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RESEARCH ARTICLE

World development and generation of waste

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Abstract

Nowadays, it is almost impossible to argue about global development without immediately stopping to think about waste; it is claimed that waste materials are correlated with the growth of the population as a consequence of consumption habits. The applied multivariable statistical analysis, both quantitative and qualitative of the BIG DATA of the OECD in the period of 1960–2050 of the World Bank from the decades of 1990–2020, and SCOPUS (1996–2020) using applied multivariate statistics. The results reveal that consumption habits are strongly influenced by access to public services more than by purchasing power, in addition, it was determined that the rate of subscriptions to cellular service is a catalyst for population indicators and ordinary waste middle tight (RO) of 0.96 m^3 for person daily, study shows the trace of evolution due to the most significant advance in communication technologies, important findings for the construction of solutions within the concepts of circular economy, sustainable development, social market economy, and social responsibility.

Keywords Environment · Sustainable Development · Indicators · Urban solid wastes · Technology

Introduction

Over two centuries ago after Thomas Robert Malthus (1766–1834) remarks about the planetary limits to population growth, and after more than 7 decades from the first international conference on sustainable use of resources held in 1949, its scope was detailed in the Brundtland report (1987) proposing the search for best practices for sustainable development, that is, equity between the social, economic and ecological dimensions; results show little progress, as the environmental control instruments show that the exploitation of nature prioritizes over environmental sustainability, accelerating the degradation of the planet (Mura 2015; Keong 2021).

The interaction of the socio-economic and environmental dimensions has generated a global consciousness to the degree of identifying humanity as the main responsible for global transgenerational changes, hence the recognition of the titled era of the "Anthropocene" (Carvalho et al. 2021; Costa 2021). But how are these dimensions understood?

Social development is a process of intentional transformation to improve the conditions of individual and collective well-being above the income level, or institutional and/or social range (Gutiérrez 2011; Vyas et al. 2022). From this perspective, social development would be the result of the

Highlights
- The consumerism generates great amounts of waste.
- Comparison in the study period using the complexity of multivariate statistical techniques of quantitative and qualitative data to enrich the results, so multiplex information can converge in a summary product "possible universal good."
- What global indicator can explain waste generation as a consequence of human development?

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improvement of the collective indexes of well-being such as life expectancy, infant mortality, available income, social protection against the risks of job loss, illness, or death, and access to social services contrasted with the change suffered by the gross domestic product (GDP) of each country (Mallarino 2004; Kundariya et al. 2021).

Economic development is defined as the process by which the real per capita income of a country increases, implying, the continuous expansion of generation and accumulation of wealth for society through the introduction of new products or better quality, optimization of production, market creation, conquest of a new source of raw material or semi-finished goods, and the creation or rupture of monopolies (Martin 2011; Kaur et al. 2021), in addition, high consumption (Reyes 2001; Tomic and Schneider 2017).

The ecological development can be marked as the insurgency of human and nature rights to maintain the balance of the ecosystem representing those administered against the ruling system (Serrano 2020). The discussion on ecological development is strengthened with the conceptualization of environmental deterioration and damage, a consequence of the impact of greenhouse gases, the protection of conservation areas, damage to the exercise of economic activities, to the health and integrity of people (Mayorga et al. 2021; Kahn et al. 2022).

The identified negative impacts of waste from cities, whether solid or liquid, affect the soil, groundwater, river channels, public roads, and even the ocean, therefore, the surveillance exercised by national and international entities in conjunction with citizen participation is of immediate interest, especially within theories such as the circular economy (Reis and Fernandes 2021; Kahn et al. 2022).

In the pretense of this balance, the World Bank since 1990 has generated a series of metrics that have been summarized in the family of World Development Indicators; these metrics facilitate the monitoring and follow-up of the commitments acquired by the countries. When using these indicators, it is important to bear in mind that most of them are the product of estimates, it is up to the governments to administer and report to the WB, so some indicators are incomplete (WB 2021).

Given that the preference of population growth is coexistence in large cities and industrialization have produced one of the biggest transgenerational pollution problems in the world: the generation of urban solid waste. It is important to study how customs and consumption habits compromise the development and lives of the same people who generate waste, especially vulnerable populations (Velásquez 2011; Costa et al. 2020; Dunel and Barbosa 2019).

The consumerism generates great amounts of waste, which if controlled would reduce the amount of MSW, mainly in large cities; however, the perception of the implications and impacts indicates that cities suffer regardless of size, inclusive indigenous populations, and with greater intensity the disorderly occupations of informal housing (Silva and Mello 2020; Takenaka 2020). The disposal and dumping of solid or liquid waste in canals, public roads, banks of streams, rivers, vacant lots, or highways aggravates the situation of contamination and proliferation of diseases (Pereira et al. 2020; Pestana and Ventura 2020).

This approach to the generation and treatment of solid waste contextualizes several challenges, from the generation at the source, classification, transfer, disposal, and final treatment (Almeida et al. 2013; Franqueto et al. 2019; Struk and Boda 2021). Thus, the discussion of the generation, management, and treatment of solid waste, especially urban waste, is affirmed in two positions: in the exponential growth of the population and consumerism, and the latter motivated by purchasing power.

The aforementioned suggests that in countries with stronger sustainable development indicators, the best management and treatment practices for MSW (RSU) can be identified, under the assumption that they have managed to develop the best procedures for reducing waste at the source, selective collection, transport, reuse, and reduction of disposable materials in formal and informal deposits.

Because it is an extremely broad topic, of multiple interests and of different interacting variables, it is appropriate to apply multivariate statistical analysis for BIG DATA processing. For this purpose, two statistical software were used: The IBM SPSS for quantitative data (Cheol-Heum et al. 2020; Tian et al. 2019) and IRaMuTeQ for the text data (Kiefer 2021; Kumar et al. 2021; Paynter et al. 2021; Romero-Silva and Leeuw 2021), to facilitate the interpretation of thought evolution environments. The results are used as inputs to reach the knowledge (diagnosis) that serves as a starting point in the creation of solutions related to waste. Therefore, the main objective was to carry out the analysis of the relationship between the consumption of products and the generation of waste, based on the BIG DATA of the World Bank in the decades of 1990–2020, using applied multivariate statistics.

Given such a large amount of information from various sources, it is important to generate a methodology that makes it easier to identify a product, which brings together all information that can become an object of study, to facilitate global decision-making, that product would be an icon of humanity. From this perspective, the manuscript provides the methodology, it makes use of techniques and procedures replicated by the scientific community, providing a path for new generations.

Materials and methods

This work was carried out, conceptualizing input "keywords," subsequently, output within oval boxes as shown in Fig. 1. Within the circles, words referring to the world

of data and its sources; and in the rectangular boxes: procedures, techniques, and software to which they were subjected.

The data and information contained in the BIG DATA of (a) the OECD (2021a, b) regarding the generation and treatment of solid waste in the countries for the period, between 1960 projected to 2050; (b) World Bank Development Indicators (WDI) for the period 1990–2020 (WB 2021); and (c) the scientific articles compiled in SCOPUS from 1996–2020 period with the search parameter "sustainable development." Each data set had a differentiated treatment, gradually the interpretation of the results allowed to extract a product (possible social good), conceptualized by Pierce (1974) in the abductive method of scientific production.

OECD (1960 to 2050)

The OECD data is related to the generation and treatment of solid waste in the countries. The data showed some differences in the indicators of (a) 0.83 kg equivalent to m^3 per person per year calculated by Arvizu and Huacuz (2003) for the International Institute in Education (IIE), (b) 1.08 kg calculated by Bustos (2009), (c) 0.96 kg from the National Institute of Statistics and Informatics (INEI) of Peru in 2014, (d) of 1.989 kg Duke University in 2015 cited by Mexico (2015), (e) México own calculation (2015) of 0.990, (f) the OECD (2020) of 1.4246 kg per person per day, and (g) 1.1095 kg calculated by Páez (2021) to measure the generation and treatment of solid waste.

The value was adjusted by calculating the simple average (Eq. 1). The adjusted value is named "Ordinary Waste Index" (RO) to be used in future calculations. The identification of the countries in graphics is carried out by adopting the ISO 3166 standard for classification by three digits.

$$\mathcal{M} = \frac{(a + b + c + d + e + f + g)}{N} \tag{1}$$

where $\mathcal{M}$ = the simple average; N = quantitate (a to g) are the values of the indicators.

The adjusted metric was related to the population reported in the World Bank database (2020) in base 10^4, the results are represented per annual ton in the world map using the Tableau Software, highlighting the first 15 countries with the highest amount of waste generated.

WDI (1990 to 2020)

The World Bank Development Indicators (WDI) database (WB 2021) was accessed to extract the information from 211 countries. The base file generated with the information for the period (1990–2020) received a data normalization treatment; afterwards, the average value of the analysis period was calculated.

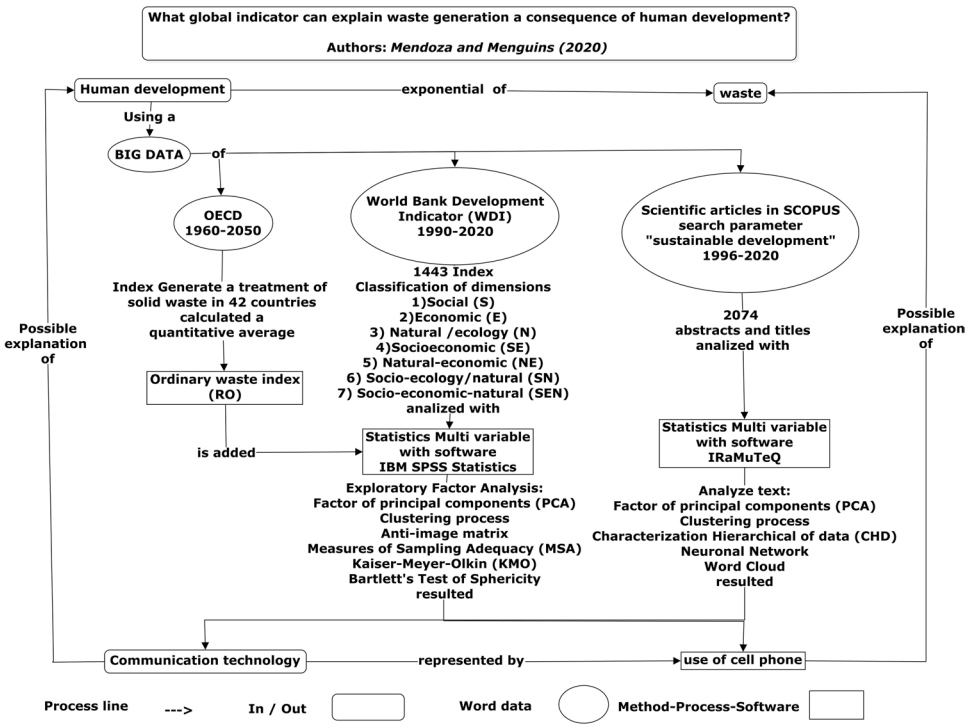


Fig. 1 Conceptual framework of research development. Source: authors, Mendoza and Menguins, using CmapsTools IHMC/USP

A new table was created to summarize the 1443 values by country. The variables (indicators) were classified with the use of the concatenate function in the following dimensions: social (S), economic (E), natural (N), socio-economic (SE), natural economic (NE), socio-ecological/natural (SN) and socio-economic-natural (SEN) for follow-up and monitoring.

To understand the interdependencies (correlations) between the variables and identify the structure of the data, the "Exploratory Factor Analysis" is successfully used with the intention of reducing the information to two dimensions called principal components, from which the factorial load can be analyzed. Furthermore, it allows finding the commonality (h^2), that is, how each variable can be explained by the factors, and finally, reduce the BIG DATA to a manageable quantity (Hair et al. 2009; Kjaldgaard et al. 2021).

The IBM SPSS Software was used in the initial exploratory analysis until finalizing in the analysis of principal components, also, called canonical analysis of factors of principal components (PCA) that identifies the total variance (Eq. 2) with a value of 1. The procedure is repeated until the data is reduced to the ideal number of two common factors that will be explained by specific variables (Eq. 3).

$$\text{Total variance} = \text{common variance} + \text{specific variance} + \text{error} \tag{2}$$

$$\text{Unique variance} = \text{specific variance} + \text{error} \tag{3}$$

The following parameters were applied: rows (countries) with more than 67% of the reported variables were selected and each variable being present in more than 84% of the countries. The data met 95% degree of confidence. The exploratory analysis of reduction of the dimension to two factors was applied, selecting a total of 360 variables completed in 181 countries. The result suggested the reduction to 47 variables identifiable by the weight of significance. From these variables that presented similarity with variables with greater weight were excluded, facilitating the entry of others.

Reaching the reduction to two main component factors, the Software calculates the indicator: (1) determinant of anti-image matrix (MSA measures of sampling adequacy); (2) the KMO (Kaiser-Meyer-Olkin measure of sampling adequacy); and (3) the Bartlett's test of sphericity:

1. The determinant of the correlation matrix indicates whether or not it is possible to apply the matrix rotation technique, the value of (0) indicates that it cannot.
2. The MSA reveals normalized values between (0.00 and 1.00) indicating the degree of adjustment of each variable to the factor analysis. Variables with values less than 0.5 are excluded because they do not have a common significance value.
3. The KMO shows the normalized values between (0.00 and 1.00), displaying the proportion of the variance that the variables as a whole present in common or the proportion, due to the common factors (Eq. 4). A test with a value less than 0.5 indicates that the data set is not adequate for the use of the technique, the closer a value to 1.0 reveals the appropriateness of applying the technique.

$$KMO = \frac{\sum\sum_{j\neq k} r_{jk}^2}{\sum\sum_{j\neq k} r_{jk}^2 + \sum\sum_{j\neq k} q_{jk}^2} \tag{4}$$

where r_{jk}^2 2 = squared of the elements of the correlation matrix off the diagonal; q_{jk}^2 = squared of the partial correlations between the variables. Acceptable values in the range of 0.5 to 1.0 (Hair et al. 1987), preferably higher than 0.8 according to Kaiser and Rice (1977), (Table 1).

4. Bartlett is based on the statistical distribution of "Chi-square (χ^2)" (Eq. 5), tests the null hypothesis (H_0), stating that there is no correlation between the variables.

$$\chi^2 = -\left[{}^{(n-1)-(2p+5)}\big/_{6}\right] \tag{5}$$

In | R | with chi-squared distribution with degree of freedom $v = {}^{p\,(p-1)}\big/_{2}$

where n = sample size, p = number of variables, | R | determinant of the correlation matrix. Acceptance decision parameters: determining index (sig.) Close to zero, greater number of values in df and number of rotations of chi-squared with chi-squared distribution with degree of freedom $v = {}^{p\,(p-1)}\big/_{2}$

SCOPUS (1996 to 2020)

The discussion is reinforced with "Scientometrics," that is, with the use of the results of qualitative data analysis. "Scientometrics" is based on the quantitative study of scientific activities through production. Among its techniques is

Table 1 Qualitative parameters of KMO

KMO	Score
$0.9 < y \leq 1.0$	Very good
$0.8 < y \leq 0.9$	Good
$0.7 < y \leq 0.8$	Average
$0.6 < y \leq 0.7$	Reasonable
$0.5 < y \leq 0.6$	Bad
≤ 0.5	Unacceptable

Author

creating indicators such as number of publications, authors, and citations, on a subject or word under study, facilitating the administration of the data and its interpretation (Maracajá et al. 2021; Silva and Ribeiro 2021).

With this objective, the R Interface software for the multidimensional analysis of texts and questionnaires (IRaMuTeQ) produced by Ratinaud (2009), It is used with preference, because from the textual data, it allows different forms of statistical analysis and generates graphs such as the finger gram, neural network and word cloud (Ratinaud and Marchand 2012; Góes et al. 2021).

Using the CAPES Newspaper platform, access was made to the SCOPUS database, through which 2,074 abstracts and titles of scientific articles were obtained from the areas of environmental sciences, social sciences, and energy, related to the phrase "sustainable development." Repeated sources were eliminated, or when the author could not be identified, or it did not contain an abstract, thus leaving 1,872 scientific articles (AC) published in the period (1996–2020).

One of the methods applied in IRaMuTeQ in addition to those mentioned in SPSS is the JK-META-BIPLOT, it consists of adding value to the cluster (hierarchical characterization of data (CHD)) by observing the words "more specific or specific," thus, the most used within a given unit of meaning or reference, Eq. 6 (Caballero-Julia et al. 2014).

$$f_{ij}^{'} = \frac{f_{ij}}{\sqrt{\max_i}\sqrt{\max_j}} \tag{6}$$

where f_{ij} is a row maximum, but not a column maximum, increasing the characterization of the individual (word).

Finally, the comparative analysis "with and without" was used to interpret the results and assess the participation of the variable RO, subsequently, the results of the techniques and quantitative methods with qualitative ones, to extract the product (possible universal good) from the deduction and induction of the results, as proposed by Pierce (1974) and applied by Mendoza and Mota (2021).

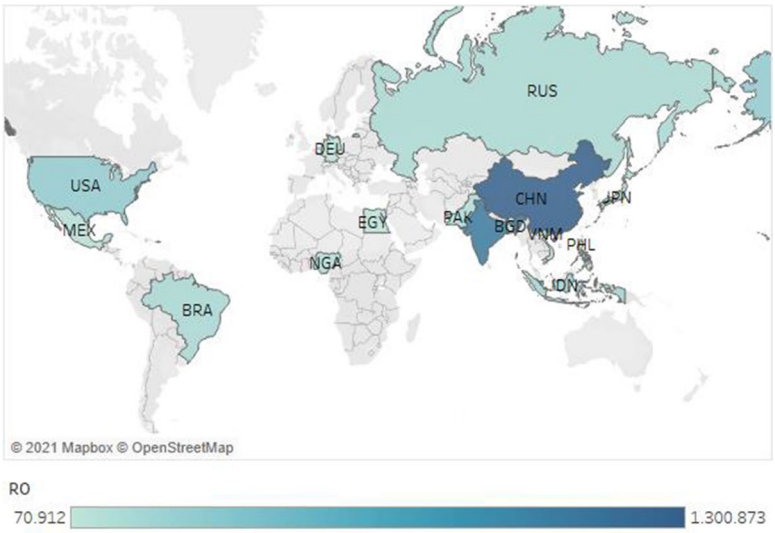
Results and discussion

The work is based on comparison in the study period using the complexity of multivariate statistical techniques of quantitative and qualitative data to enrich the results, so multiplex information can converge in a summary product "possible universal good," as expected when applying the abductive scientific method.

Using the adjusted RO with a value of 1.1975 and the average of the population from 1990 to 2020 (WB 2021), the number of daily tons per country was calculated, the results are shown in Fig. 2.

The list of the fifteen countries with the highest generation and treatment of urban solid waste (GyTRSU) linearly relates the number of the population with consumerism and consumerism with purchasing power (Silva and Mello 2020; Takenaka 2020). In this statement, there is a tacit contradiction related to the number of people and families with purchasing power, since a large part of the population is in a state of socioeconomic vulnerability (Rosales-Mendoza and Mota 2021).

The claim of sustainable development suggests an equitable approach that could solve current difficulties for the present and future generations, hence the importance of an analysis of the indicators used by the World Bank. In this sense, the adjusted metric of the quantity of production of RO would be useful for follow-up and monitoring of actions in the construction of solutions and public policies, the reason why it is important to assess the convenience of its use and its interaction with other metrics (indicators).



Country	RO
CHN	1.300.873
IND	1.068.996
USA	305.114
IDN	215.255
BRA	174.502
RUS	166.081
PAK	142.245
JPN	139.877
NGA	129.447
BGD	125.734
MEX	99.717
DEU	95.105
VNM	79.302
PHL	77.472
EGY	70.912

Fig 2 Wasted urban by country Tn/daily. Source: author using World Bank data (2021) and TABLEAU graphic representation

The assessment of the competence, relevance, and sufficiency of the use of the metric was carried out using information from the World Bank; the product of the proximity analysis of the data 381 final variables of 181 countries processed in the IBM SPSS Statistics software revealed 99.4% of validity in the re-scaled Euclidean distance used. The data processing did not discard the variable (RO), on the contrary, it includes it within the seven final variables that help in the construction of the two main component factors. Table 2 shows the results with and without the variable.

In general, the participation of RO favorably affects the development of the results, except for the decrease in the position of variable N73 from 0.268 to 0.125 in the position of communities. The other variables increased their value, as well as an improvement for the rest of the values. The determining index is closer to zero, the KMO index improved, as did the number of times of convergence in Bartlett's rotation, and the values of Eigenvalues and rotation sums of squared loadings increased their impact and relevance in the study.

Once validity is confirmed, the results of the applied multivariate analysis BIG DATA of the World Bank Development Indicators (WDI) are compared, shown in Fig. 3, in column one: the product of component main factors (PCA) (Fig. 3a and c) without the participation of the variable of RO and in column two including the variable RO (Fig. 3b and d); in row one, the analysis is carried out with all the countries (Fig. 3a and b) and in line two excluding the participation of China, India, and the USA (Fig. 3c and d).

Looking at column one in Fig. 3a, it is observed by distance as the countries of China (CHN), India (IND), and the United States of America (USA) stand out, when they are excluded to obtain a better view of a second group (Fig. 3c), the countries of Japan (JPN), Brazil (BRA), Indonesia (IDN), Ireland (IRN), and Germany (DEU) are already noted, the third group for the rest of the countries. In column two, when comparing the main components factor (x-axis) with the study variable RO (y-axis) in Fig. 3b highlight CHN and IND, countries disappearing USA, and in Fig. 3d remain in the second group IDN, BRA, JPN, and Russia (RUS), United Kingdom (GBR), and France (FRA) appear, disappearing from view IRN and DEU. The RO values (y-axis) are from more than one to 80,000 tons accumulated on average per year per country.

China and India differ in their productive structure; however, they share the position of the greatest polluters in the international community (Oliva 2014). In China, the electricity sector is considered the main contributor to climate change, air pollution and responsible for 15% of the country's electricity generation; however, this sector contributes less than 1% of total emissions of carbon dioxide (CO_2), nitrogen dioxide (NO_2) and dry carbon dioxide (SO_2) (Wang et al. 2021).

Considering it was projected that China would produce by 2020 more than 30% of the global emissions of greenhouse gases (GHG), due to the Neo-Malthusian model of increasing the intensive use of technological devices, modernization of agriculture, and the preferential consumption of national products, the value of minus 1% in GHG emissions is notorious (Perdomo 2016). And India, aware of the contribution of emissions emanating from

Table 2 Analysis with and without the RO variable

Indicators		Without RO	With RO	Parameter
Determinant		1.944E-5	1.830E-7	Best close to zero
Kaiser-Meyer-Olkin measure of sampling adequacy		0.712	0.779	Greater than 0.5
Bartlett's test of sphericity	Approx. Chi-Square	1921.968	2743.351	Greater amount
	Distance frequency	15	21	Greater amount
	Significancy	0.000	0.000	Close to zero
Communalities	N73[(1)]	0.268	0.125	Next to one
Extraction method: principal component analysis (PCA)	ES403[(2)]	0.951	0.973	Next to one
	ES755[(3)]	0.934	0.965	Next to one
	ES776[(4)]	0.974	0.987	Next
	ES1122[(5)]	0.909	0.979	Next to one
	S1414[(6)]	0.972	0.978	Next to one
Eigenvalues	Component 1[(7)]	63.076	66.096	Greater amount
	Component 2[(8)]	20.390	19.196	Greater amount
Rotation sums of squared loadings	Component 1	42.049	52.980	Greater amount
	Component 2	83.466	85.292	Greater amount

Author. (1) Agriculture, forestry, and fishing, value added (current LCU), [(2)]Exports of goods, services, and primary income (BoP, current US$), [(3)]Merchandise imports by the reporting economy (current US$), [(4)]Cell mobile subscriptions, [(5)]Primary education, pupils, and [(6)]Urban population, [(7)]Component of factor 1 (x-axis), and [(8)]component of factor 2 (y-axis)

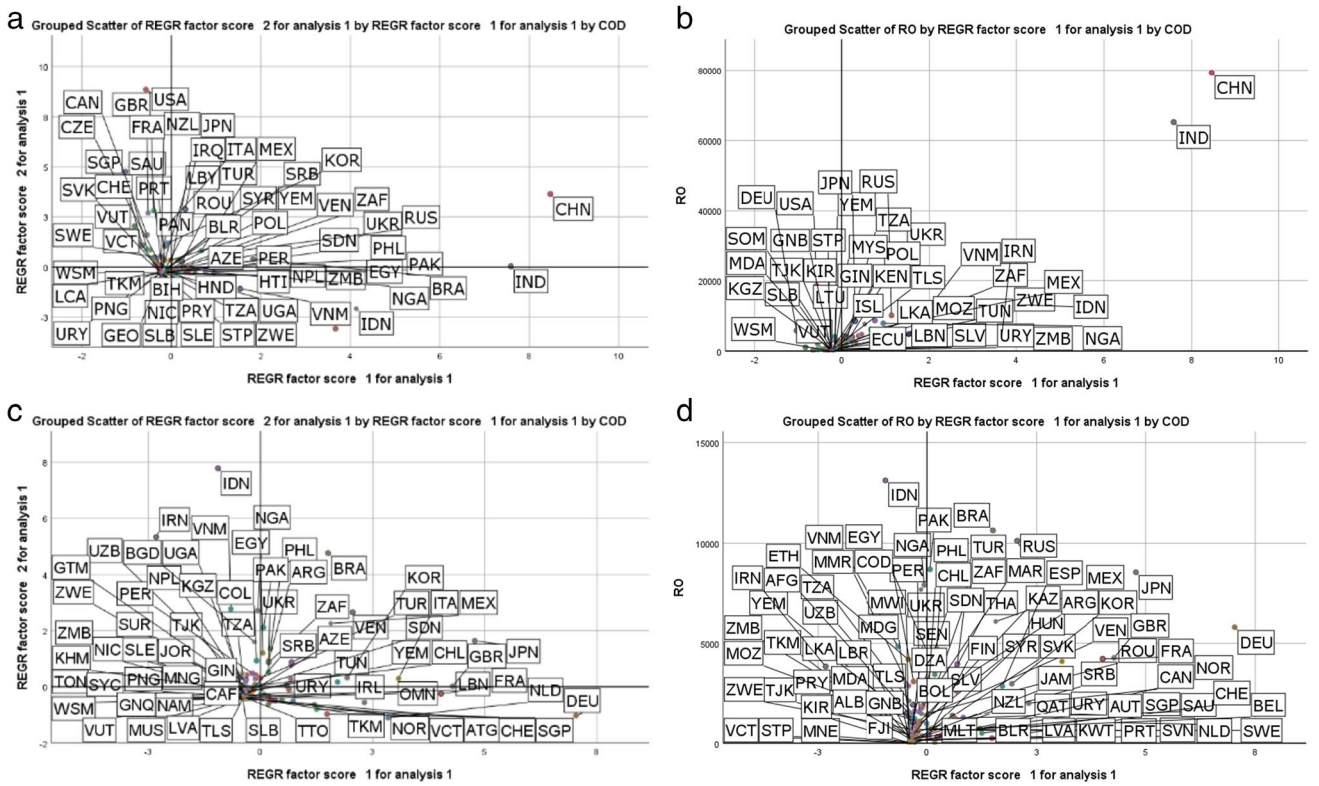


Fig. 3 The World Bank Development Indicators (WDI)/RO. Source: author

Table 3 Indicators

Code	Description	Without		With	
		1*	2**	1*	2**
ES403	Exports of goods, services, and primary income (BoP, current US$)	0.101	0.508	0.816	−0.513
ES755	Merchandise imports by the reporting economy (current US$)	0.782	−0.529	0.831	−0.497
ES776	Cell mobile subscriptions	0.782	−0.568	0.975	0.050
ES1122	Primary education, pupils	0.800	0.519	0.610	0.678
S1414	Urban population	0.970	0.174	0.975	−0.021
N73	Agriculture, forestry, and fishing, value added (current LCU)	0.101	0.508	0.263	0.705
RO	Ordinary wasted			0.947	0.216

*Relationship with the component of factor 1 (x-axis)/**Relationship with the component of factor 2 (y-axis). Source: author

large hydroelectric reservoirs, has generated a series of mitigation measures in sustainable planning (Zhi-Guo et al. 2021).

CHN and IND conditions are not distant from the rest of the countries that make up the G20, nor from the countries that are outside this development classification. An early interpretation of the results leads to think that effectively the generation of waste is directly related to the growth of the world population (Silva and Mello 2020; Takenaka 2020); however, the disappearance of the USA in Fig. 2b and IRN together with DEU and the appearance of other countries in Fig. 2d allows to question that premise.

Such appearance and disappearance could be related to the electronic waste collected to be recycled in developed countries, which are simply sent to other developing countries, where the "cost" of treatment is much lower (Natume and Sant-Anna 2017).

The results of the seven main dependent variables that make up the basis of the two main component factors are detailed in Table 3, going forth with the analysis of without and with RO, reading these variables can help to better understand what happens in the world.

These variables in order of importance (results with RO) are: (1) Cell mobile subscriptions (ES776); (2) Urban

population (S1414); (3) Ordinary waste index (RO); (4) Imports of merchandise by the declaring economy in the USA $ currency (ES755); (5) Elementary education, students (ES1122), Exports of goods, services and primary income, balance of goods of people, in US $ currency (ES403); and (6) Agriculture, forestry and fishing, current added value LCU (N73). There is no difference between the socioeconomic variable ES776 and the social variable S1414, both have the same weight of 0.975 in relation to the multivariate component.

Apparently, the first variable of urban population concentrations explains world development (Silva and Mello 2020; Takenaka 2020). However, the second variable with equal weight generates a series of uncertainties regarding from: who, where, why, and to how many cellular mobile service subscriptions a person can have, in addition, it does not guarantee that people have purchasing power, due to access to services and requirements to operate on a day-to-day basis, making it a requirement rather than a necessity. Many people live in debt for acquiring a state-of-the-art cellular device; another condition is access to the signal (Aguiar et al. 2014; Rodríguez et al. 2020).

The ES776 variable, as well as the ES403, the ES755 and even the ES1122 are all closely intertwined, the subscription of the mobile service is a variable worthy of study, because it includes the trace of the developmental history of humanity, since the discovery of energy through the development of technology and its intrinsic relationship with ordinary waste.

Going deeper and to obtain a representation of the countries before these variables, the analysis of characterization/hierarchical classification (CHD) of main components applied to the independent variables (countries) was used. The use of this technique was helpful because by grouping the participants it facilitates interpretation from the cluster and infers in the total study population (Niño 2020).

In the first Fig.4a, it shows the result of the analysis without RO, the product of four main clusters, the first formed by Colombia (COL), Japan (JPN), Republic of Korea (KOR), Vietnam (VNM), Indonesia (IDN) and Iran is added to the second, Uzbekistan (UZB) and Iraq (IRQ) are added to the third, and the fourth cluster includes the rest of the countries. In Fig. 4b includes RO, the four main clusters are made up of Paraguay (PRY), Myanmar (MMR), COL, KOR, UZB, VNM, and IDN, the second cluster adds Lao (LO), Guinea (GIN), Cambodia (KHM), Uganda (UGA), and Tanzania (TZA), the third adds Iran (IRN), and the fourth the rest of the countries. Fig. 4c and d show the position of the main component variables without and with RO, respectively.

The countries that maintain their presence in the main group final product of the analysis correspond to Colombia, Republic of Korea, and Vietnam. In Colombia, efforts have been made to reach remote territories and rural areas with technology as part of the fulfillment of the SDGs through

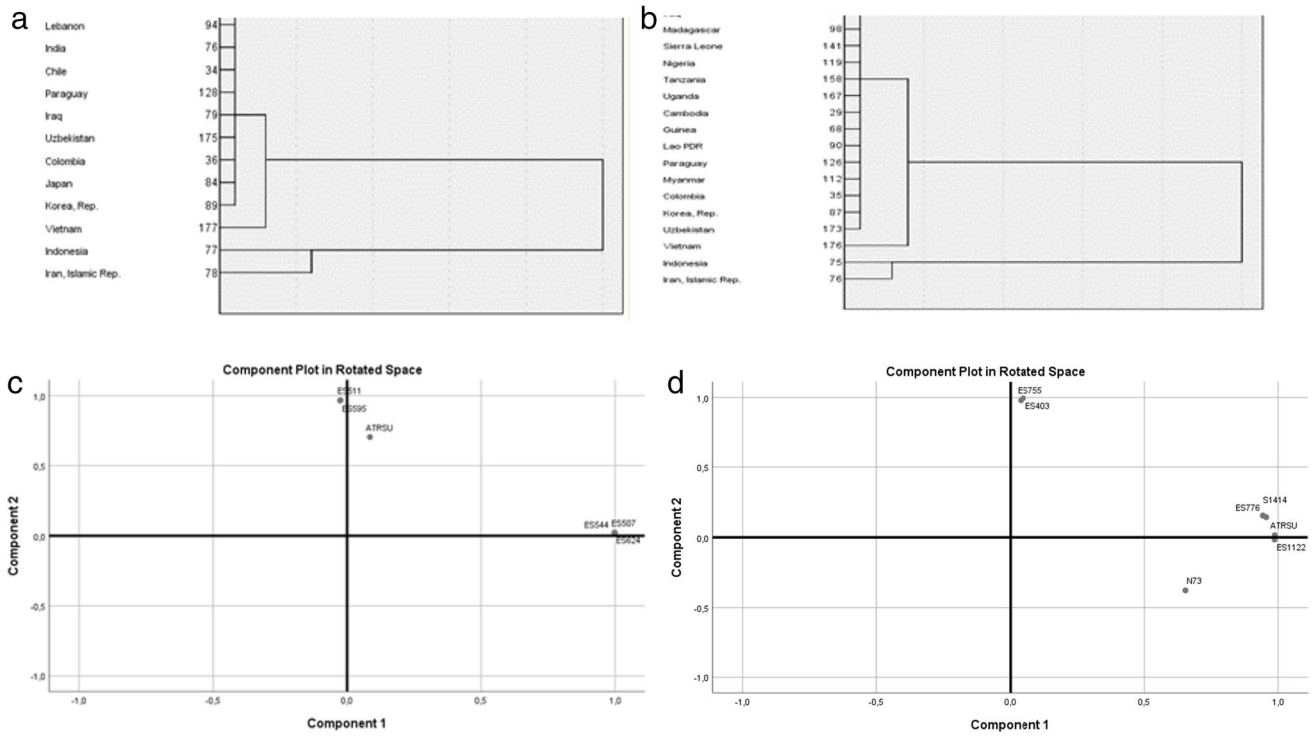


Fig. 4 Characterization hierarchical of data (CHD)/PCA position without and with RO. Source: author

programs such as digital social inclusion and WIFI Zones (Cervera-Quintero 2021).

In Korea, efficiency in the use of renewable energy is the basis for GHG reduction, strengthened by the implementation of public policy based on the use and protection of natural resources (Sosa 2020); and in Vietnam, the trade war between the USA and CHN has caused large technology firms to increase their manufacturing operations in that country (Reyes-López 2021); another aspect that may favor development also as a result of the trade war is the diversion of CHN's global supply chain, despite global supply chain disruption, the post-pandemic Vietnamese economy may accelerate if countries such as the USA, JPN and the European Union divert the CHN supply chain and place it in VNM.

Thus, it makes sense to reduce the main component factors to the seven variables. Subscription to cellular technology services represents a wealth of information that allows us to explain the evolution of world and country development.

The results of the analysis of textual data of the World Development Indicators compared with scientific articles with gold classification in the SCOPUS database and access through the CAPES Newspaper platform are displayed in Fig. 5, in column one indicators World Bank Development Committee (IDWB) and in column two 2074 scientific articles (SA) from 1996 to 2021.

In Fig. 5a and b reveals the number of related indicators according to the classification given in the study and the number of scientific articles collected in the SCOPUS database in the period 1996 to 2021; shows the neural network of each of the items subject to analysis by column, and row three reveals the product in the word cloud.

The supremacy of indicators related to socioeconomic aspects regarding the other indicators confirms the results of the quantitative analysis, of the seven main components, of which five are identified as ES, which is proportionally valid. The scientific work represented in the graph even though, in the last year the number of articles decreased from 176 to 172, reveal the commitment and growing concern of the scientific community in addressing the issue of world sustainable development and of the countries.

Neural networks and word clouds emphasize population, trade, development, education, and control characterizing the reality of the Anthropocene (responsibility human do climate change), the imposition of humanity on nature (Milton et al. 2021; Palmer et al. 2022). Searching in the results for some word that is related or characterized with the subscription to the cellular service, almost invisible in the word technology appears.

This word also contains the evolution of world development and countries; its link with waste also makes sense, for example, the production of the cellular devices has undergone several radical changes over time, both in cost, models, shapes, figures, capacity, durability, etc. Its acquisition reveals an adjustment of the service to the population without neglecting the ability to pay.

The result of the comparison of the neural network and word cloud between the World Development Indicators (WDI) and the scientific contributions, shows an agreement in the socioeconomic approach, with specific observations with the growth of the population, financial transactions, education, and even placing the female gender in the focus of its rights, in such a way that the related indicators are apparently biased in their favor. In scientific production, environmental issues appear that begin to shape public policy and interrelationships of countries, as the way to guarantee a healthy environment for the present generation as well as for future ones, facilitated by the development of communication technology.

In summary, the evolution of humanity can be explained by using the cellular device as an icon, representing the development of technology from the generation and use of energy, to the latest advancement and use of information technologies. Its study can generate new applications that embrace responsibility conceived in the Anthropocene era, including the theories and concepts of circular economy, responsible use of resources, sustainable development, and green economy.

Conclusions and recommendations

From the scientific works reviewed to construct this manuscript, it is the first to gather mixed information (qualitative and quantitative) at a global level, obtained from official and scientific databases, facilitating the extraction of a product that could facilitate understanding; therefore, the construction of immediate solutions to the indicated problem of waste in cities. Comparison works with a similar purpose were cited in the manuscript, and their information served as the basis for the development of the proposed work. Importance (a) the use of the abductive method, that is, extract from deduction and induction, (b) using qualitative and quantitative techniques with state-of-the-art software to create a product that brings together the pieces of "possible universal good," (c) facilitate the comprehension and understanding of the object of study "historical cause and effect of waste generation."

The results show that the development of humanity and the generation of waste can be explained with the observation and study of the subscription to the cellular service, turning the cell phone into an icon of the evolution of technological advances and, therefore, of the human genre. Such knowledge can provide the basis for the creation of

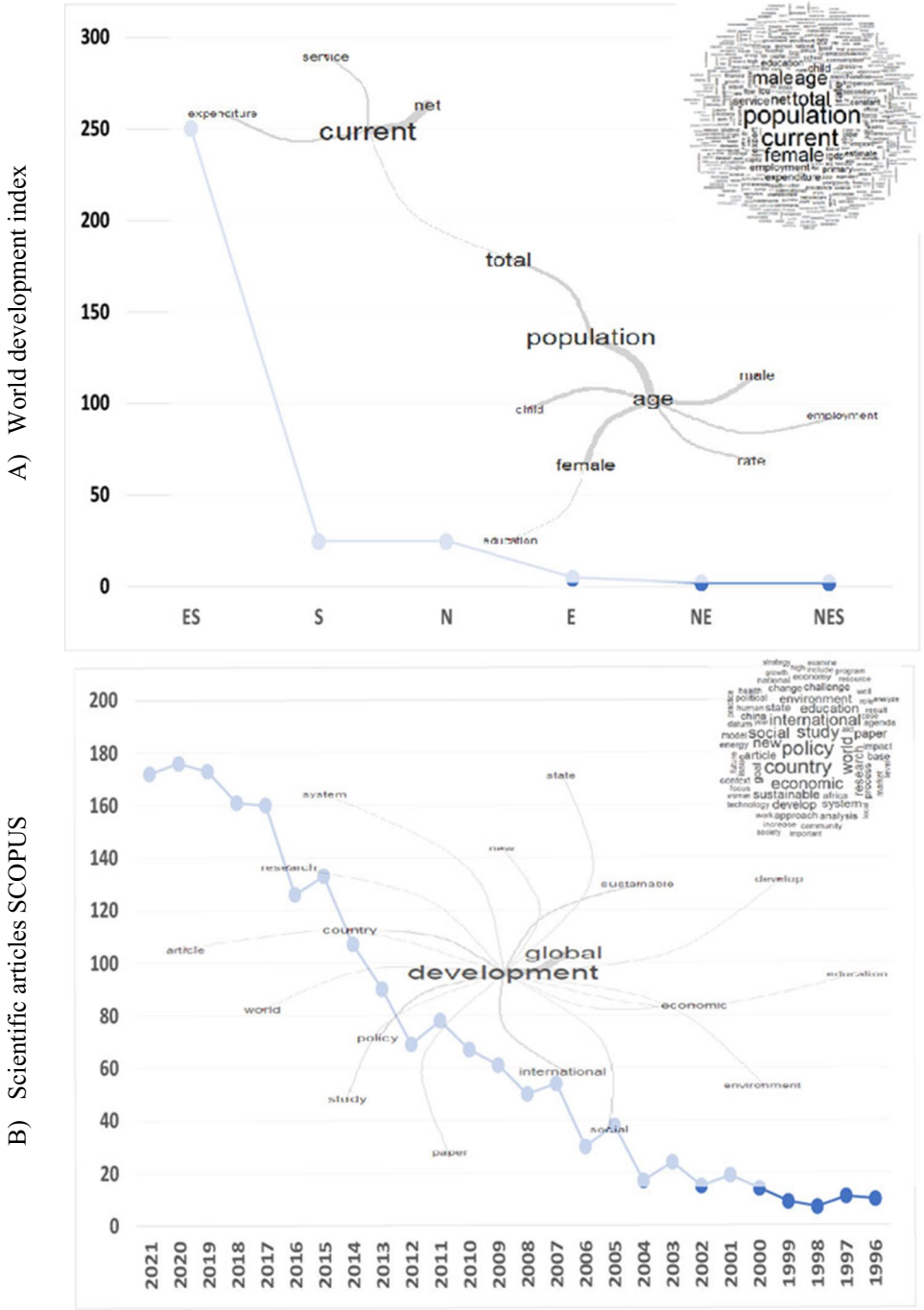


Fig. 5 **A** Comparative analysis of WDI (1990–2020) versus **B** SA SCOPUS (1996–2021). Source: author

immediate solutions involving economic theory: green, social solidarity, sustainable, environmental, and circular.

The cellular service subscriptions index confidently reveals world development, in addition, if it can be named, a natural socioeconomic catalyst due to its interaction with the components of sustainable development; related to waste it also plays an explanatory role, as for its acquisition or "not," reveals access to social services such as education, infrastructure, health, and security. On the other hand, it leaves a doubt that the amount of solid waste is correlated to purchasing power, given the fact that many people have more than one subscription and others do not have purchasing power, but with a need created for technology, they even go into debt to be able to buy a device.

Although the production of waste is not correlated to the subscription of cellular service, it is to the silent imperialism of access to social services; an Anthropogenic flag of conquest, strengthened by international agreements and treaties that, assisted by technology, reaffirm once more.

For future calculations related to solid waste, the use of the ordinary waste index (RO) generation metric (index) of 0.75 kg per person per day, equivalent to 0.75 m^3, is recommended. This metric adjusts the predecessor values in quantity as in concept. In concept, because the generation of solid or liquid waste does not guarantee its adequate management and treatment, as it is intended to be included in the name of management and treatment of solid urban waste. It only reveals the reality of the production for its monitoring and follow-up, in addition, it is proposed that the product of multiplying the number of the country's population by OR be incorporated into the list of development indicators of the World Bank.

Purchasing power does not encourage consumption as much as the access to energy, because different benefits come along with it, especially health, education, communications, and transportation. Therefore, it is important when building solutions that favorably affect the present and future generations and the reuse of materials contained in waste, everything must be part of the circular economy, social and solidarity.

The results of data analysis of the World Bank development indicator, data in the IBM SPSS Statistics, and IRaMuTeQ software with the participation of the RO index, facilitate the understanding of the current state, which is a starting point for the construction of solutions, it is recommended to include the metric within the World Bank family of development indicators because it makes visible the impact of access to goods and services versus the impact on nature.

The management (administration) and treatment of solid waste is a situation of global impact and can be resolved with strategic alliances of public-private partnerships, avoiding private monopolization, and promoting the initiatives of non-profit organizations being funded through international banks. It's monitoring and follow-up require making quantitatively visible the different actions that are carried out, in this regard, deepening the study of the cellular service subscription indicator could be the vehicle that leads to making visible the impacts produced on nature, society, and the economy. In addition, it facilitates the construction of a healthy management of the materials contained in solid waste, optimizing its use.

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Declarations

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