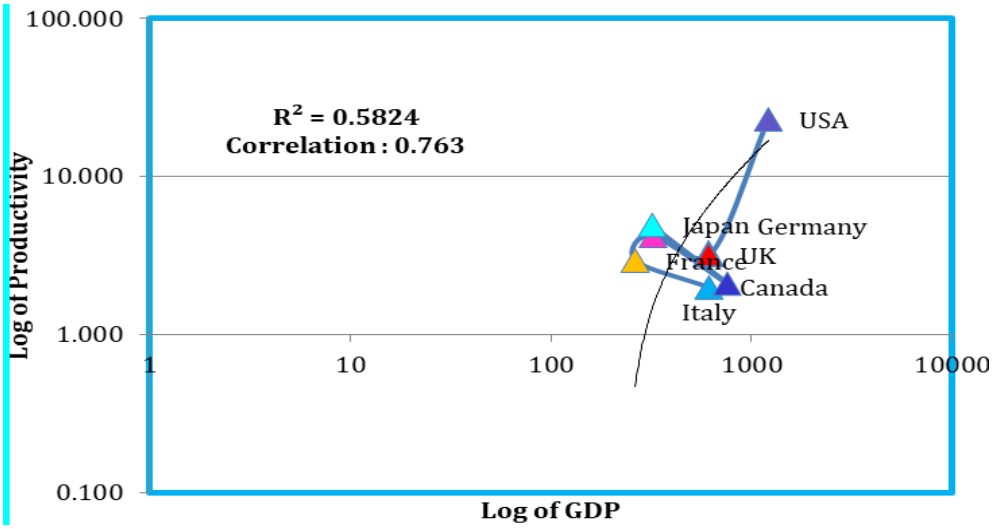

Figure 4: Correlation between GDP and productivity of G7 countries

The correlation 0.763 specifies the optimistic association between GDP and research publications. It also measures the strength and direction of the relationship between variables and depicts a strong and positive relation between GDP and productivity.

The correlation between GDP and total productivity of BRICS countries is characterized in Figure 5. The regression line shows the association between GDP and research output with a regression value of R^2 =0.84, indicating that there is a strong positive linear relationship between the two variables, meaning that as one variable increases, the other variable tends to increase as well and correlation 0.767 values of BRICS specifies a more optimistic association between GDP and research publications. Whereas in BRICS, the country Brazil alone is directly proportionate to the country's economic size, other countries are closely related. The countries Russia and China are far from the regression line.

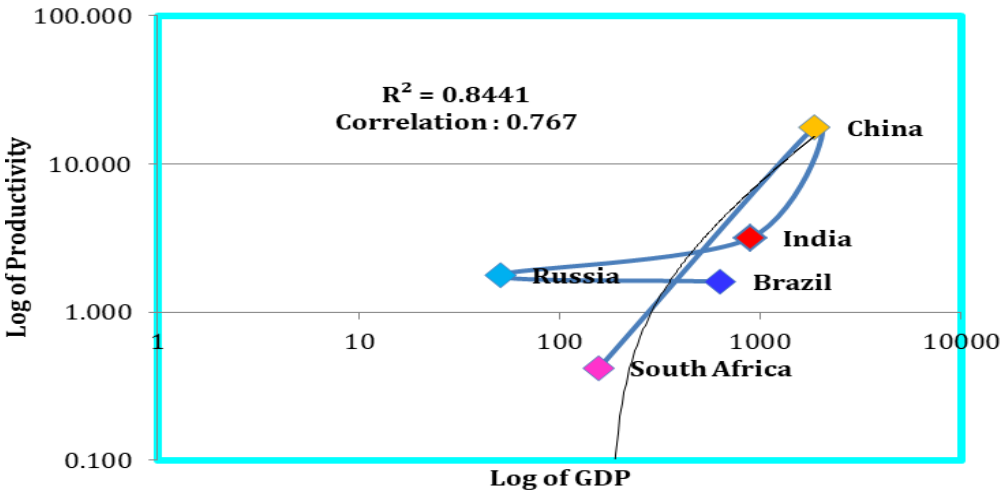

Figure 5: Correlation between GDP and productivity of BRICS countries

Hypothesis 1: A positive correlation between GDP and research production is proved with a correlation value of 0.763 for G7 countries and 0.767 for BRICS countries. This implies that 76% of the link persists between GDP and research productivity for both G7 and BRICS countries.

Table 2 divulges the productivity, GDP, and GDP Per Capita of G7 and BRICS countries; their concern towards economic resources, provision of technological evolution, and financial distributions to the research field of SWM differs greatly. All the G7 countries are high-income countries. The USA is high in GDP (23.000) and GDP per capita (69287.500). While analyzing GDP with publication, it secures 7th position with 52.739 US$, which displays a reduced amount of intensity in this research. Italy, with a GDP (of 2.100) and GDP per capita (of 35551.300), secures the first position with 360.476 US$, expressing that in G7 countries, Italy emphasizes more in SWM research than other countries.

Table 2
Socio-Economic Analysis of G7 and BRICS Countries in the field of Solid Waste Management

Countries		TP	GDP in Trillion US $	Publications / GDP in Trillion US $	GDP Per Capita in USD	Publications / GDP Per Capita in USD	Type of Country
G7 Countries	USA	1213	23.000	52.739(7)	69287.500	0.018(2)	HI
	Italy	757	2.100	360.476(1)	35551.300	0.021(1)	HI
	UK	617	3.190	193.417(3)	47334.400	0.013(3)	HI
	Canada	613	1.990	308.040(2)	52051.400	0.012(4)	HI
	Germany	323	4.220	76.540(5)	50801.800	0.006(6)	HI
	Japan	320	4.940	64.777(6)	39285.200	0.008(5)	HI
	France	263	2.940	89.456(4)	43518.500	0.006(6)	HI
BRICS	China	1859	17.730	104.851(4)	12556.300	0.148(2)	UMI
	India	895	3.170	282.334(3)	2277.400	0.393(1)	LMI
	Brazil	631	1.610	391.925(1)	7518.800	0.084(3)	UMI

	South Africa	157	0.419	374.702(2)	6994.200	0.022(4)	UMI
	Russia	51	1.780	28.652(5)	12172.800	0.004(5)	HI

HI – High-Income Country; UMI – Upper Middle-Income Country; LMI – Lower Middle-Income Country.
Source: https://databank.worldbank.org/indicator/NY.GDP.PCAP.CD/1ff4a498/Popular-Indicators and https://databank.worldbank.org/indicator/NY.GDP.MKTP.CD/1ff4a498/Popular-Indicators

In BRICS countries, China, Brazil, and South Africa are upper-middle-income countries; Russia is the only developed country, and India is the only lower-income country. China has 17.730 GDP and 12556.300 GDP per capita, but while comparing GDP with publication (104.851), it secures 4th position, which persists in a slowdown process. The low ratio of countries' publications / GDP and GDP per Capita might indicate inattention to this specific research area. Brazil has a 1.610 GDP and 7518.80 GDP per capita, in first place with 391.925 US$. It states that in BRICS countries, Brazil alone gives prominence in SWM research than other countries.

Hypothesis 2: The positive correlation between GDP per capita and research production of G7 countries is proved with a correlation value of 0.845 (Meo et al. 2013). However, it has not been proven for BRICS countries, which secured a correlation value of 0.473, which epitomizes no association between GDP per capita and the publication of SWM.

The entire benefit of the Activity Index (AI) is that it deliberates both the scope of the subject field and the size of the country. The Relative Specialization Index (RSI) infers average performance in this particular field. Table 3 signifies the Activity Index and RSI of G7 and BRICS countries.

Table 3
AI and RSI of G7 and BRICS Countries

Countries		Activity Index						RSI
		2007-2009	2010-2012	2013-2015	2016-2018	2019-2021	Mean	
G7 Countries	USA	126.00	110.33	105.41	93.85	92.78	86.904	0.98
	Italy	103.23	74.97	123.15	100.82	97.03	79.674	0.98
	UK	91.26	10.21	88.82	97.44	107.75	77.608	0.97
	Canada	196.83	139.56	102.75	79.99	77.99	103.43	0.98
	Germany	88.94	81.29	70.20	108.25	114.86	71.059	0.97
	Japan	96.96	145.58	102.36	98.60	87.14	86.408	0.98
	France	109.23	115.94	98.20	100.52	93.72	83.419	0.98
BRICS	China	81.60	79.74	80.64	101.84	116.52	71.699	0.97
	India	69.33	86.12	71.79	104.81	119.07	69.262	0.97
	Brazil	43.71	76.51	82.85	120.96	113.64	63.343	0.97
	South Africa	36.60	86.32	52.16	89.62	142.73	63.561	0.97
	Russia	67.60	49.82	49.40	125.41	126.93	58.751	0.97

The performance of the USA, Canada, and France is greater than the world's average in the specified field in the first three block periods and less than in later block periods in G7 countries. In G7 and at the world level, the USA is the largest solid waste producer; hence, they concentrate too much in this field, and in later periods, it was reduced, so the effort is also less. RSI of 0.98 designates that the production of SWM is relatively more active than other research.

It also shows a fluctuating trend in commencement periods, but at the latest block period, it shows an up-surging trend in BRICS countries. All other countries except Brazil depict an increasing trend in the 2019-2021 block. China is also the major producer of solid waste; therefore, they emphasize this specific research production. At the same time, evaluating the relative specialization indexes, the values 0.97 and 0.98, which are nearer to 1, specify that countries' performances are more significant than the average.

In both G7 and BRICS countries, the largest producer of solid waste contributes more research publications, and their active performance in this specific field is also excellent. Table 4 signifies the Impact of G7 and BRICS countries and their cluster level with the total link strength of SWM research output.

Table 4
Impact of G7 and BRICS countries and their Cluster Level of SWM Research

Countries		Documents	Total Citation	Normalized Citation	Cluster	Total link strength
G7 Countries	USA	1213	39605	1423.96	4	10940
	Italy	757	20690	819.28	6	9945
	UK	617	20657	828.86	10	8265
	Canada	613	16867	593.10	4	6946
	Germany	323	8347	348.22	6	3258
	Japan	320	7268	286.69	1	3926
	France	263	7816	300.75	1	2532
BRICS	China	1859	44312	2076.54	4	18683
	India	895	23112	1076.50	4	8093
	Brazil	631	8753	430.82	5	4730
	South Africa	157	2193	143.12	1	1277
	Russia	51	574	39.35	3	366

G7 Countries with many documents received more citations and have muscular link strength with minimum cluster level. The USA has more publications (1213) with total citations (39605) and is clustered with only four countries, and their total link strength is also great, with 10940 designating strong association among collaboration. The UK produced only 617 documents that received more citations (39605) and clustered with more countries (10), demonstrating that collaborative research has more effect than unaccompanied research.

In BRICS countries, China also produced more documents (1798) with more citations (44312) and clustered with only four countries with the highest link strength (18683). China, as

a developing country associated with developed countries like the USA, to enhance their research, and the collaboration among the BRICS countries was progressively active, and a closer, more widespread, and solid partnership in scientific collaboration was recognized (Figure 6).

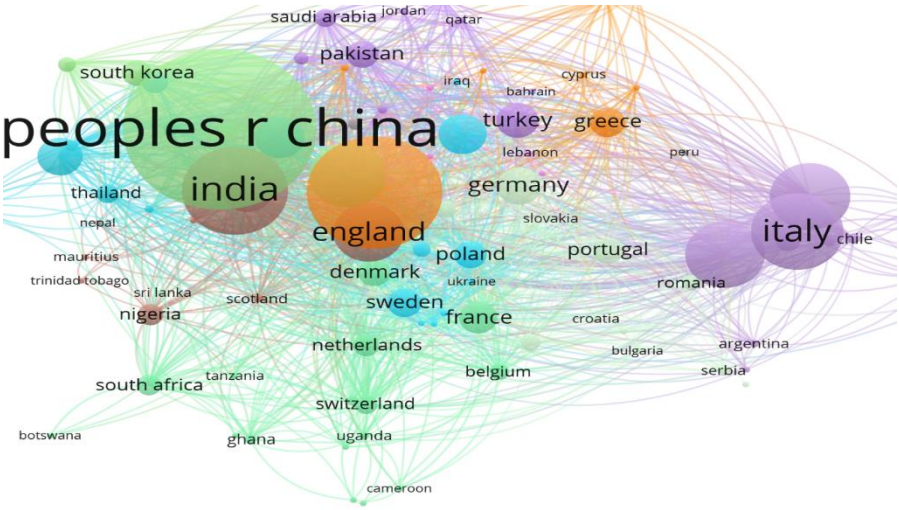

Figure 6: Impact of G7 and BRICS countries and their cluster level of SWM research

Table 5 and Figure 7 represent the most prolific organization of SMW research for 2007-2021 to determine which countries' organizations focus much on SWM research, whether developing or developed countries. China has the highest productivity in the research field. Organizations like the University of Regina and the University of Central Florida, which belong to G7 countries, are more collaborative and concentrated in SWM research because they are furnished with well-equipped laboratories and allot more funds in research and development. Developing countries like China mostly collaborated with 4-10 clusters with developed countries like the USA to progress their work quality. Of the top 20 organizations, eight organizations were contributed by China, representing that in BRICS countries, China alone tends to collaborate and contribute more to prolific organizations.

Table 5
Top 20 Most prolific organizations in SWM research

S.No	Organization	Country	Output	Citation	Normalized Citation	Clusters	Total Link Strength
1	University of Regina	Canada	203	5052	139.97	10	4117
2	Chinese Academic Science	China	187	5402	215.64	4	2609
3	Tsinghua University	China	123	4214	166.21	4	2530
4	Technical University of Denmark	Denmark	117	5897	181.25	2	4071
5	University of Tehran	Iran	107	2384	112.03	9	2061
6	Tongji University	China	92	3038	128.65	4	1617
7	Beijing Normal University	China	91	2806	88.25	10	2057
8	North China Electric Power University	China	89	3063	70.29	10	2581

S.No	Organization	Country	Output	Citation	Normalized Citation	Clusters	Total Link Strength
9	Zhejiang University	China	86	2123	105.17	4	1637
10	Indian Institute of Technologies	India	83	3078	116.03	1	1415
11	Peking University	China	80	1860	54.65	10	1424
13	Shanghai Jiao Tong University	China	69	1467	83.75	4	1714
14	University Kebangsaan Malaysia	Malaysia	58	1632	81.96	6	1212
15	University Autonoma De Barcelona	Spain	58	2060	69.45	2	1138
16	University of Technology Malaysia	Malaysia	46	1864	89.67	6	1089
17	Nanyang Technology University	Singapore	43	2034	73.36	4	1217
18	University of Central Florida	USA	33	1594	45.98	9	1140
19	University of Insubria	Italy	27	806	51.53	5	1071
20	Lund University	Sweden	26	1568	48.74	2	1178

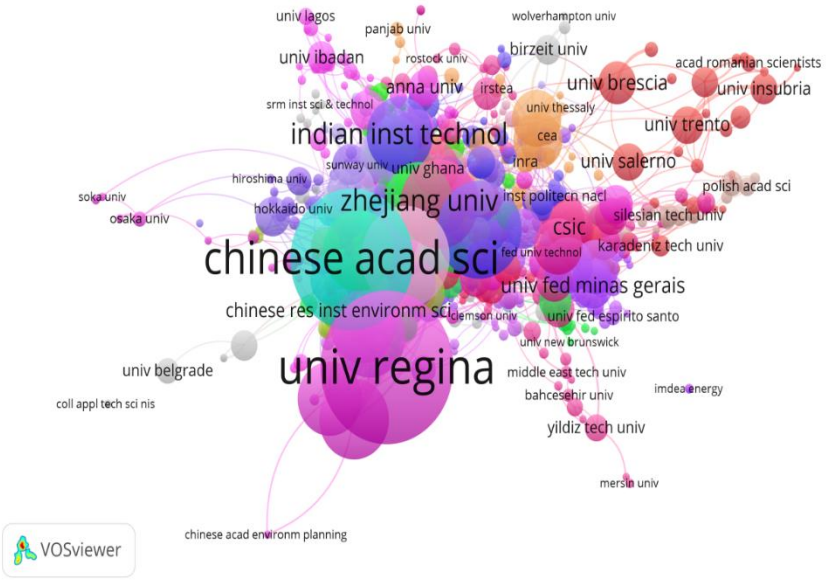

Figure 7: Top 20 Most prolific organizations in SWM research productivity

Discussion

At the national level, the inept management of solid waste grounds numerous ecological and public health problems, which are adversely replicated in the economic growth of a country (Abu Qdais, 2007; Kaza, Yao, Bhada-Tata & Van Woerden, 2018). This study envisioned to examine the socio-economic analysis of G7 and BRICS countries with their publications in the field of solid waste management which illustrates that GDP and productivity of the G7 and BRICS countries correlated positively with 76% designates that the publications of the country

strongly associated with their financial and monetary resources (Barboza & Ghisi, 2018) has been contrary with (Meo et al, 2013) the productivity and GDP of pharmacological science in Middle East countries and found that there is no association between the GDP and research outcomes. It also inferred that the BRICS countries and G7 countries correlate with GDP and publications. However, the country with the lowest GDP, Italy, has the highest average of 360.476. Despite Italy's low GDP, SWM research publications show it is more concentrated in this field. With the highest GDP and securing first position in producing solid waste, the USA spends vast funds on research and development, but not in this field. China in BRICS countries has a high proportion of publications. Still, comparing with GDP indicates that they are not very concerned about SWM research and need some scientific evolution and economic distributions to the SWM research field.

The study explores that no association between GDP per capita and productivity is implied in the survey (Meo et al., 2013) on the impact of GDP spending on research and development in pharmacological sciences in the Middle East. It is noteworthy that HI countries shared a minimum output of SWM contrary to the publication of ischemic heart disease (IHD) in HI countries. However, UMI and LMI countries are concentrated (Okhovati, Zare & Bazrafshan, 2015). It also found that countries with many documents received more citations and had muscular link strength with minimum cluster level. The growth model of G7 and BRICS countries follows a linear growth pattern rather than exponential growth pattern with an R^2 value of (G7:0.3353) and (BRICS: 0.0352) conflicts with the study of (Nishavathi & Jeyshankar, 2018), which establish that exponential growth model fits to the trajectory growth of research output published by the AIIMS and the same consequences agree with the study of Jozi and Nourmohammadi (2022) on world scientific research of pathology and forensic medicine and (Yang et al, 2013) on solid waste research. The comparison between G7 and BRIC countries with world share reveals that in the previous blocks, production of G7 countries was high when associating with BRICS countries, but in later block years, BRICS countries tracked the up-surging trend. Hence, it divulges that evolving countries are much more focused on solid waste management research to retain their atmosphere from the polluted effects of inorganic and biodegradable elements and are about the welfare of society. In G7 countries, Germany reinforced the top reprocessing rate at the global level in 2021, with more than 56% handling their municipal waste effectively, followed by the USA. Germany and the USA are the largest producers of solid waste; hence, they concentrate more on this research. However, while comparing this with GDP, the efforts taken by those countries are low because of the low revenue from the research. The top 20 organizations are mainly from China, especially Chinese academic Science dealing with environmental sciences, and the study accompanies more collaboration (Goodale et al., 2022).

Conclusion

Enduring efforts must be taken to promote research in SWM by G7 countries, as developed countries can allot more monetary funds to improve their research in this specific field and protect the environment from pollution problems (Borozan, Bayar & Gavriletea, 2018) and BRICS countries also can take efforts to prevent the creation of solid waste and to reprocess the waste in low budget. It will help to increase future scientific production, develop the world's social and economic aspects, and prevent society from having hazardous health issues. Research could explore new approaches and technologies for managing waste in these contexts, such as

decentralized waste management systems, informal recycling networks, and community-based waste reduction programs (de Castro, Camioto Morales, Mariano & do Nascimento Rebelatto, 2016).

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