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A Theoretical and Practical Approach to Exponential Relation between Innovation and Sustainable Development

Teoretyczne i praktyczne podejście do wykładniczej relacji między innowacjami a zrównoważonym rozwojem

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Abstract
Aside from the political, geographic, economic, legal, social, and cultural problems that every nation, state, and government faces, it is evident that sustainable development is the key to sustainability, progress, and improving the quality of life. Achieving SDG targets has been seen as the primary trend for the past 15 years and the foreseeable future. In this direction, with an eye towards the fifth industrial revolution, innovation has been viewed as one of the primary production variables, along with land, labor, capital, and entrepreneurship, to help address current and future difficulties facing humanity. This study aimed to shed light on the connections between innovation and sustainable development. To test Hypothesis H1, which states a positive solid relationship between the SDG Index and ISO 9001 Index, we conducted a statistical analysis using regressive analysis between the Sustainable Development Goals Index and Innovation Index. This was done to compare the results to Hypothesis H0, which suggests no such relationship exists. The research's findings indicate that scientific management of the factors of production opens up possibilities for long-term sustainable development, ensuring the prosperity of society and everyday life for future generations, encouraging economic growth, and improving the quality of life without endangering the environment. Innovation, embodied in the ISO 56000 family of standards, is applied as an efficient and effective tool, which is urgently needed. The overall conclusion of the study – which also serves as a practical and social contribution to the field – is that, to achieve and sustain sustainable development scenarios, all interested parties – individuals, public and private institutions, decision-makers, and civil society – should look forward to ensuring that the SDG and innovation are built and maintained. Innovation principles can be applied as effective and efficient tools.

Key words: SDG Index, innovation index, ISO 56000, quality management

Streszczenie
Oprócz problemów politycznych, geograficznych, ekonomicznych, prawnych, społecznych i kulturowych, przed którymi stoi każdy naród, państwo i rząd, oczywiste jest, że zrównoważony rozwój jest kluczem do postępu i poprawy jakości życia. Osiąganie Celów zrównoważonego rozwoju jest postrzegane jako główny trend w dającej się przewidzieć przyszłości. W tym kierunku, z myślą o piątej rewolucji przemysłowej, innowacje są postrzegane jako jedna z głównych zmiennych produkcyjnych, obok ziemi, pracy, kapitału i przedsiębiorczości, pomagająca stawić czoła obecnym i przyszłym trudnościom stojącym przed ludzkością. Celem tego badania było ukazanie powiązania pomiędzy innowacjami a zrównoważonym rozwojem. Aby przetestować Hipotezę H1, która stwierdza pozytywną, solidną zależność pomiędzy Indeksem SDG a Indeksem ISO 9001, przeprowadziliśmy analizę statystyczną przy użyciu analizy regresyjnej pomiędzy Indeksem Celów Zrównoważonego Rozwoju a Indeksem Innowacji. Dokonano tego w celu porównania wyników z Hipotezą H0, która sugeruje, że taka zależność nie istnieje. Wyniki badań wskazują, że naukowe zarządzanie czynnikami produkcji otwiera możliwości długoterminowego, zrównoważonego rozwoju, zapewnienia dobrobytu społeczeństwa i życia codziennego przyszłym pokoleniom, wspierania wzrostu gospodarczego i poprawy jakości życia bez zagrażania środowisku. Innowacja zawarta w grupie norm ISO 56000 może być stosowana jako wydajne i skuteczne narzędzie, które jest pilnie potrzebne. Ogólny wniosek z badania – które

stanowi również praktyczny i społeczny wkład w tę dziedzinę – jest taki, że aby osiągnąć i utrzymać scenariusze zrównoważonego rozwoju, wszystkie zainteresowane strony – osoby fizyczne, instytucje publiczne i prywatne, decydenci i społeczeństwo obywatelskie – powinniśmy z niecierpliwością oczekiwać stworzenia i utrzymania Celów zrównoważonego rozwoju i innowacji. Zasady innowacji można zastosować jako skuteczne i wydajne narzędzia.

Słowa kluczowe: indeks Celów zrównoważonego rozwoju, indeks innowacji, ISO 56000, zarządzanie jakością

1. Introduction

This critical analysis article on sustainability studies examines the relationship between innovation and the Sustainable Development Goals since both are crucial for enhancing life quality and maintaining healthy ecosystems. Innovation and sustainable development are meant to go hand in hand, as reflected in the ISO 56000 standards family. This research's primary question was examined using quantitative techniques and regression analysis of the relationships between the Innovation Index and the Sustainable Development Goals Index. It was previously thought that sustainable development and innovation were significant, related domains and that segregated data and materials about these topics existed, along with previously published works, scholarly article books, and online libraries. Since production elements are becoming increasingly susceptible to abuse, damage, pollution, corruption, and other dangers, quality management principles and ISO standards must be implemented immediately. All stakeholders, including decision-makers and civil society, should collaborate to achieve the UN Sustainable Development Goals 2030 agenda. This is because there are currently insufficient methods, systems, and techniques for improving innovation processes, which could lead to new products and services, improved business climates, competitive advantages, and innovative ones that would have a positive impact on economic growth and the enhancement of life quality as part of long-term sustainability and development.

2. Materials and methods

Aiming to achieve human development goals while allowing natural systems to continue offering humans the ecosystem services and natural resources they require, sustainable development is an organizing concept (Johnson, Baldos, Corong, Hertel, Polasky, Cervigni, Roxburgh, Ruta, Salemi, Thakrar, 2023). A civilization where resources and living conditions satisfy human needs without jeopardizing the stability and integrity of the earth is the intended outcome (Robert, Parris, Leiserowitz, 2005; Mensah, 2019). Sustainable development aims to balance social progress, environmental protection, and economic growth. Sustainable development means meeting present needs without compromising future generations (Brundtland Report, 1987).
The Rio Process, which was started during the Rio de Janeiro Earth Summit in 1992, was the first attempt to institutionalize sustainable development. In 2015, the United Nations General Assembly approved the Sustainable Development Goals (SDGs) to achieve global sustainable development. The SDGs explain how the goals are interconnected and indivisible (Purvis, Mao, Robinson, 2019). The 17 objectives of the UNGA address issues such as poverty, inequality, environmental degradation, climate change, peace, and justice. The concept of sustainability as a norm has connections to sustainable development. *Sustainability is often thought of as a long-term goal (i.e., a more sustainable world), while sustainable development refers to the many processes and pathways to achieve it*, according to UNESCO's formulation of the contrast between the two ideas (UNESCO, 2015). The notion of sustainable development has faced numerous critiques. Although some view development as oxymoronic or paradoxical and believe it to be intrinsically unsustainable, others are dissatisfied with the meager progress made thus far (Brown, 2015; Williams, Millington, 2004). The fact that *development* is not defined consistently is one aspect of the issue (Berg, 2020; Clark and Alicia, 2020).
Capacities for long-term growth. To successfully pursue sustainability, six interconnected capacities are required: (a) gauge the system's progress towards sustainable development;
(b) advance equity within and between generations;
(c) adjust to shocks and surprises;
(d) move the system towards more sustainable development pathways;
(e) connect knowledge to action for sustainability and
(f) create governance structures that enable people to collaborate in using other abilities.
The United Nations World Commission on Environment and Development published the Brundtland Report (UN, 1987), often known as Our Common Future, in 1987. One *sustainable development* definition mentioned in the report is now commonly used (Keeble, 1988). Sustainable development satisfies current needs without jeopardizing the capacity of future generations to satisfy their own. It includes two essential ideas:

- The belief that the environment's capacity to supply present-day needs and those of the future is constrained by the state of technology and social organization and
- The concept of *needs*, in particular, the basic needs of the world's poor, to which primacy should be accorded.

Thus, sustainable development looks for a balance between social progress, environmental preservation, and economic growth. The Sustainable Development Goals (SDGs), also called the Global Goals, consist of 17 interconnected objectives. They are designed to serve as a *shared blueprint for peace and prosperity for people and the planet, now and in the future* (UN, 2017). Resolution on the 2030 Agenda for Sustainable Development, Work of the Statistical Commission, adopted by the General Assembly on Jul 6, 2017 (Isnaeni, Dulkiah, Wildan, 2022).

The short titles of the 17 SDGs are:

1. No Poverty
2. Zero hunger
3. Good health and well-being
4. Quality Education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation, and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice, and strong institutions
17. Partnerships for the goals

By placing sustainability at its core, the SDGs highlight sustainable development's interrelated environmental, social, and economic dimensions (Schleicher, Schaafsma, Vira, 2018; Bali Swain, Yang-Wallentin, 2020). The UNGA established the SDGs in 2015 as a component of the Post-2015 Development Agenda. In place of the Millennium Development Goals, which were finished that year, this agenda aimed to create a new framework for global development (Biermann, Kanie, Kim, 2017). These objectives were publicly stated and approved in a UNGA resolution known as the 2030 Agenda or Agenda 2030 (UN, 2015).

A UNGA resolution establishing concrete targets for each goal and offering metrics to gauge progress was adopted on Jul 6, 2017, making the SDGs more practically applicable (UN, 2017). While some goals have no deadline, most are expected to be completed by 2030.

2.1. Innovation

Innovation is the practical implementation of ideas that result in introducing new goods or services or improving the offering of goods or services (Opie, Elliott, 1983). ISO TC 279 in the standard ISO 56000:2020 (ISO, 2020) defines innovation as *a new or changed entity realizing or redistributing value*.

2.2. Innovation ISO standards family – ISO 56000

By providing a broad framework, the ISO 56000 family of standards and guide documents aims to assist organizations in effectively implementing, maintaining, and continually enhancing an innovation management system (ISO, 2020; Liehr, 2023; Meyer, 2020).

The family consists of the following standards:

1. ISO 56000:2020: Innovation management — Fundamentals and vocabulary.
2. ISO/AWI 56001: Innovation management — Innovation management system — Requirements.
3. ISO 56002:2019: Innovation management — Innovation management system — Guidance.
4. ISO 56003:2019: Innovation management — Tools and methods for innovation partnership — Guidance.
5. ISO/TR 56004:2019: Innovation Management Assessment — Guidance.
6. ISO 56005:2020: Innovation management — Tools and methods for intellectual property management — Guidance.
7. ISO 56006:2021: Innovation management — Tools and methods for strategic intelligence management — Guidance.
8. ISO/DIS 56007: Innovation management — Tools and methods for idea management — Guidance.
9. ISO/CD 56008: Innovation management — tools and methods for innovation operation measurements — Guidance.
10. ISO/DTS 56010: Innovation management — Illustrative examples of ISO 56000.

Innovation frequently occurs when creators create more efficient goods, procedures, services, technology, artwork, or business models available to the public, governments, and markets (Lijster, Thijs, 2018). According to Forbes (Forbes, 2015), innovation is more likely to involve the practical application of an invention – that is, a new or improved ability to significantly impact a market or society – than the invention itself. Additionally, not all innovations necessitate new inventions, as noted by Schumpeter (Schumpeter, 1939).

When a technical or scientific challenge must be solved, engineering is frequently how technical innovation appears. Diverse definitions of innovation have been discovered through surveys of the literature. A 2014 survey found over 40 definitions, compared to about 60 found by Baregheh et al. in 2009 across various scientific journals (Edison, Ali, & Torkar, 2014). *Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services, or processes, to advance, compete, and differentiate themselves successfully in their marketplace*, concluded Baragheh et al. after analyzing the results of their survey to create a multidisciplinary definition (Baregheh, Rowley, Sambrook, 2009).

Peter Drucker states that innovation is the unique role of entrepreneurship, regardless of the setting—a family kitchen, an established company, or a public service organization. It is the process by which the business owner either develops fresh resources capable of generating wealth or gives existing resources more capacity to do so (Drucker, 2002).

2.3. Economics and Innovation

Economist Robert Solow showed that economic growth consisted of two parts in 1957. The first element is an increase in production that includes capital and wage labor. Productivity was determined to be the second component. Since then, instead of presuming that technological advancements and inventions lead to increases in productivity, economic historians have attempted to understand the process of innovation itself (Dudley, 2012).

Joseph Schumpeter, who characterized the economic consequences of innovative processes as *constructive destruction*, was primarily responsible for the emergence of the concept of innovation following World War II. Consistent neo-Schumpeterian scholars of today perceive innovation processes as anything other than neutral or apolitical (Jasanoff, Kim, 2015; Papaioannou, 2020). Instead, it is possible to view innovations as socially produced processes. As a result, how innovation is conceptualized relies on the political and social environment in which it occurs (Robra, Pazaitis, Giotitsas, Pansera, 2023). *Today, innovation is best understood as an innovation under capital,* claims Shannon Walsh (Walsh, 2021). The appropriation of knowledge (for example, through patenting), the widespread practice of planned obsolescence (including lack of repairability by design), and the Jevons paradox – which characterizes negative consequences of eco-efficiency as energy-reducing effects tend to trigger mechanisms leading to energy-increasing effects – all indicate that the current hegemonic purpose for innovation is capital valorization and profit maximization (Lange, Pohl, Santarius, 2020).

2.4. Measuring sustainable development and innovation

It is widely acknowledged that to move the focus from assessing economic events to monitoring sustainable development, society requires an improved statistical *compass*. Regarding the latter idea, decisions must be made on whether to use resources to maximize human well-being now, preserve them for later use, or maximize the well-being of one nation at the expense of another. Sustainable development indicators consider the intergenerational dimensions of human well-being and the existing state of human well-being, including how it is distributed within and across nations, in addition to widely used macroeconomic metrics like GDP. The idea of sustainable development centers on issues such as climate change, the depletion of natural resources, and other issues that have long-term effects on society. Ensuring sustainable development indicators meet official statistics' quality standards is a crucial selection consideration. Any statistical work done within an intergovernmental organization's statistical program or under a national statistical system is considered official statistics. Most recommended indicators are already generated by national statistical agencies and gathered by supranational and international organizations like Eurostat and the United Nations. This is especially true for the select group of indicators chosen because they are widely available across numerous foreign databases. The degree to which the indicators accurately represent the issues they are intended to monitor and the similarities in the SDI sets already utilized by nations are two other crucial factors that are applied (UENEFE, 2014). Since innovation requires commensurability to allow for quantitative comparisons, measuring it is intrinsically challenging. However, originality is the very definition of innovation. As a result, comparisons between different goods and services could be more useful (Fagerberg, Mowery, Nelson, 2005). However, Edison et al. discovered 232 innovation measures while assessing the literature on innovation management. These measures were grouped according to five dimensions: factors that facilitate an innovation process, measures to access the activities within an innovation process, output from the innovation process, effect of the innovation output, and inputs to the innovation process (Edison, Torkar, 2013).

2.5. On relations between sustainable development and innovation

Innovation and sustainable development are two ideas that are strongly related. To achieve human development goals, sustainable development must allow natural systems to continue giving humans access to the natural resources and ecosystem services they depend on (Anadon, Alicia, Kira, Suerie, Sharmila, William, 2015). Innovation can be a critical factor in attaining sustainable development by offering fresh and imaginative approaches to pressing global issues, including poverty, inequality, climate change, environmental degradation, peace, and justice (McKinsey, 2022). Novel technologies, such as renewable energy, eco-friendly infrastructure, and circular economy models, have the potential to mitigate carbon emissions, preserve natural resources, and encourage sustainable patterns of consumption and production (Anadon, Alicia, Kira, Suerie, Sharmila, William, 2015).

New business models, social enterprises, and public-private partnerships that promote social advancement, economic growth, and environmental sustainability can all be created by innovation (McKinsey, 2022). However, innovation must be pursued sustainably to ensure the stability of the natural system and the integrity of the planet is maintained. Economic growth, environmental preservation, and social progress must be balanced to achieve this. The concepts of intergenerational equality, polluter pays, precautionary principle, and Kira, Suerie, Sharmila, and William (Anadon, Alicia, Kira, Suerie, Sharmila, William, 2015) state that the principles of sustainable development must serve as a guide for innovation. In summary, innovation and sustainable development are two ideas that support one another. Sustainable development can offer new and inventive ways to accomplish sustainable development, and innovation can find a home within sustainable development that protects the environment and human well-being.

2.6. Sustainable Development Goal 9: Industry, Innovation and Infrastructure

The ninth Sustainable Development Goal aims to: *Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation* (UNDP, 2018). This target includes, among other things, the percentage of the population working in the manufacturing sector, residing in a mobile network-covered area, or having internet access (UNESCO, 2020). Twelve indicators are used to track progress towards the eight targets of SDG 9. The first five targets are outcome-oriented: creating resilient, inclusive, and sustainable infrastructures; encouraging sustainable and inclusive industrialization; expanding access to markets and financial services; modernizing

all industries and infrastructures for sustainability; and advancing industrial technology research and development. Means of implementation targets comprise the remaining three targets (Bartram, Brocklehurst, Bradley, Muller, Evans, 2018). Promote domestic technological development, industrial diversification, and sustainable infrastructure development for emerging nations. Ensure that everyone has access to information and communications technologies.

2.7. Methodology and methods (Research framework, the purpose of the case study)

The framework of the research was the relationship between the Sustainable Development Goals Index and the Innovation Index from a global perspective and global ecosystem. Given the lack of numerical, statistical, and algebraic arguments on the relations between the SDG Index and the Innovation Index, this study adopts a theory-building mode and aims to investigate the following research questions:

1 Ho: There is not a strong connection/relation between the SDG Index and the Innovation Index.

2 H1: There is a strong connection/relation between the SDG Index and the Innovation Index.

Considering that there are few types of research on the relations between the SDG Index and the Innovation Index, listed in the literature review of this paper research, and considering that theoretical approaches on relations between Sustainable Development and Innovation, and specifically between SDG Index and Innovation Index, as well as numerical, statistical and algebraic arguments on relations between them doesn't exist.

Specifically, while acknowledging the importance of connections/relations between sustainable development (SD goals) and Innovation (especially related to ISO 56000 family of innovation ISO standards), prior empirical research doesn't exist, and those written do not explain statistically if there is any connection/relation between them, thus, a theory building was needed, supported by analysis and evidence. For this, with this critical analysis article, an exploratory approach was adopted, using a single in-depth case study approach, appropriate for building an in-depth understanding of a phenomenon and allowing closer investigation of theoretical constructs.

2.7.1. Case selection

The case was selected based on three main criteria: (1) a theoretical approach, (2) suitability of relations, and (3) practical positive impacts on relations between the SDG Index and the Innovation Index.

The case project ran in stages: (1) identifying needs for sustainable development, (2) identifying needs for innovation, and ISO 56000, and (3) identifying the rank of the countries for SDG and Rank of countries for Innovation Index.

2.7.2. Data collection

Data for the SDG Index has been gathered from the SD Report 2023 (UNSDG, 2023), an annual ranking of countries by their achievement of fulfilling 17 SDGs of Agenda 2030.

Data for the Innovation Index has been gathered from the GII Report 2023 (GII, 2023).

2.7.3. Data analysis

A correlation and inferential analysis (regression) between these indices for 131 countries worldwide were performed.

In the table 1, 131 countries are listed for SDG Index (taken from UNSDG Report 2023), and for the Innovation Index (taken from GII 2023).

Based on these data and information from secondary resources, an inferential analysis (regression) between the SD Index and the Innovation Index per country was built.

Table 1. List of countries per SDG Index and Innovation Index, source: authors research, using data from UNSDG Report 2023 and GII Report 2023.

No	Country	SDG. I	Inn. I	No	Country	SDG. I	Inn. I	No	Country	SDG. I	Inn. I	No	Country	SDG. I	Inn. I
1	Finland	86.8	61	**34**	Belarus	77.5	26.8	**67**	Algeria	70.8	16.1	**100**	South Africa	64	30.4
2	Sweden	86	64.2	**35**	Romania	77.5	34.7	**68**	Türkiye	70.8	38.6	**101**	Bahrain	63.7	29.1
3	Denmark	85.7	58.7	**36**	Serbia	77.3	33.1	**69**	El Salvador	70.7	21.8	**102**	India	63.4	38.1
4	Germany	83.4	58.8	**37**	Lithuania	76.8	42	**70**	Ecuador	70.4	20.5	**103**	Lao RD	63	18.3
5	Austria	82.3	53.2	**38**	Ukraine	76.5	32.8	**71**	Indonesia	70.2	30.3	**104**	TRND & TBG	63	20.7
6	France	82	56	**39**	Australia	75.9	49.7	**72**	Colombia	70.1	29.4	**105**	Honduras	62.9	16.7
7	Norway	82	50.7	**40**	USA	75.9	63.5	**73**	Jordan	69.9	28.2	**106**	Botswana	62.7	24.6
8	Czech Rep	81.9	44.8	**41**	Malta	75.5	49.1	**74**	Malaysia	69.8	40.9	**107**	Ivory Coast	62.3	18.2
9	Poland	81.8	37.7	**42**	Georgia	75	29.9	**75**	Mexico	69.7	31	**108**	Ghana	61.8	21.3
10	Estonia	81.7	53.4	**43**	Thailand	74.7	37.1	**76**	UAE	69.7	43.2	**109**	Senegal	61.8	22.5
11	UK	81.7	62.4	**44**	Bulgaria	74.6	39	**77**	Egypt	69.6	24.2	**110**	Kenya	60.9	21.2

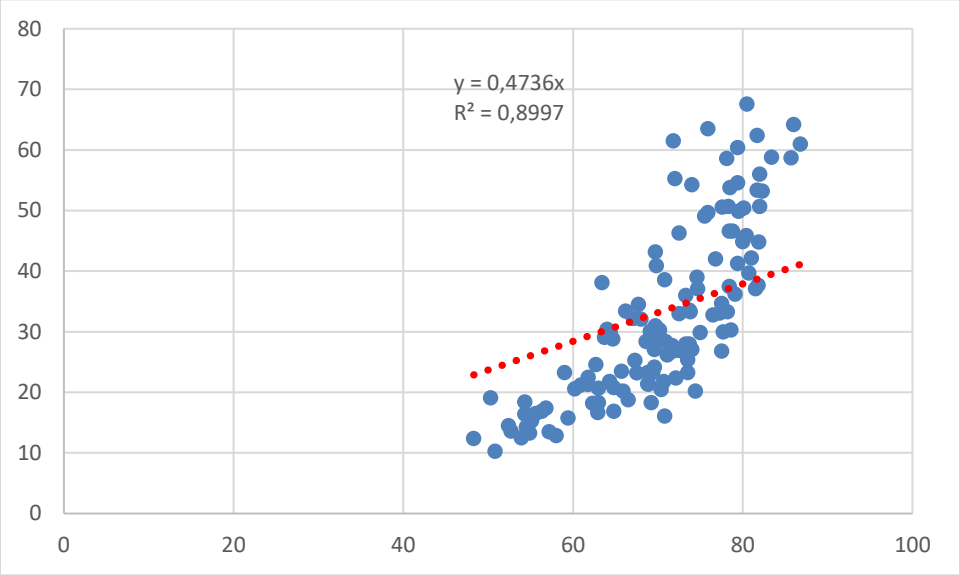
12	Croatia	81.5	37.1	**45**	Kyrgyzstan	74.4	20.2	**78**	Jamaica	69.6	27.1	**111**	Rwanda	60.2	20.6
13	Slovenia	81	42.2	**46**	B & H	74	27.1	**79**	Sri Lanka	69.4	23.3	**112**	Guatemala	59.4	15.8
14	Latvia	80.7	39.7	**47**	Israel	74	54.3	**80**	Tajikistan	69.2	18.3	**113**	Pakistan	59	23.3
15	Switzerland	80.5	67.6	**48**	Russian Fed	73.8	33.3	**81**	Iran	69.1	30.1	**114**	Mali	58	12.9
16	Spain	80.4	45.9	**49**	Argentina	73.7	28	**82**	Bolivia	68.9	21.4	**115**	Mauritania	57.2	13.5
17	Ireland	80.1	50.4	**50**	Brazil	73.7	33.6	**83**	Cabo Vrd	68.8	23.3	**116**	Tanzania	56.8	17.4
18	Portugal	80	44.9	**51**	Costa Rica	73.6	27.9	**84**	Paraguay	68.8	21.4	**117**	Togo	56.3	16.9
19	Belgium	79.5	49.9	**52**	Albania	73.5	25.4	**85**	Oman	68.6	28.4	**118**	Zimbabwe	55.6	16.5
20	Hungary	79.4	41.3	**53**	Azerbaijan	73.5	23.3	**86**	Mauritius	68	32.1	**119**	Benin	55.1	16
21	Japan	79.4	54.6	**54**	Armenia	73.3	28	**87**	S. Arabia	67.7	34.5	**120**	Cameroon	55.1	15.3
22	Netherlands	79.4	60.4	**55**	Viet Nam	73.3	36	**88**	Lebanon	67.5	23.2	**121**	Uganda	55	16
23	Slovakia	79.1	36.2	**56**	Cyprus	72.5	46.3	**89**	Panama	67.3	25.3	**122**	Guinea	54.9	13.3
24	Italy	78.8	46.6	**57**	NR Mcdn	72.5	33	**90**	Philippines	67.1	32.2	**123**	Ethiopia	54.5	14.3
25	Moldova	78.6	30.3	**58**	Tunisia	72.5	26.9	**91**	Nepal	66.5	18.8	**124**	Nigeria	54.3	18.4
26	Canada	78.5	53.8	**59**	DominicanR	72.1	22.4	**92**	Qatar	66.2	33.4	**125**	Zambia	54.3	16.4
27	Greece	78.4	37.5	**60**	China	72	55.3	**93**	Bangladesh	65.9	20.2	**126**	Burundi	53.9	12.5
28	N. Zealand	78.4	46.6	**61**	Singapore	71.8	61.5	**94**	Brunei Drsl	65.7	23.5	**127**	Mozambique	52.7	13.6
29	Iceland	78.3	50.7	**62**	Peru	71.7	27.7	**95**	Cambodia	64.8	20.8	**128**	Burkina Faso	52.4	14.5
30	Chile	78.2	33.3	**63**	Kazakhstan	71.6	26.7	**96**	Nicaragua	64.8	16.9	**129**	Angola	50.8	10.3
31	Korea Rep	78.1	58.6	**64**	Montenegro	71.4	27.8	**97**	Mongolia	64.7	28.8	**130**	Madagascar	50.3	19.1
32	Uruguay	77.7	30	**65**	Uzbekistan	71.1	26.2	**98**	Kuwait	64.4	29.9	**131**	Niger	48.3	12.4
33	Luxembo-urg	77.6	50.6	**66**	Morocco	70.9	28.4	**99**	Namibia	64.3	21.8				

3. Results and discussion

Following the listing of nations based on the Innovation Index and the Sustainable Development Goals Index, I conducted an inferential analysis between the two. The results showed a solid relation between the two, supporting the H1 hypothesis that there is a strong relationship between SDG Index and Innovation Index, as opposed to the H0 hypothesis, which was that there is no. The following table lists the countries according to the SDG Index, which was used as the Y in the regression methods, and the Innovation Index, which was used as the X in the Excel data analysis positive solid relations.

In the graphic 1, a correlation analysis, in a graphical mode, is given, showing a solid positive relation between the SDG Index and the Innovation Index.

Graphic 1. Positive relations between the SDG Index and the Innovation Index, source: drawn by the authors using data from UNSDG Report 2023 and GII Report 2023.



Regressive analysis:

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.948529
R Square	0.899708
Adjusted R Square	0.892015
Standard Error	22.47771
Observations	131

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	589224.4	589224.4	1166.209	1.8E-66
Residual	130	65682.17	505.2475		
Total	131	654906.6			

	Coeffi-cients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Inn. I	1.899646	0.055627	34.14981	8.9E-67	1.789595	2.009697	1.789595	2.009697

$R^2 = 0.89978$
$Y = 0.4736x$
$R = 0.948529$
$R^2 > 50\%$

H1 = There is a strong relation between the SDG Index and the Innovation Index has been verified

These findings have demonstrated a positive solid relationship or connection between the Innovation Index and the SDG Index in real-world settings. A regressive analysis was used in this critical analysis piece to verify statistically the substantial correlation between the Innovation Index and the SDG Index.

The significant implication is that investing in innovation helps with investing in the SDGs. Similarly, higher levels of the SDG Index refer to higher levels of the innovation index, thus illustrating the relationship between the two.

When it comes to the issue of ranking countries for the SDG Index and Innovation index a descriptive analysis was held, showing the mean for SDG Index is 70.14962, while the mean for Innovation Index is 32.32901, The minimum SDG Index is 48.3, while the minimum for Innovation index is 19.3, and the maximum of SDG Index is 86.8, while the maximum for Innovation Index is 67.6, in a list of 131 countries (Table below).

Table 2. Top ten countries for SDG Index and Innovation Index

Country	SDG. I	Country	Inn. I
Finland	86.8	Switzerland	67.6
Sweden	86.0	Sweden	64.2
Denmark	85.7	USA	63.5
Germany	83.4	UK	62.4
Austria	82.3	Singapore	61.5
France	82.0	Finland	61.0
Norway	82.0	Netherlands	60.4
Czech Rep	81.9	Germany	58.8
Poland	81.8	Denmark	58.7
Estonia	81.7	Korea Rep	58.6

Table 3. Countries between median (+5 and -5 in median – SDGI Median - 70.14962, Innovation Index median - 32.32901)

Country	SDG. I	Country	Inn I
Algeria	70.8	Chile	33.3
Türkiye	70.8	Russian Fed	33.3
El Salvador	70.7	Serbia	33.1
Ecuador	70.4	NR Macedonia	33.0
Indonesia	70.2	Ukraine	32.8
Colombia (median)	**70.1**	**Philippines (median)**	**32.2**
Jordan	69.9	Mauritius	32.1
Malaysia	69.8	Mexico	31.0
Mexico	69.7	South Africa	30.4
UAE	69.7	Moldova	30.3
Egypt	69.6	Indonesia	30.3

Table 4. Countries ranked in the last ten positions for the SDG Index and Innovation Index.

Country	SDG. I	Country	Inn I
Guinea	54.9	Cameroon	15.3
Ethiopia	54.5	Burkina Faso	14.5
Nigeria	54.3	Ethiopia	14.3
Zambia	54.3	Mozambique	13.6
Burundi	53.9	Mauritania	13.5
Mozambique	52.7	Guinea	13.3
Burkina Faso	52.4	Mali	12.9
Angola	50.8	Burundi	12.5
Madagascar	50.3	Niger	12.4
Niger	48.3	Angola	10.3
Guinea	54.9	Cameroon	15.3

Carefully investigating the SDG Index ranking, the 20 top countries are from the European continent, while the last 20 countries mostly (18) are from the African continent, while Innovation Index ranking, among the top 20 countries, besides most are European, inside this group, USA, China, Japan, Singapore, Korea Rep, Canada, and Israel join the club, while between last 20 countries, 18 are African and 2 from Central Americas.

Table 5. Descriptive statistics for SDG Index and Innovation Index.

Characteristics	SDGI	Inn I
Mean	70.14962	32.32901
Standard Error	0.776173	1.244231

Median	70.9	29.1
Mode	79.4	23.3
Standard Deviation	8.883705	14.24087
Sample Variance	78.92021	202.8024
Kurtosis	-0.51972	-0.53379
Skewness	-0.46253	0.654717
Range	38.5	57.3
Minimum	48.3	10.3
Maximum	86.8	67.6
Sum	9189.6	4235.1
Count	131	131
Largest(1)	86.8	67.6
Smallest(1)	48.3	10.3
Confidence Level(95.0%)	1.535565	2.461561

4. Implications for theory and practice, limitations, and further research

Regarding the hypothesis, a new avenue for investigation into the relationship between sustainable development and innovation viewing them as a means of enhancing life quality has been made possible by the research's conclusive findings.
This article's critical analysis of the relationship between innovation and sustainable development significantly contributes to the field. It demonstrates that governments, public and private sectors, international organizations, and non-governmental organizations (NGOs) should all carefully examine establishing and upholding relationships between innovation and sustainable development, particularly those between the UN Sustainable Development Goals and innovation principles, while on the issue of sustainable development the study shows Europe is leading region, and Africa enjoys come difficulties on applying SD Goals and principles, while on the issue of Innovation, besides Europe is a leading region there is increasing competition from USA, China, Japan, Canada, Singapore, Korea Republic, Israel etc., while the same situation belongs for the bottom of the ranking, where African countries enjoy the last places, with a couple of interference from Central America countries.
Additional investigation is required to confirm that these relationships will grow stronger, transforming the SDGs and innovation into practical global tools for raising living standards.

5. Conclusions and recommendations

This critical analysis piece emphasizes the economic and social significance of innovation and the SDGs for both present and future generations. This study utilized a large amount of data regarding the SDG Index and Innovation Index, providing statistics regarding the positive solid relations of the two indexes for the year 2023 for the first time. It is possible to conclude the following:

1. Scientific management of production elements, including innovation, opens doors for long-term sustainable development, ensuring the prosperity of society and everyday living for future generations while fostering economic growth and improving the quality of life without endangering the environment.
2. To promote healthier ecosystems and a better environment for everybody, scientific management of sources of production necessitates the implementation of ISO standards, including the ISO 56000 family. As a result, relationships and connections between the Sustainable Development Goals Index (SDGI) and Innovation Index should be strengthened.
3. The research's overall conclusion is that for all parties involved – individuals, public and private institutions, decision-makers, and civil society – achieving and maintaining sustainable development scenarios is something to look forward to. By applying innovation principles as practical and efficient tools, all parties should anticipate the immediate need to establish and maintain relationships and connections between SDG and innovation.
4. Innovation and sustainable development have positive solid relationships. The significant implication is that investing in innovation helps with investing in the SDGs. Similarly, higher levels of the SDG Index refer to higher levels of the innovation index, thus illustrating the relationship between the two.
5. Improving the innovation climate as a component of the ISO 56000 standard family's quality management system will, in tandem with efforts to realize sustainable development goals, have an accurate global indicator of improving life quality.
6. It is essential to highlight the work's contribution to scientific research and its economic ramifications. More study is required to confirm that these relationships will only strengthen in the future, transforming the SDGs and innovation into practical global tools for raising living standards.
7. Regarding the SDG Index ranking, 20 top countries are from the European continent, while the last 20 countries mostly (18) are from the African continent, while about Innovation Index ranking, among the top 20 countries, most are European, inside this group,

USA, China, Japan, Singapore, Korea Rep, Canada and Israel join the club, while between last 20 countries, 18 are African and 2 from Central Americas.

8. Improving life quality, investing in Sustainable Development Goals and Innovation, Europe, the leading region shall continue for a long time to enjoy the benefits, while for African countries a long path towards sustainability and innovation is opened ahead.

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