

ROLE OF GDP IN THE SUSTAINABLE GROWTH ERA

Katarina Gajdosova, D ORCID: https://orcid.org/0000-0002-5585-0761

University Instructor, Business Administration, University of the People, USA

Corresponding author: Katarina Gajdosova, e-mail: katarina.gajdosova@uopeople.edu

Type of manuscript: research paper

Abstract: While there is a correlation between economic growth and the increase in living standards, economic theory is evident in the purpose of the Gross Domestic Product (GDP) measurement. GDP measures only the production capacity and economic growth, not the nation's development, as often claimed by policymakers. Furthermore, as several studies show, by focusing on economic growth and neglecting the other two crucial systems, the ecosystem, and the social system, we will not be able to achieve economic growth in the future. Since the GDP was developed in 1937, it has faced criticism not only for its limitation related to its construction. Also, the concept of economic growth is currently being challenged and being replaced by the pursuit of sustainable development. Therefore, the role of GDP, as an economic growth indicator, in our economy needs to be clarified and re-assessed. The main aim of this paper is to investigate the usefulness of the GDP in the era of sustainable development. To achieve this, we investigated the historical development of various measures of economic growth, as well as the historical development of the GDP as an economic growth metric. Furthermore, we argue that the future of GDP should be in the multi-dimensional indicators, which are used to measure the sustainable development of a country, as opposed to a self-standing single-dimensional measure of economic growth. As a case study, we also construct two measures, based on Analytical Hierarchical Process (AHP) using the free online software 'SuperDecisions: our Simple three-dimensional index of the nation's growth and the enhanced holistic three-dimensional index - Holistic Nation's Growth Index. Using the AHP method, we showcase the difference between the countries' rankings if we consider only economic growth and if we focus on the country's development more holistically. Our comparative study reveals that it is not enough to look only at three main systems, the economic, social, and ecosystem while assessing the countries' development. It is necessary to also investigate and try to capture the relationships between those three main systems.

Keywords: Holistic Nation's Growth Index, Gross Domestic Product, degrowth, post-growth, inclusive growth, gross ecosystem product, sustainable growth.

JEL Classification: O47, Q01, Q57.

Received: 09.07.2023

Accepted: 19.08.2023

Published: 30.09.2023

Funding: There is no funding for this research.

Publisher: Academic Research and Publishing UG, Germany.

Founder: Academic Research and Publishing UG, Germany; Sumy State University, Ukraine.

Cite as: Gajdosova, K. (2023). Role of GDP in the Sustainable Growth Era. *SocioEconomic Challenges*, 7(3), 94-112. <u>https://doi.org/10.61093/sec.7(3).94-112.2023.</u>

Copyright: © 2023 by the author. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).





Introduction

Since the Gross Domestic Product (GDP) measure was created in 1937 by Simon Kuznetz, it has been deployed for different purposes. Its first role was to measure how much the U.S. economy produced and how fast it recovered from the crisis. Later in 1944, it became a widely used measure of economic activity and growth of countries. As early as the 1970s, it was clear that GDP has flaws, and the journey of trying to correct, improve, or completely replace GDP has started. There were methodological issues and conceptual matters flagged and worked on. From the methodological perspective, GDP does not correctly reflect the actual economic production of a country, as it cannot capture unpaid work, the underground economy, or the value of leisure. From the conceptual perspective, other systems, such as the ecosystem and social system, have been harmed by focusing solely on economic growth.

Furthermore, we have already realized that by focusing on economic growth and neglecting the other two crucial systems, the ecosystem, and the social system, we will not be able to achieve economic growth in the future. The damaged ecosystem, which cannot meet human needs anymore, is not providing the necessary resources for economic growth. Therefore, the focus on the GDP as a measure of economic growth is short-sighted.

Several initiatives were put forward between the 1970s and now to correct these issues, ranging from simplistic Measure of Economic Welfare in 1972 and slowly progressing to more sophisticated measures such as Net Economic Welfare in 1980, The index of Sustainable Economic Welfare in 1989, the Human Development Index and Ecological Footprint in 1990, Genuine Progress Indicator in 1995, the Green Net National Product in 1997, Green GDP in 2004, Happy Planet Index in 2006, Gross Ecosystem Product in 2015. The underlying data systems, the national accounts systems, have also been going through an innovation process, incorporating the system of Environmental-Economic Accounting (approved as a statistical guideline in 2021).

Analyzing the importance of the GDP and its role in the era when sustainable development is promoted, it is necessary to clarify whether and how this measure is still valid. The future of this measure is closely related to the importance of economic growth that is under scrutiny as we move toward a more sustainable future. Several theories have been put forward, such as the necessity of degrowth in the future or decoupling economic growth from well-being and becoming agnostic to economic growth. In this case, it might appear that GDP will lose its prominent role as a measure. Other theories suggest that we will be able to sustain our economic growth without destroying our planet, thanks to technological advancements. In this case, GDP will still play an essential role as a financial measure.

Several theories about sustainable, inclusive, green, or balanced growth are being proposed between these extreme views. In their statements, economic growth and GDP could still play an important role, with few adjustments in the economic system, such as proper pricing of natural resources and environmental damage, market regulations targeting the environment, and transition to new economic systems, such as circular or doughnut economy.

The first part of this paper brings forward the economic theories dealing with the future of economic growth. Based on the analysis of the existing approaches, the paper concludes that there is a need to rethink how we look at economic growth and its measurement. Furthermore, it provides a chronological overview of the newly constructed measures and initiatives to improve, supplement, or replace the GDP. Based on the analysis of this information, the paper claims that while GDP might lose its prominence as a single-dimensional measure of economic growth, it is gaining importance as a part of new multi-dimensional multidisciplinary measures of holistic development of a nation.

In the practical part of the paper, we collect secondary data reflecting the economic, social, and ecosystem and construct a three-dimensional holistic measure of the nation's growth (HNG). In this part of the paper, we prove that the ranking of the countries using the different measures of growth varies, and the focus only on economic growth is rather short-sighted.



Literature review

Issues with the GDP as a measure of economic growth

Over the last 80 years of the existence of the GDP, economic growth has been correlated with improving society's living standards. As Soubbotina (2004) mentioned, economic growth can reduce poverty and solve other social problems. Economic growth is "a means to fuel progress in societal terms - including increasing well-being and equity - rather than increasing economic output as an objective in itself" (Sen, 2021).

On the other hand, there has been rising skepticism about the accuracy the GDP can provide in measuring economic growth. Samuelson (1995, p. 419) states that GDP and even GNP are not perfect measures of genuine economic welfare. It is also not constructed to reflect well-being and living standards, as it is often used for. The first warning regarding GDP not being able to measure the welfare of a country came already in 1959 when Economist Moses Abramovitz stated that "we must be highly skeptical of the view that long-term changes in the rate of growth of welfare can be gauged even roughly from changes in the rate of growth of output" (As cited in Payden & Rygel, 2012).

Also, the purpose of the System of National Accounts (SNA), from which GDP is derived, is clear, as stated by Paul McCarthy P. (2018): "The main purpose of the national accounts framework is to support a statistical approach to the measurement of economic activity by estimating the volume of value added that sums up to the GDP aggregate. SNA states that it is not intended as a framework for measuring welfare (cf. SNA2008 §1.1 and § 1.75), and it does not even need to mention that it is not fit for resource use and environmental sustainability analysis."

History has given us several examples where economic growth was not followed by more remarkable progress in human development but rather by greater inequality, unemployment, overconsumption, or depletion of natural resources (Soubbotina, 2004). The following issues are arising connected with the continuous economic growth, such as:

- > pollution of air, soil, and water caused by the continuously increasing economic activities;
- > depletion of natural resources caused by unsustainable continuous usage of unrenewable natural resources;
- related social issues, such as inequality.

As Samuelson and Nordhaus mentioned in their earlier version of the Economics textbook (1995), in 1972, Nordhaus and Tobin discussed the criticism of the GDP as not meaningfully representing the national output. The methodological shortcomings are as follows:

- ➢ Not reflecting the activities produced by the underground economy and unpaid work;
- Not remembering the value of leisure;
- ▶ Not reflecting on how nature (ecosystem) is contributing to the economic activity.

Rethinking focus on the economic growth

Several previous publications touched upon GDP and economic growth and its future in Sustainable Development Era. Economists are calling for a rethinking of how we measure progress, such as Maxton (2011), as we can observe that the economic ideas and behavior in the last few hundred years of business and economics have not faced real progress at all because progress is expressed exclusively through objective indicators (and their material nature, for example, shopping and consumption) based on which improvement cannot be fully quantified. Modern society is characterized by growth obsession, often seen in the context of an exclusive increase in economic wealth (Ivkovic, 2016).

Samuelson's and Nordhaus' comment about economic growth is "a race between depletion and invention" (2010, p. 15). In general, there are two extreme views proposed in this sense. The first extreme view claims that our





society can't continue economic growth without destroying and completely exploiting our planet. The economists accepting this view propose two ways of dealing with the (EEA, 2021):

- Degrowth to slow down production and consumption and focus on other criteria for development than economic growth.
- > Post-growth to decouple economic growth and well-being and become agnostic about economic growth.

The IMF Working Paper on the Sustainable Development Goals (SDGs) and GDP (Alexander et al. 2018) brings awareness to "the need for GDP growth to be decoupled from environmental degradation and linked with sustainable production, consumption, and meaningful jobs." Such solutions are proposed at politically high levels, and related initiatives have been pursued, such as the European Green Deal and the U.N. Sustainable Development Goals. However, scientists have not yet provided a consensus on whether it is possible to return to the 19th-century level of decoupling (EEA, 2021).

The other opinion suggests that achieving our current economic growth rate is possible without destroying our environment. Economists following this thought are called "cornucopians," "technological optimists" (Samuelson & Nordhaus, 2010, p. 268), or "Ecomodernists" (EEA, 2021), and they believe that the human race and the market economy will cope with any limitations in resources by improving technological and scientific advancements. In between these two extreme views, several economic theories are rising. In general, those theories focus on "sustainable" economic growth and learning to live within the limitations of our scarce natural resources, or we will suffer dire and irreparable consequences." (Samuelson, 2010, p. 267). New economic growth theories evolved, such as Welfare economics (Encyclopaedia Britannica, 1998) or the Economy of Well-being (OECD, 2019). Other terms used in the context of the new sustainable growth are: a) "Balanced" (Mennillo et al., 2011), b) "inclusive" (The Scottish Government, 2022), c) "green" (OECD, 2011). To be able to measure the newly proposed growths, several challenges need to be addressed, such as the proper pricing of natural resources; effective pricing of environmental damage; market regulations targeting environment. Reflecting on these new economic growth theories and sustainable growth, new systems of economies have been proposed, such as circular (The Circular Economy in Detail, n.d.) or doughnut economy (Raworth, n.d.).



The Doughnut of social and planetary boundaries.

Figure 1. Doughnut economy framework

Source: Doughnut economics action lab (n.d.).



Also, several projects are underway, either in the context of corporate or national accounting, that are trying to create a new category of assets that will adequately capture natural resources and their value. Despite the fact mentioned by Samuelson (2010, p. 274) that "few would doubt that a healthy and clean environment has a high value, but placing reliable values on the environment, particularly on the nonmarket components, has proved a difficult business," several initiatives were realized in this direction, such as System of Environmental-Economic Accounting (U.N., 1993) and the UN SEEA system of ecosystem accounting (U.N., 2021).

Diving further into the theory of sustainable growth, in the book Human Ecology, Marten (2001) stated that "Economic growth is impossible to sustain if it depends upon ever-increasing quantities of resources from ecosystems with limited capacities to provide the resources. Nor is sustainable development a luxury to be pursued after economic development and other priorities such as social justice are achieved. Damaged ecosystems that lose their capacity to meet basic human needs close off economic development and social justice opportunities. A healthy society gives equal attention to ecological sustainability, economic development, and social justice because they are all mutually reinforcing." Marten, in the book, illustrates the interaction between the social system and ecosystem, emphasizing the energy, material, and information outflows and inflows between the two ecosystems."



Figure 2. Interaction of the human social system with the ecosystem

Source: Marten (2001).

The idea of connecting the ecosystem and social system with the economic system was further developed by the 'Gross Ecosystem Product' project, measuring the ecosystem's contribution to human well-being, which started in 2015 in China. The project is based on the idea of using the GEP as a measure of the ecosystem's contribution, GDP as a measure of the economic system's contribution, and the Human Development Index (HDI) as a measure of the social system's contribution to the sustainable growth (Ouyang, 2020).





\$ sciendo

AR&P

Figure 3. Interrelation of the three main systems in measuring the nation's growth and development

Source: Adopted from Ouyang (2020).

Chronological overview of the practical initiatives tackling the issues related to GDP and economic growth measurement

Hand in hand with the theoretical developments, practical initiatives have been taking place to handle the issues related to economic growth measurements and GDP. The detailed chronological evolution of different newly proposed measures, indices, and statistical standards have been developed by Gajdosova (2023), and it is presented below.









Figure 4. Timeline of initiatives to handle the issues related to economic growth measurement

Source: Gajdosova (2023).

Methodology and research methods

This paper consists of two parts, the theoretical and the empirical part. Firstly, we analyzed the existing literature on the importance of economic growth in the future and developments in the field of GDP measurement. The paper also presents a chronological overview of the practical work regarding the newly proposed measurements, indices, and statistical standards related to the transition to sustainable growth.

The empirical part of the paper focuses on the comparison of the ranking of the six countries with the highest achieved GDP in 2020 based on the three criteria:





AR&P

- Ranking based on the GDP growth;
- Ranking based on the simple three-dimensional index, representing the three main systems; economic (GDP), social system (Human Development Index), and ecosystem (Environmental Performance Index in the future to be replaced by the Gross Ecosystem Product);
- Ranking based on our designed three-dimensional holistic index of the nation's growth (HNG).

Methodological process

To perform the analysis mentioned above and comparison and to construct the two indicated indices, the following methodological process was followed:

1	Identification and definition of the
т	necessary systems
~	Identification of the relationships between
2	the systems
3	Selection of measures
4	Data collection
5	Index calculation (in SuperDecisions)

Identification and definition of the necessary systems and their relationships and measures

The simple three-dimensional index is based on the theory that the nation's development depends on the three main systems; the economic, social, and ecosystem. Therefore, this kind of indicator should better estimate the true nation's growth than the GDP growth alone.



Figure 5. Simple three-dimensional index of the nation's growth

Source: Adopted from Ouyang (2020).

The HNG index is further used to test the null hypothesis that the economic growth measured solely by the GDP differs from the holistic economic growth measured by the HNG. The HNG index is a more complex threedimensional measure of the nation's growth, incorporating the three main systems like the simple index (economic, social, and ecosystem) but also taking into account the sub-systems that are created by the interconnection of the main systems: the socio-economic system, the environmental-economic system, the socio-ecological system.

Figure 5 illustrates the three main systems and three sub-systems and their interrelationship, together with the indexes and measures selected to calculate the HNG index. The relationship between the systems and the measurements is also considered when constructing the HNG index.



Socio-ecological system

Figure 6. Holistic three-dimensional index of nation's growth (HNG)

Source: author's compilation.

To represent the three sub-systems, further measures were selected, and the HNG model uses 12 measures in total. The Socio-Economic system is referenced by the unemployment rate, wealth distribution (Palma), Economic Freedom Index, and Global Innovation Index. The Climate risk index and carbon footprint represent the Environmental-economic system. The Happiness Index, household consumption, and consumption-based CO2 represent the socio-ecological.

The simple index and the holistic index HNG are constructed as a rating model based on Analytical Hierarchical Process (AHP) using the free online software 'SuperDecisions.' The AHP method was developed by Professor Thomas Saaty (SuperDecisions, n.d.), and he supported the development of the SuperDecisions software.

The AHP is, according to its developer, professor Saaty (1987), "a general theory of measurement. It is used to derive ratio scales from discrete and continuous paired comparisons.... It has found its widest applications in multi-criteria decision-making, planning and resource allocation, and conflict resolution. In its general form, the AHP is a nonlinear framework for carrying out both deductive and inductive thinking without using syllogism by considering several factors simultaneously and allowing for dependence and feedback, and making numerical tradeoffs to arrive at a synthesis or conclusion."

This method is well-suited for this paper, as Professor Saaty (1987) already illustrated in his article an example of the use of the AHP in reflecting on the 'overall welfare of a nation.' Also, the method of AHP has already been used in other forms of sustainability assessment based on the multi-dimensional nature of the concept (Hermann et al., 2007; Krajnc & Glavič, 2005; Singh et al., 2007). The structure of AHP is illustrated below:



ち sciendo



Figure 7. The Structure of the analytic-hierarchy process (AHP) process.

Source: Razikin & Isa (2013)

Based on the analyzed theoretical background, economic growth cannot be sustained if it depends upon everincreasing demand quantities of resources from an ecosystem with limited resources (Marten, 2001). Therefore, stable economic growth needs to be sustainable and consider all three main systems, not only the economic system but also the social system and ecosystem.

The decision tree of the rating model of the simple three-dimensional index is represented in Figure 8 below:



Figure. Simple three-dimensional index of nation's growth AHP hierarchy

Source: author's compilation.

The step-by-step process of AHP hierarchy analysis of the simple three-dimensional index in the SuperDecisions software is demonstrated on the screenshots from the software below:







File Design	Comput	stions k	ole development _.	simple.sumou. ra	atings			
Boe	Main N	Vetwo	ork: rating	sustainab	le development si	mple.sdmod: ratings//		
Information F	Panel		Net	vork	Judgmer	nts Ratings		
Net: 0								
Node: Cluster: socia	al sub			160	oal 🛛 🗐 🛨			
Attachments						2criteria	economic_sub	Ð
Model Struct	ure			Goo	al Node 🛛 🔽 🖸	1Economic_syst 🖊 🗍	GDP 🛛 🖸	
model Struct	ure .					2social system		
Create/Edit D	letails						<u>੫</u>	
Show Prioritie	es					3ecosystem		
Make/Show C	Connections			_				
				Θ	Add Node	Add Node	Add Node	
							social sub	3
						Environmental_Z	Human_Develor 🖊 🔽	1
						Add Node	Add Node	
Main Netw	vork: rating_s	sustainabl	le development_s	imple.sdmod: rat	lings			- 0 ×
File Design	Computa	tions H	elp					
Щ®	Main N	letwoi	rk: rating_	sustainabl	<u>e development_sin</u>	nple.sdmod: ratings//		
nformation Pa	anel		Netv	/ork	Judgmen	ts Ratings		
Net: 0			1	Choose	2 Cluster co	mparisons with respect to 2c	riteria - 3 Results	
Node: Cluster: social	Leub		Node (luctor	Graphical Verbal Matrix			• •
Attachments	_300		Chor	se Cluster	economic sub is ?	????? more Preference than ecosystem s	sub	Hybrid -
						, _	Inconsistency: 0.0000	0 3333
Model Structu	ire				1. economic_sub >=	9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5	No comp. ecosystem~	0.3333
Create/Edit De	etails				2. economic_sub >=	9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5	No comp. social_sub	0.3333
Show Priorities	s		0		3 accevetors our and			
Make/Show C			-		J. ecosystem_su-	9.5 9 8 7 6 5 4 3 2 7 2 3 4 5 6 7 8 9 >=9.5	No comp.	
widke/Show C	onnections				J. ecosystem_au	9.5 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 >=9.5	No comp.	
wake/show C	onnections				o. ecosystem_su	95 9 8 / 0 5 4 3 2 2 3 4 5 0 / 8 9 >=95	No comp.	
Hake/Show C	onnections				o. ecosystem_suv=	us	No comp.	
Hake/Show C	onnections		•		d. ecosystem_sd	n°a a a 1 0 3 4 3 5 1 3 4 2 0 1 8 A >≅n°3	No comp.	
wake/show C	onnections				. eusystem_su - 22	us u 8 / 0 3 4 3 2 2 3 4 5 0 / 8 U >≋us	No comp.	
make/ Show C	connections		0			us u u (u s 4 3 2 2 3 4 5 0 7 8 U >≈9.5	No comp.	
nakt/SNOW C	connections				. ecosystem_se	us u 8 / 0 3 4 3 2 2 3 4 5 0 / 8 U >≋us	No comp.	
nake/SNOW (connections		0		. ecosystem_se	us y y y y y y y y y	No comp.	
nakt/SNOW (connections		•			us	No comp.	
Main Netw	vork: rating_	sustainab		simple.sdmod:	ratings	n°a a a 1 a a a a a a	No comp.	- 0
Main Netw File Design	vork: rating_ Comput	_sustainab ations H	Die development Help	_simple.sdmod: 1	ratings	n°a a a 1 a a a a a a	No comp.	- 0
Main Netw File Design	vork: rating Compute Main N	sustainab ations H Vetwo	Die development Help Drk: rating	_simple.sdmod: sustainal	ratings	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design	vork: rating_ Compute Main N	sustainat ations F Netwo	ble development Help Drk: rating	_simple.sdmod: _ <u>sustainal</u> nents	ratings ble development_s Ratings	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design H I I I I I I I I I I I I I I I I I I I	work: rating Computer Main N	sustainat ations F Netwo	ble development Help Jung Jung Jung	simple.sdmod: sustainal beents	ratings ble development_s Ratings	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design	vork: rating Comput Main N Select criteria	sustainat ations F Netwo a for ratin	ble development telp jrk: rating Judgn g alternatives	_simple.sdmod: _ <u>sustainal</u> eents	ratings ble development_s Ratings	simple.sdmod: ratings//	No comp.	- 0
Main Network File Design Vetwork Step 1: S Step 2: A	vork: rating Compute Main N Select criteria Add alternat	_sustainat ations F Netwo a for ratin ives	ble development Help Jrk: rating Judgn g alternatives	_simple.sdmod: sustainal ients	ratings ble development_s Ratings	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Compared to the second Step 1: Step 2: A Step 3: D	vork: rating Compute Main N Select criteria Add alternat Define rating	sustainab ations F Netwo a for ratin ives a scale for	ble development Help prk: rating Judgn g alternatives re each criterion	_simple.sdmod: sustainal hents	ratings ble development_s Ratings	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Vetwork Step 1: S Step 2: A Step 3: D Ratings Tal	vork: rating Compute Main N Select criterie Add alternat Define rating ible	sustainab ations F Netwo a for ratin ives a scale for	Die development Help Dirk: rating Judgn g alternatives reach criterion	_simple.sdmod: _ <u>sustainal</u> pents	ratings ble development_s Ratings	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Design Step 1: S Step 2: A Step 3: D Ratings Tal Jisplay Option	vork: rating Compute Main N Select criteria Add alternat Define rating bble ons Sho	sustainab ations F Netwo a for ratin ives g scale for ow/Hide	De development Help Drk: rating Judgn g alternatives reach criterion	_simple.sdmod: _ <u>sustainal</u> ients	ratings ble development_s Ratings Manage Ratings	simple.sdmod: ratings//		- 0
Main Netw File Design Design Step 1: S Step 2: A Step 3: D Ratings Tal isplay Option Category N.	vork: rating a Computa Main N Select criteria Add alternat Define rating Ible ons Shot ames F	sustainaa ations + Netwo a for ratin ives y scale for ow/Hide	Die development Help rrk: rating Judgn g alternatives r each criterion Calculat	.simple.sdmod: <u>sustainal</u> ients ions	ratings ble development_s Ratings Manage Ratings Copy Ratings Table to Clipb	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Design Step 1: S Step 2: A Step 3: D Ratings Tal Visplay Option Category Pr Category Pr	work: rating Compute Main N Select criteria Add alternat Define rating ible ons Sho riorities T	sustainat Netwo a for ratin ives g scale for ow/Hide Criotites Col	ble development Help rrk: rating Judgn g alternatives r each criterion column Synthe	simple.sdmod: _ <u>sustainal</u> ients ions ions ize whole mode	ratings ble development_s Ratings Manage Ratings Copy Ratings Table to Clipb Clear Ratings Judgments Clear Ratings Judgments	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design File Design Step 1: S Step 2: A Step 3: D Step 3: D Ratings Tal Step 3: D Category Na Category Pr Both	work: rating, Comput. Main N Select criteria Add alternat Define rating ible ons Shc iames F riorities T	sustainat sustainat Netwo a for ratin ives g scale for pow/Hide Priorities Col	ble development Help Judgn g alternatives reach criterion	_simple.sdmod: <u>sustainal</u> ients ions ize whole mode ize whole mode	ratings ble development_s Ratings Copy Ratings Copy Ratings Judgment Copy Ratings Judgment Copy Ratings Judgment Copy Ratings Judgment Revert to Relative Mode	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Design Design Step 1: S Step 2: A Step 3: D Ratings Tal Display Option Category Nr Category Pr Both	vork: rating Compute Main N Select criteria Add alternat Define rating bble Shames © F riorities © T	sustainab Netwo a for ratin ives g scale for pw/Hide Priorities Co	ble development Help prk: rating Judgn g alternatives r each criterion Column Synthe Col	simple.sdmod: sustainal ients ions ions ize whole mode umn Priorities	A acceptain at a second	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Design Step 1: S Step 2: A Step 3: D Ratings Tal Display Option Category Pr > Both Alternatives	vork: rating Comput Main N Select criteria Add alternat Define rating ible ons Shc ames F riorities T	sustainab ations P Netwo a for ratin vives g scale for pow/Hide crotals Col	each criterion Column Synthe Col GDP GDP GDD	_simple.sdmod: sustainal tents ions 	A anage Ratings Manage Ratings Manage Ratings Copy Ratings Table to Clipb Clear Ratings Judgments Revert to Relative Mode ental_p Human_Develop	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Step 1: S Step 2: A Step 2: A Step 2: A Step 3: D Ratings Tal Isplay Option Category Na Category Na Category Pr Both Alternatives 105A	vork: rating Compute Main N Select criteria Vorderine rating bble ons Sho arms P riorities T Priorities 0.2824	sustainaal ations Aletwoo a for ratim wves g scale for ovy/Hide Priorities C otals Colu Totals 0.4482	ble development telp prk: rating Judgn g alternatives reach criterion Synthe Column Synthe Col (1.0000) (20-15 mil	.simple.sdmod: 	Manage Ratings Manage Ratings Copy Ratings Table to Clipb Clear Ratings Table to Clipb Clear Ratings Table to Clipb Clear Ratings Table to Relative Mode ental.p Human_Develop (0.5000) 9.3-9.2	simple.sdmod: ratings//	No comp.	
Main Netw ile Design Design Step 1: S Step 2: A Step 3: D Ratings Tal isplay Option Category Nr. Both Alternatives 1USA 2China	vork: rating, Compute Main N Select criteria Add alternat Define rating bale ons Shot ames friorities T Priorities 0.2824 0.2071	sustainat ations H Aletwoo a for ratin vives y scale for pow/Hide Totals Col Totals 0.4482 0.3287	e development leip prk: rating g alternatives reach criterion Column Column Synthe Col GDP (1.0000) (1.0000) 20-15 mil	simple.sdmod: sustainal sents synthesize ions size whole mode imn Priorities Environm (0.5000) 70-50 40-30	A decoystant_ad	simple.sdmod: ratings//	No comp.	
Main Netw File Design Control Control Step 1: S Step 2: A Step 3: D Step 3: D Step 3: D Step 3: D Step 3: D Step 3: D Category Nr 2 Category Pr 3 Both Alternatives 1USA 2China 3Japan	work: rating Compute Main N Select criteria Add alternat Define rating ble Priorities T 0.2821 0.2821 0.1872	sustainab Netwo a for ratin vives y scale for pow/Hide Priorities Color 0.4482 0.4482 0.3287 0.2193	each criterion column Column Column Column Synthe Col Column Synthe Col Column Synthe Col Column Synthe Col Column Synthe Col Column Synthe Col Column Synthe Synthe	simple.sdmod: sourcessessessessessessessessessessessessess	A decoynamical and a constraints of the second seco	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Vetwork Step 1: S Step 2: A Step 3: D Ratings Tal Display Option Category Nr Category Nr Category Pr Both Alternatives 1USA 2China 3Japan 4Germany SUK	work: rating, Comput. Main N Select criteria Add alternat Define rating ble Priorities T Priorities 0.2824 0.2824 0.3822 0.1382	sustainab a for ratin ives g scale for ov/Hide Priorities C otals Colu 0.3287 0.32193 0.32193	ble development Help prk: rating Judgn g alternatives r each criterion Column Synthe Col GDP (1.000) (20-15 mil 14-10 mil 10-5 mil 3-2 mil	simple.sdmod: 	A acceptant at the second seco	simple.sdmod: ratings//	No comp.	- 0
Main Netw File Design Design Step 1: S Step 2: A Step 3: D Ratings Tal Display Option Category Pr Category Pr Category Pr Both Alternatives 1USA 2China 3Japan 4Germany 5UK 6India	vork: rating Comput Comput Main N Select criteria Add alternat Select criteria Define rating ble ms Shd ames F riorities T 0.2824 0.2071 0.1972 0.1975 0.0156	sustainab Netwo a for ratin vives g scale for priorities C orotals Colu 0.4482 0.3287 0.2193 0.2193 0.22531 0.0247	ble development Help prk: rating g alternatives r each criterion g synthe Col GDP (1,0000) (1,0000) 20-15 mil 14-10 mil 10-5 mil 3-2 mil 3-2 mil	simple.sdmod: 	A anage Ratings A anage Ratings A anage Ratings A clear Ratings Table to Clipb Clear Ratings Table to Clipb Clear Ratings Lable to Clipb A clear Ratings Lable t	simple.sdmod: ratings//	No comp.	

Figure 9. Simple three-dimensional index of nation's growth AHP hierarchy analysis process in the SuperDecisions software

Source: Source: author's compilation.





The enhanced HNG index follows a similar structure. However, it is further improved and incorporates 12 measures and the relationships between the main systems that form the sub-systems. Based on this idea, we developed the structure tree for the HNG index as follows.



Figure 10. HNG index AHP hierarchy

Source: author's compilation.

The importance of all three main systems is the same in both ranking models. Therefore, all three primary objectives weight 0.3333 with 0.0000 inconsistency (the inconsistency should not be higher than 0.10 for the model to be valid). Each objective has a relevant scale designed, and each objective value is recorded on the created scale.

The step-by-step process of AHP hierarchy analysis of the HNG index in the SuperDecisions software is demonstrated on the screenshots from the software below:









Information P	Main N											
Information P		etwori	k: rating_s	sustainable	development.sd	mod: ratings	4		_			
N-t-O	Panel		Netw	ork	Judgmer	nts	Ratings					
Node:			1.	Choose	2. Node con	nparisons v	vith respec	t to Goal N	ode	3. R	lesults	
Cluster:			Node Cl	uster	Graphical Verbal Matrix	Questionnaire Direct			Normal —	1		Hybrid 🛁
Attachments			Choose	se Node 🔳	Comparisons wrt	'Goal Node" not	de in "2criteria" o	cluster		Inconsisten		
Model Structu	ure		Goal	Node 🗕	1. 1Economic sv~	=9.5 9 8 7 6 5 4	3 2 2 3 4 5 6	7 8 9 >=9.5 No co	1Economi	c~		0.33333
Create/Edit De	etails		Clu	ster: 1Goal	2. 1Economic sv~ >=	=9.5 9 8 7 6 5 4	32123456	7 8 9 >=9.5 No co	mp. 3 3ecosyste	~ m		0.33333
Show Prioritie	s		Choos	se Cluster 🚽	3. 2social syst~ >	=9.5 9 8 7 6 5 4	32123456	7 8 9 >=9.5 No co	omp. 3			10.00000
Make/Show C	Connections			iteria 🚽								
										م م د	npleted 🏓 iparison 🌮	
File Design	Main N	itions Hel letwor	k: rating_s	sustainable	development.sd	lmod: ratings	11					
Network	ć		Judgme	nts	Ratings							
Step 1: S	Select criteria	for rating a	alternatives									
Step 1: S	Select criteria Add alternati	for rating a	alternatives									
Step 1: S Step 2: A New alternativ	Select criteria Add alternativ	for rating a ves Current alte	alternatives	Double click all	ternative to edit:							
Step 1: S Step 2: A New alternativ	Select criteria Add alternation ve name:	for rating a ves Current alte	ernatives	Double click al	ternative to edit:							
Step 1: S Step 2: A New alternativ	Select criteria Add alternation ve name: ative	for rating a ves Current alte 1USA 2China	ernatives	Double click all	ternative to edit:							
Step 1: S Step 2: A New alternativ Create Alterna	Select criteria Add alternative ve name: ative	for rating a ves 1USA 2China 3Japan 4Germany	ernatives	Double click all	ternative to edit:							
Step 1: S Step 2: A New alternativ Create Alternat Copy Alternat	Select criteria Add alternative ve name: ative tives	for rating a ves Current alte 1USA 2China 3Japan 4Germany 5UK	ernatives	Double click all	ternative to edit:							
Step 1: S Step 2: A New alternativ Create Alternat Copy Alternat Paste Alternat	Select criteria Add alternati ve name: ative tives tives	for rating a ves Current alte 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte	alternatives ernatives natives to delete ernative(s)	Double click all	ternative to edit:							
 Step 1: S Step 2: A New alternativ Create Alternation Copy Alternation Paste Alternation Step 3: E 	Select criteria Add alternatii ve name: ative tives tives Define rating	for rating a ves Current alte 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ea	ernatives enatives natives to delete ernative(s) ach criterion	Double click all	ternative to edit:							
 Step 1: S Step 2: A New alternativ Create Alternation Copy Alternation Paste Alternation Step 3: E Ratings Ta 	Select criteria Add alternatii ve name: ative tives tives Define rating uble	for rating a ves Current alte 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ea	ernatives enatives natives to delete ernative(s) ach criterion	Double click all	ternative to edit.							
 Step 1: S Step 2: A New alternativ Create Alternativ Copy Alternation Paste Alternation Step 3: E Ratings Ta Display Option 	Select criteria Add alternative ve name: ative tives Define rating bble ons Show	for rating a ves Current alte 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ei w/Hide	alternatives ernatives natives to delete ernative(s) ach criterion Calculations	Double click all	ternative to edit:	To rate an alterr	ative with respect t	to a criterion, click o	n a cell			
 Step 1: S Step 2: A New alternativ Create Alternat Copy Alternat Paste Alternat Step 3: E Ratings Ta Display Optio Category N 	Add alternative name: ative ative tives tives before rating able before show the second secon	for rating a ves Current altt 1USA 2China 3Japan 3Japan SUK Select alter Delete Alte scale for ea w/Hide iorities Colu	ernatives ernatives to delete ernative(s) ach criterion Calculations erm Synti	Double click all	ternative to edit: ternative ge Ratings y Ratings Table to Clipboard	To rate an alterr	ative with respect t	to a criterion, click o r the Rating scale int	n a cell tensities for that crit	erion.		
 Step 1: S Step 2: A New alternativ Create Alternativ Create Alternativ Create Alternativ Create Alternativ Step 3: E Ratings Ta Display Option Category N Category N Category N Category N 	Select criteria Add alternatin ve name: ative tives Define rating bible Unns Show lames Pririorities To	for rating a ves Current alts 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ei w/Hide iorities Colu- tals Colum	alternatives anatives to delete anatives to delete anative(s) ach criterion Calculations ann Synthesize Synthesize	Double click all	ternative to edit: ternative ge Ratings Ratings Table to Clipboar Clear Ratings Judgments	To rate an alterr then click the do Click to select th Move to the nex	ative with respect t wn arrow to display e one you think app cell by clicking with	to a criterion, click o the Rating scale inf biles.	n a cell tensities for that crit	erion,		
 Step 1: S Step 2: A New alternativ Create Alternativ Create Alternativ Create Alternativ Create Alternativ Step 3: E Ratings Ta Display Optio Category Pr Category Pr Both 	Select criteria Add alternatin ve name: ative tives bible bible bible show s Show armes @ Pri riorities @ To	for rating a ves Current alts 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ea w/Hide iorities Colum	Internatives Institutes Institutes Institutes Institutes Institutes Institutes Institutes Institutes Institute Insti	Double click all Save Edited Al Save Edited Al All Manu hesize Copy whole model C Priorities F	ternative to edit: ternative sge Ratings Ratings Table to Clipboar Jear Ratings Judgments Revert to Relative Model	To rate an alterr d then click the do Click to select th Move to the next	ative with respect t wn arrow to display c one you think app cell by clicking with	to a criterion, click o the Rating scale in lies. the mouse.	n a cell tensities for that crit	erion.		
 Step 1: S Step 2: A New alternativ Create Alternativ Copy Alternal Step 3: D Ratings Ta Step 3: D Category Pr Both 	Select criteria Add alternation ative name: ative tives tives Define rating bble ons Show lames Prinivities To Priorities To	for rating a ves Current alta 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ei w/Hide iorities Colum	atternatives anatives to delete anative(s) ach criterion Calculations and Synth Synthesize Column CO2	Double click all Save Edited Al Save Edited Al Annu hesize Copp whole model C GDP	ternative to edit: ternative sege Ratings Ratings Table to Clipboar Clear Ratings Judgments event to Relative Model unemployment_r	To rate an alterr d then click the do Click to select th Move to the nex climate_risk_index	ative with respect t wn arrow to display c cell by clicking with criticking with Environmental_p	to a criterion, click o the Rating scale in lies. h the mouse.	n a cell tensities for that crit Global_innovatio	erion.	Human_Develop	wealth_Gi *
 Step 1: S Step 2: A New alternativ Create Alternativ Create Alternative Step 3: E Ratings Ta Display Optio Category Pr Both Alternatives 	Select criteria Add alternatin ve name: ative tives tives bble Define rating bble Define rating bble Priorities To	for rating a ves Current alta 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ei w/Hide iorities Colu tals Colum Totals	Internatives Institutes Institute	Pouble click all Save Edited AJ Save Edited AJ All hesize Copy whole model C Priorities f (0.2000)	ternative to edit: ternative age Ratings / Ratings Table to Clipboars Zear Ratings Judgments Revert to Relative Model unemployment_r (0.2000)	To rate an alterr d then click the do Click to select th Move to the next (0.3333)	ative with respect t wn arrow to displaye cell by clicking with Environmental_p (0.3333)	to a criterion, click o the Rating scale int the mouse. htppiness_index (0.333)	n a cell tensities for that crit Global_innovatio (0.2500)	erion.	Human_Develop (0.2500)	wealth_di # (0.2000)
 Step 1: S Step 2: A Step 2: A New alternative Create Alternative Copy Alternal Step 3: C Step 4: C<td>Select criteria Add alternati ve name: ative tives tives ble Define rating ble ons Show lames Priorities To Priorities 0.2147 0.117</td><td>for rating a ves Current altr 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ei w/Hide iorities Colum Totals Colum</td><td>alternatives anatives to delete enative(s) anative(s) a</td><td>Double click all Save Edited Al Save Edited Al Copy whole model Copy (0.2000) 20-15 mil</td><td>ternative to edit: ternative</td><td>To rate an altern d then click the do Click to select th Move to the next (limate_risk_index 0.3333) 20-25 40 so</td><td>ative with respect 1 wr arrow to display e one you think app : cell by clicking with Environmental.p. (3.3333) 70-60 wr an</td><td>to a criterion, click o the Rating scale int Jiles. htp:messindex (0.3333) 7-6 5 c</td><td>n a cell tensities for that crit Global_inpovatio 0.2500 70-60 72-60</td><td>erion.</td><td>Human Develop (0.2500) 9.3-9.2 9.5 5.9.4</td><td>wealth.di (0.2000) 1.5-2</td>	Select criteria Add alternati ve name: ative tives tives ble Define rating ble ons Show lames Priorities To Priorities 0.2147 0.117	for rating a ves Current altr 1USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ei w/Hide iorities Colum Totals Colum	alternatives anatives to delete enative(s) anative(s) a	Double click all Save Edited Al Save Edited Al Copy whole model Copy (0.2000) 20-15 mil	ternative to edit: ternative	To rate an altern d then click the do Click to select th Move to the next (limate_risk_index 0.3333) 20-25 40 so	ative with respect 1 wr arrow to display e one you think app : cell by clicking with Environmental.p. (3.3333) 70-60 wr an	to a criterion, click o the Rating scale int Jiles. htp:messindex (0.3333) 7-6 5 c	n a cell tensities for that crit Global_inpovatio 0.2500 70-60 72-60	erion.	Human Develop (0.2500) 9.3-9.2 9.5 5.9.4	wealth.di (0.2000) 1.5-2
 Step 1: S Step 2: A Vew alternative Create Alternative Copy Alternat Paste Alternative Step 3: E Ratings Ta Display Optio Category N Category Pr Both Alternatives 1USA 2China Jianan 	Select criteria Add alternative ative tives ble Define rating ble ons Show armes Priorities To Priorities 0.2147 0.1173 0.1173	for rating a ves Current alt 1USA 2China 3Japan 4Germany SUK Select alter Delete Alte scale for ei w/Hide iorities Colum Totals 0.2089 5 0.2356 1	Internatives Institutes Institutes Institutes Institutes Institutes Institute(s) In	Double click all Save Edited Al Save Edited Al Save Edited Al Hesize Copp whole model GDP (0.2000) 20-15 mil 10-5 mil	ternative to edit: ternative ternative age Ratings Ratings Table to Clipboar Clear Ratings Judgments Revert to Relative Model unemployment_r (0.2000) unemployment_r 0.2000 5.7 2.3	To rate an alterr d then click the do Click to select th Move to the next (u.3333) 20-25 40-50 10-5	ative with respect t wn arrow to display cell by clicking with Environmental_p (0.3333) 70-60 40-30 80-70	to a criterion, click o the Rating scale in lies. hthe mouse. happiness_index (0.3333) 7-6 6-5	n a cell tensities for that crit (0.2500) 70-60 53-57 50-53	erion. (0.2500) 	Human_Develop (0.2500) 9.3-9.2 9.5-9.4 9.3-9.2	wealth.cli (0.2000) 1.5-2 3.5-4 1-1.5
 Step 1: S Step 2: A New alternative Create Alternative Copy Alternative Step 3: D Ratings Ta Display Option Category N Category N Category N Category N Category N Alternatives 1USA Alternatives Japan 4Gernany 	Select criteria Add alternative ative tives tives bible ons Shov ames Priorities To Priorities To 0.2147 0.1173 0.1322	for rating a ves Current altt 1USA 2China 3Japan 4Germany SUK Select alter Delete Alte scale for ei w/Hide iorities Colu tals Colum Totals 0.3825 3 0.2386 1 0.2289 5 1 0.2385 1 0 0.2385 1 0.2385 1 0.2385 1 0 0.2385 1 0.2385 1 0 0 0 0 0 0 0 0 0 0 0 0 0	Internatives Institutes Institute	Copy Copy	ternative to edit: ternative age Ratings y Ratings Table to Clipboan Lear Ratings Judgments Revert to Relative Model unemployment_r (0.2000) 8-9 5-7 2-3 3-4	To rate an alterr d then click the do Click to select th Move to the next (0.3333) 20-25 40-50 10-5 13-15	ative with respect t wn arrow to displaye cell by clicking with Environmental_p (0.3333) 70-60 40-30 80-70	to a criterion, click o the Rating scale int here in the mouse. (0.333) 7-6 6-5 6-5 6-5 6-7	n a cell tensities for that crit (0.2500) 70-60 53-57 50-53 53-57	erion. (0.2500) -2-(4) -2-(4) -2-(4) -4-(-6) -4-(-6)	Human Develop (0.2500) 93-92 95-94 93-92 95-94	wealth_di = (0.2000) 1.5-2 3.5-4 1-1.5 1.5-2
 Step 1: S Step 2: A Step 2: A New alternative Create Alternative Step 3: C Ratings Ta Display Optio Category Pi Both Alternatives 1USA 2China 3Japan 4Gernany SUK 	Select criteria Add alternative ative tives bible Define rating bible Show riorities To Priorities 0.2147 0.1172 0.1322 0.1537 0.2296	for rating a ves Current alt 11USA 2China 3Japan 4Germany 5UK Select alter Delete Alte scale for ei w/Hide iorities Colu tals Colum 10.3825 3 0.2083 5 0.2356 1 0.2358 6 0.2358 6 0.2358 6 0.2358 6 0.2358 6 0.2358 6 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0.2358 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	atternatives arratives arratives to delete errative(s) arrative(s) claculations mn Synth arrative(s) claculations mn Synth arrative(s) colourn	Double click all Save Edited Al Save	ternative to edit: ternative ternative age Ratings Table to Clipboarn Car Ratings Ludgments Revert to Relative Model unemployment_r (0.2000) 8-9 5-7 2-3 3-4 4-5	To rate an alterr d then click the do Click to select th Move to the nex dimate_risk_index (0.3333) 20-25 40-50 10-5 13-15 70-75	ative with respect t wn arrow to display cell by cicking with Environmental_p (0.3333) 70-60 40-30 80-70 80-70 90-80	to a criterion, click o the Rating scale ini lies. https://www.click. https://wwwwwwwwwwwwwwwwwww.click. https://wwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwwww	n a cell folial innovatio (0.2500) 70-60 53-57 50-53 53-57 53-57 57-60	erion. (0.2500) - 22-41) - 22-41) - 42-61 10-(-15)	Human Develop (0.2500) 9.3-9.2 9.3-9.2 9.3-9.2 9.3-9.2 9.3-9.2	wealth di # (0.2000) 1.5-2 3.5-4 1-1.5 1.5-2 1.5-2

Figure 11. HNG index AHP hierarchy analysis process in the SuperDecisions software

Source: author's compilation.

Table 1. Data collected for the construction of the HNG index 2020 (in mil. U.S. \$)

	GDP (mil. U.S. \$	IQH	EPI (in the future GEP)	Carbon footprint (Total CO2 in Mt	Happin ess index	electric ity consumption per capita (kWh)	Econo mic freedom index	Unemp loyment rate	Popula tion growth	House hold consumption	te Risk index (CRI) umber better	ma ratio (2019) e better	Glo bal Innovation Index
ountry	hig her better	clo ser to 1 better	hig her the better	lo wer the better	hig her the better	lo wer the better	hig her the better	lo wer the better	hig her the better	lo wer the better	Clima higher the nu	Pal lower th	hig her the better
SA	1 9,377,380. 52	.92	9.3	535.3	.94	2,037	6.6	.1		3	3.83	.65 (2020)	0.56
hina	1 4,616,539. 91	.949	7.3	1680.42	.124	,429	9.5		.2	2.5	5.17	.86 (2011)	3.28
apan	4 ,363,130.6	.923	5.1	061.77	.871	,698	3.3	.8	0.3	5.3	.5	.28	2.7





	6											(2018)	
ermany	3 ,463,685.4 3	.944	7.2	36.88	.076	,871	3.5	.8	.1	5.7	3.83	.9	6.55
к	2 ,824,026.2 3	.924	1.3	13.73	.165	,585	9.3	.5	.4	13.2	3.83	.47 (2020)	9.78
ndia	2 ,508,593.7 5	.642	7.6	411.73	.573	,119	6.5			6	8.17	.09 (2011)	5.59

Source: World Bank Data (n.d.), Greenwatch (n.d.), World Happiness Report (2021), Heritage (n.d.), Human Development Reports (n.d), OECD (2020).

The following data for the relevant countries for 2020 were collected from various statistical sources and used in computing the indices.

Results

Theoretical analysis

The GDP as an economic growth measure is generally adopted and well-accepted due to its simplicity and objectivity. However, it also has several shortcomings when we assess it from the perspective of shifting toward sustainable growth. We can look at the deficiencies from a methodological and conceptual perspective.

The methodological shortcomings are as follows:

- > Not reflecting the activities produced by the underground economy and unpaid work;
- > Not remembering the value of leisure;
- > Not reflecting on how nature (ecosystem) is contributing to the economic activity.

The conceptual shortcomings are as follows:

- > Ignoring the depletion of the environment;
- > Including activities that are damaging the environment;
- > Not reflecting other factors of societal development and well-being;
- Includes activities not aligned with societal development (such as weapons trading, war activities, crime activities boosting consumption of certain goods, etc.);
- > Not reflecting the distribution of the income;
- > Not reflecting accurately contemporary trends in economic development, such as the value of social media.

After analyzing the various literature and research related to the future of economic growth as an indicator of a nation's growth and to the GDP as its measure, it is clear that there is a need to rethink how we view the development of our society. We are heading from the exclusive focus on economic growth towards focusing on more complex sustainable growth and development. Academics, researchers, national statistical institutions, and international organizations recognized the pressing need. They started to develop new measures that would reflect the new way of perceiving human development. Several concepts, measures, and indices were developed that aim to either adjust, complement, or replace GDP. Analyzing the newly proposed measures, we concluded that capturing a nation's growth and measuring it is a complex matter and will require more than one measure. The complexity must be captured by multi-dimensional measures incorporating various aspects necessary to nurture growth. Therefore, the future of the GDP is not clear when it comes to being only the measure of economic growth. However, it is increasingly becoming a part of more complex and dimensional measures that are continuously developed and tested.

Empirical analysis



To determine whether a country's short-term economic growth varies from its long-term perspective of growth, we performed a comparative analysis of the three different rankings of the six countries with the highest GDP achieved in 2020. The first ranking shows how countries perform in terms of the GDP annual growth (%).





Source: author's compilation.

		Weights	0.333333	0.3333334	0.3333335
Country	Rating	Priorities	GDP	Environmental performance index	Human Development Index
1. USA	0.448177	0.282432	1	0.19245	0.152082
2. China	0.328686	0.207131	0.415244	0.037037	0.533776
3. Japan	0.219281	0.138186	0.172427	0.333333	0.152082
4. Germany	0.312903	0.197185	0.071599	0.333333	0.533776
5. UK	0.253054	0.15947	0.029731	0.57735	0.152082
6. India	0.024748	0.015596	0.029731	0.021383	0.023129

Table 2. AHP ranking model results for the simple index 2020





Source: author's compilation.

Table 3 found Author's OneDrive. Please follo link can be the the at https://docs.google.com/spreadsheets/d/1PzJXtEHSU2f5zIIyFRJLA8oSM 7DtxV0 e93V0XEGOE/edit?usp=sh aring.

As it is clear from Figure 10, the highest annual GDP growth in 2020 was achieved in China. However, when looking at the simple multi-dimensional measure we constructed, China switches first with the USA. Only looking at the more complex and holistic multi-dimensional measure that incorporates the sub-systems, such as the socioecological, socio-economic, and environmental-economic systems, will reflect the long-term perspective of the nation's growth - sustainable growth.

On the third chart in Figure 11, it is evident that the national growth of China is not sustainable as opposed to the growth of the U.K. From this example, we can assume that China would be overexploiting the other two systems and the three sub-systems, to perform well economically in the short term. The U.K. seems not to balance well between short-term economic growth and potential growth, focusing more on the latter.

India seems to be a case of a country that is not doing well in terms of short-term economic growth and still lacks in increasing its potential for long-term sustainable growth. In some cases, however, we can observe that some countries kept their position regardless of the rating scheme.

Germany kept its ranking, whether looking at the short-term performance or the long-term perspective of sustainable growth. It seems that the economic growth of Germany is balanced, and the country is already incorporating the aspects of interconnected systems and sub-systems in its policies. A similar conclusion we can make out of our analysis of Japan.

The comparative study also reveals that only looking at three main systems, the economic, social, and ecosystem, is not enough to reflect the long-term potential of the nation's growth fully. It is necessary to look into and try to capture the relationships between the main systems.



Comparative analysis of the countries' rankings

Figure 13. Comparative analysis of the countries' ranking

Source: author's compilation.

Conclusions



During the decades of the wide usage and acceptance of the GDP as a measure of economic growth, it became apparent that it has several methodological and conceptual shortcomings. Several initiatives have been launched to improve or replace the GDP. Even though economic growth correlates with improving living standards, GDP cannot be used as a well-being and nation's growth measurement. Furthermore, the focus on economic growth started to be scrutinized more often as we also realized its negative aspects, such as environmental damage.

Analyzing the various literature and research, it is clear that the role of the GDP as a single measure of economic growth will be slowly decreasing in significance. However, GDP, as a part of more complex and multidimensional measures, will be booming shortly as we are becoming better at capturing the complexity and interconnectivity of our systems.

We also confirmed that measuring the GDP growth is relevant only for short-term economic growth and does not capture the potential of future growth or the nation's actual growth and development. The latter can be measured via multi-dimensional measures. We tested a simple three-dimensional measure already proposed in the literature, encompassing the economic, social, and ecosystem. This measure provides a better view of a country's potential and sustainable growth. However, it still fails to reflect on the interconnectivity of these systems.

Therefore, we designed a new measure, a more holistic nation's growth index (HNG), that also considers the three sub-systems: environmental-economic system, socio-economic system, and socio-ecological system. This index seems to capture well the complexity of economic growth in a more comprehensive way, as it also incorporates the long-term potential and sustainability of the nation's development.

This paper gives a clear vision for future research in economic growth that is long-term and sustainable. Further research can construct the HNG index over time and compare and analyze whether the respective countries are developing in the right direction. Another proposal would be to compare the HNG index with the SDG index, measuring the countries' progress in achieving their 17 sustainable development goals. This can serve as a reasonable control variable as it monitors the progress of 231 sustainable development indicators.

Author Contributions: conceptualization, Gajdosova, K.; methodology, Gajdosova, K.; software, Gajdosova, K.; formal analysis, Gajdosova, K.; resources, Gajdosova, K.; data curation, Gajdosova, K.; writing-original draft preparation, Gajdosova, K.; writing-review and editing, Gajdosova, K.; visualization, Gajdosova, K.; supervision, Gajdosova, K.; project administration, Gajdosova, K.

Conflicts of Interest: The author declares no conflict of interest.

Data Availability Statement: All the data used in the study are reported and publicly mentioned in the paper.

Informed Consent Statement: Not applicable.

References

- 1. Alexander, T., Dziobek, C., & Galeza, T. (2018). Sustainable Development Goals (SDGs) and GDP: What National Accounts Bring to the Table. *IMF Working Paper*. [Link].
- 2. Anielski, M. (2014). Alberta's Genuine Progress Indicator. *Encyclopedia of Quality of Life and Well-Being Research*, 128–133. [CrossRef].
- 3. Bartelmus, P., Stahmer, C., Tongeren, J. V. (1991). Integrated environmental and economic accounting: framework for a sna satellite system. *Review of Income and Wealth*, 37(2), 111–148. [CrossRef].
- 4. Binswanger, Hans. (2013). The Economic Process as a Growth Spiral. [CrossRef].
- 5. Cambridge Dictionary. (2023). Welfare definition. [Link].
- 6. Chelli, F. M., Ciommi, M., & Gigliarano, C. (2013). The Index of Sustainable Economic Welfare: A Comparison of Two Italian Regions. *Procedia Social and Behavioral Sciences*, 81, 443–448. [CrossRef].
- Costanza, R., d'Arge, R., de Groot, R., Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., **, O'Neill, R. V., Paruelo, J., Raskin, R. G., Suttonkk, P., Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, 387. Oak Ridge National Library. [Link].



 Darmstadter, J. (2000). Greening the GDP Is It Desirable? Is It Feasible? Resources for the Future, issue 139. [Link].

\$ sciendo

AR&P

- 9. Dodani, S., LaPorte, R. E. (2005). Brain drain from developing countries: how can brain drain be converted into wisdom gain? Journal of the Royal Society of Medicine, 98(11), 487–491. [CrossRef].
- 10.Econlib. (2018). Well-being and Welfare. [Link].
- 11.EEA. (2021). Growth without economic growth. European Environment Agency. [Link].
- 12.EOL (2022). n.d. Ease of Living (EoLI) Index India 2022. [Link].
- 13. Eunice Foote, "Circumstances Affecting the Heat of the Sun's Rays," *The American Journal of Science and Arts* 22, no. 66 (November 1856): 383–384. [Link].
- 14.Gajdosova, K. (2023). GDP in the context of Sustainable Development. International Academic Institute Journal (publishing in progress).
- 15. Greenlaw, G. A., & Shapiro, D. (2017). Principles of Economics 2e. OpenStax. [Link].
- 16.Hamilton, K., Clemens, M. (1998). Genuine Savings Rates in Developing Countries. The World Bank. [Link].
- 17.Hermann, B. G., Kroeze, C., & Jawjit, W. (2007). Assessing environmental performance by combining life cycle assessment, multi-criteria analysis, and environmental performance indicators. *Journal of Cleaner Production*, 15(18), 1787-1796. [CrossRef].
- 18. Ivkovic, A. F. (2016). Limitations of the GDP as a measure of progress and well-being. Ekonomski Vjesnik. Econviews. [Link].
- 19.K. Raworth. n.d. Doughnut Economics lab. [Link].
- 20.Kirchherr, J., Reike, D., Hekkert, M. 2017. Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221–232. [CrossRef].
- 21.Kovacic, Z., et al. (2019). The Circular Economy in Europe: Critical Perspectives on Policies and Imaginaries, Routledge. [Link].
- 22.Krajnc, D., & Glavič, P. (2005). A model for integrated assessment of sustainable development. *Resources, Conservation, and Recycling*, 43(2), 189-208. [CrossRef].
- 23.Marten, G. G. (2001). Human Ecology: Basic Concepts for Sustainable Development. Earthscan. [Link].
- 24.Maxton, G. (2011). The End of Progress (1st ed.). Wiley. Retrieved from [Link].
- 25.McCarthy P. 2018. Integrated frameworks for economic accounting standards. Eurostat. [Link].
- 26.Mennillo, G., Schlenzig, T., Friedrich, E. (2011). Balanced Growth: Finding Strategies for Sustainable Development. Springer Publishing. [Link].
- 27. Nautiyal, H., Goel, V. (2021). Sustainability assessment: Metrics and methods. *Methods in Sustainability Science*, 27–46. [CrossRef].
- 28.NEF. (2006). The (un)happy planet index. An index of human well-being and environmental impact. New Economics Foundation. [Link].
- 29.OECD. 2019. The Economy of Well-Being. Remarks by Angel Gurría. [Link].
- 30. Ouyang, Z. 2020. Gross Ecosystem Product (GEP). Virtual Expert Forum on SEEA Experimental Ecosystem Accounting 2020. [Link].
- 31.Ouyang, Z., Song, C., Zheng, H., Polasky, S., Xiao, Y., Bateman, I. J., Liu, J., Ruckelshaus, M., Shi, F., Xiao, Y., Xu, W., Zou, Z., & Daily, G. C. (2020). Using gross ecosystem product (GEP) to value nature in decision-making. *Proceedings of the National Academy of Sciences*, 117(25), 14593–14601. [CrossRef].
- 32.Payden, Rygel. (2012). GDP: What's it good for? Point of View. [Link].
- 33.R.W. Saaty (1987). The analytic hierarchy process—what it is and how it is used, *Mathematical Modelling*, 9, (3–5), 49–68. [CrossRef].
- 34.Raza, A., Sui, H., Jermsittiparsert, K., Żukiewicz-Sobczak, W., & Sobczak, P. (2021). Trade Liberalization and Environmental Performance Index: Mediation Role of Climate Change Performance and Greenfield Investment. *Sustainability*, 13(17), 9734. [CrossRef].
- 35.Razikin, M.A.M.; Isa, H. The use of analytical hierarchy process (AHP) in the product development process. In Proceedings of the International Symposium on the Analytic Hierarchy Process, Kuala Lumpur, Malaysia, 23–26 June 2013. [Link].
- 36.Rittenberg, L. & Tregarthen, T. (2009). Principles of Economics. Flat World Knowledge. [Link].

AR&P



- 37.Samuelson, Paul A., William D. Nordhaus. (2010). Economics (Nineteenth Edition). New York: McGRAW HILL. [Link].
- 38.Schweinfest, S., Alfieri, A., Chan, J. Y., Edens, B. n.d. The Rise, Fall and Rethinking of Green GDP | System of Environmental Economic Accounting. United Nations. [Link].
- 39.SEDAC. n.d. Environmental Sustainability Index, 2005 Release: Environmental Sustainability Index (ESI), Columbia University. [Link].
- 40.Sen, K. 2021. Why should I care about economic growth? UNU-WIDER. Retrieved January 30, 2023, from [Link].
- 41.Singh, R. K., Murty, H. R., Gupta, S. K., & Dikshit, A. K. (2007). Development of composite sustainability performance index for steel industry. *Ecological Indicators*, 7(3), 565-588. [CrossRef].
- 42.Soubbotina, T. P. (2004). Beyond Economic Growth An Introduction to Sustainable Development.WBI learning resources series. [Link].
- 43. Stanford University. (2022). Gross Ecosystem Product (GEP) (Beijing, China). Natural Capital Project. [Link].
- 44.Super Decisions. (n.d.). Super Decisions. [Link].
- 45.Sverko Grdic, Z., Krstinic Nizic, M., & Rudan, E. (2020). Circular Economy Concept in the Context of Economic Development in E.U. Countries. *Sustainability*, 12(7), 3060. [CrossRef].
- 46.System of Environmental Economic Accounting. (n.d.). [Link].
- 47. The Circular Economy in Detail. n.d. [Link].
- 48. The Scottish Government. 2022. Inclusive growth: what does it look like? [Link].
- 49. Tone, S. (2021, April 12). GEP, a Green Alternative to GDP, Gaining Ground in China. #SixthTone. [Link].
- 50.U.N. (1993). System of Environmental Economic Accounting. [Link]
- 51.U.N. (2021). System of Environmental-Economic Accounting— Ecosystem Accounting (SEEA EA). White cover publication, pre-edited text subject to official editing. [Link].
- 52.UN. (1987). Report of the World Commission on Environment and Development: Our Common Future. [Link].
- 53.UN. (n.d.) The 17 goals. Sustainable Development. [Link].
- 54. Weitzman, m. L., Lofgreno, K. G. (1997). On the Welfare Significance of Green Accounting as Taught by Parable. *Journal of Environmental Economics and Management*, 32, 139/153. [Link].
- 55. World Bank Open Data. (n.d.). World Bank Open Data. [Link].
- 56.Ye, Y. (2021). GEP, a Green Alternative to GDP, Gaining Ground in China. #SixthTone. [Link].