SUSTAINABLE LIFESTYLES AND INNOVATION SYSTEMS: IMPLICATIONS FOR G20 AGENDA

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The Group of Twenty (G20) discussions have increasingly emphasized the importance of research, innovation, and the digital economy; however, the integration of innovation systems with climate response strategies, particularly sustainable lifestyles, remains underexplored. This paper aims to bridge this gap by proposing a conceptual framework that aligns sustainable lifestyles with innovation systems and examines the implications for ongoing and future G20 dialogues. This paper analyzes data on sustainable lifestyles and innovation systems, emphasizing the G20 forum's key role in promoting sustainable lifestyle goals. It highlights how international cooperation within the G20 can advance innovation systems to foster climate resilience and sustainable development.

Keywords: G20; innovation systems; sustainable lifestyles; sustainable development; resource efficiency.

ESTILOS DE VIDA SUSTENTÁVEIS E SISTEMAS DE INOVAÇÃO: IMPLICAÇÕES PARA A AGENDA DO G20

Apesar de as discussões do Grupo dos Vinte (G20) se concentrarem em pesquisa e inovação e economia digital, de alguma forma, não vinculam os sistemas de inovação a aspectos da resposta climática, especialmente estilos de vida sustentáveis. Portanto, torna-se importante examinar as ligações entre estilos de vida sustentáveis e sistemas de inovação. Este documento busca propor uma estrutura para estilos de vida sustentáveis e sistemas de inovação, além de examinar as implicações para as discussões do G20. O documento analisa dados sobre estilos de vida sustentáveis e sistemas de inovação e tem como objetivo destacar o papel do fórum do G20 na promoção de sistemas de inovação e objetivos de estilos de vida sustentáveis por meio da cooperação internacional.

Palavras-chave: G20; sistemas de inovação; estilos de vida sustentáveis; desenvolvimento sustentável; eficiência de recursos.

ESTILOS DE VIDA SOSTENIBLES Y SISTEMAS DE INNOVACIÓN: IMPLICACIONES PARA LA AGENDA DEL G20

Los debates del Grupo de los Veinte (G20) se han centrado en la investigación y la innovación y en la economía digital y, sin embargo, de alguna manera no se centran en vincular los sistemas de innovación con aspectos de la respuesta al cambio climático, especialmente con estilos de vida sostenibles. De ahí la importancia de examinar los vínculos entre los estilos de vida sostenibles y los sistemas de innovación. Este documento pretende proponer un marco para los estilos de vida sostenibles y los sistemas de innovación, además de examinar las implicaciones para los debates del G20. El documento analiza datos sobre estilos de vida sostenibles y sistemas de innovación y

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pretende destacar el papel del foro del G20 a la hora de impulsar los sistemas de innovación y los objetivos de estilos de vida sostenibles a través de la cooperación internacional.

Palabras clave: G20; sistemas de innovación; estilos de vida sostenibles; desarrollo sostenible; eficiencia de los recursos.

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1 INTRODUCTION

Agenda 21, the outcome document of the United Nations Conference on Environment and Development held in Rio de Janeiro, highlighted that unsustainable production and consumption patterns require international attention along with actions by governments and major groups including industry. 2015 saw the catapulting of sustainable consumption and production (SCP) when, out of the seventeen sustainable development goals (SDGs), Goal 12 was adopted as a dedicated goal on responsible consumption and production. In Group of Twenty (G20) discussions, SCP picked pace since 2017 with the G20 Leaders´ Declaration from the Hamburg Summit. India's G20 Presidency in 2023 marked the strongest focus on SCP, emphasizing sustainable lifestyles.

The Intergovernmental Panel on Climate Change (IPCC) has emphasized that global emissions could be reduced by 40%-70% by 2050 through demand-side management, supported by infrastructure and technology while meeting people's basic needs (IPCC, 2023). According to the International Energy Agency (IEA), Sustainable lifestyle-compatible actions in the energy sector alone would reduce annual global carbon dioxide (CO_2) emissions by more than 2 billion tonnes (Gt) in 2030, which is 20% of the emissions reductions needed by 2030 to put the world on a pathway to net zero emissions (IEA, 2023). Lifestyles and consumption/demand side actions are crucial to climate action.

Numerous case studies illustrate the interplay between sustainable lifestyles and innovation systems. For example, the transition to electric vehicles in Norway demonstrates how a combination of technological innovation, supportive policies, and social acceptance can drive electric mobility (Kanger et al., 2019; Kotilainen et al., 2019). Similarly, the adoption of smart home technologies in Germany shows how innovations in energy management contribute to sustainable living (Nahm, 2017; Hipp and Binz, 2020; Wen et al., 2021).

Target 12.a of SDG 12 (responsible consumption and production) focuses on supporting developing countries to strengthen their scientific and technological capacities to move towards SCP. Despite this, there is little

attention in national and international discussions and scholarly work on linking innovation systems and sustainable lifestyles.

Sustainable lifestyles got a big boost under India's G20 Presidency, as the country prioritized the theme of "Lifestyle for Environment" (LiFE). Under the G20 Brazilian Presidency, a new Research and Innovation Working Group under the Sherpa track is expected to further build on these efforts by promoting collaborative research, technological advancements, and innovative solutions aimed at fostering sustainable development and environmental responsibility across member countries. G20 discussions have focused on research and innovation and sustainable lifestyles and yet somehow does not focus on linking innovation systems to aspects of climate response especially sustainable lifestyles.

It hence becomes important to examine the linkages between sustainable lifestyles and innovation systems. This paper seeks to propose a framework for sustainable lifestyles and innovation systems along with examining the implications for G20 discussions. The paper analyses data on sustainable lifestyles and innovation systems and aims to highlight the role of G20 forum in nudging innovations systems and sustainable lifestyles objectives through international cooperation.

2 FRAMEWORK FOR SUSTAINABLE LIFESTYLES AND INNOVATION SYSTEMS

Respecting our ecosystems' carrying capacities requires a complete transformation of our current consumption and production systems (Bengtsson et al., 2018). Sustainable consumption and lifestyles need to be seen from the perspective of SCP systems and resource value chains, which include the stages of resource extraction, manufacturing and processing, consumer use, and disposal. Broadly, resource value chains consist of three segments: upstream (resource extraction), mid-stream (manufacturing and processing) and downstream (consumption and disposal). Mainstream frameworks on SCP, including SDG 12, fail to holistically consider all segments of resource value chains, along with the roles of various instruments and innovation systems (TERI, 2022; 2023; Kedia et al., 2023). The working definition of sustainable lifestyles is: "individual consumer choices and attitudes towards the consumption of goods and services to further human wellbeing, spur innovations, while minimizing ecological footprint and waste so as to promote intragenerational and intergenerational equity for sustainable development" (TERI, 2022, p. 6).

Advancing SCP systems requires innovation frameworks characterized by the collaboration of diverse actors and supported by knowledge, technology, infrastructure, resources, markets, policies, and other essential factors (Cohen, 2015; Longhurst et al., 2016; Avelino et al., 2019; Geels, Kern and Clark, 2023). Innovation systems enable organizations and governments to address the

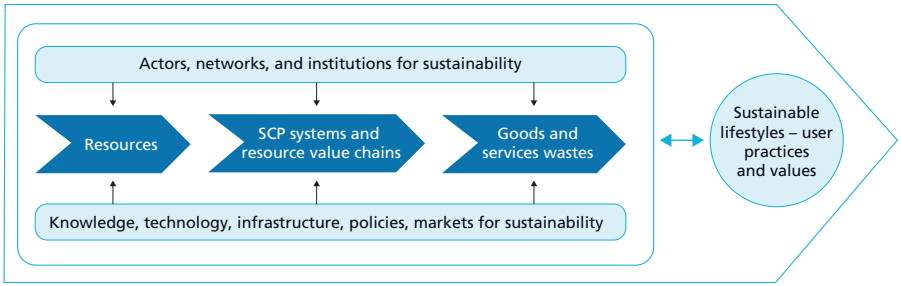
challenges of SCP by creating more efficient resource-use methods, minimizing waste and pollution, and developing sustainable products and services. To comprehend the role of innovation in sustainability transitions, focusing on contemporary consumption-production systems offers a powerful analytical lens.

Traditional policy approaches aimed at reducing human impacts on the environment through technological change – such as enhancing resource efficiency and promoting renewable energy sources – are insufficient to meet the most urgent sustainability challenges of the twenty-first century. Scholars and practitioners argue that a fundamental transformation of our lifestyles and social institutions is required to achieve a truly sustainable future. Holistic conceptions of innovation systems are needed to incorporate lifestyle dimensions – which encompasses the products and services consumed, activities, interests, opinions, value systems, personality traits, self-conception, and attitudes toward various product classes – into innovation systems analysis, significantly enhancing our understanding of how these factors influence sustainable development and drive systemic change.

The innovation system consists of various actors, including businesses, research institutions, political figures, and consumers, as well as the connections between them, such as the flow of goods, research and development (R&D) partnerships, knowledge sharing, and producer-consumer relationships. Institutions play a crucial role in coordinating these activities. Consumers are key players in these networks and must support the transformation, as no innovation will thrive without consumer adoption. Changing consumption patterns, like those seen in sharing economies, can accelerate the transformation and significantly reduce resource consumption (Pérez and Marín, 2016).

The analytical framework (figure 1) offers a view of how innovation systems and sustainable lifestyles intersect to promote SCP. It underscores the importance of merging innovative practices with sustainable lifestyles to meet long-term environmental and social objectives. Technological innovations, whether incremental or major, should be paired with social innovations to foster inclusive growth and strengthen social resilience. This combined approach provides significant opportunities for integrating sustainable lifestyles and advancing sustainable development. Traditional policies, which focus solely on technological advancements such as resource efficiency and renewable energy, fall short in addressing the major sustainability challenges that confront contemporary society. Achieving faster and deeper progress toward sustainability in consumption-production systems requires a fundamental rethink and reshaping of our lifestyles and social institutions (Cohen, Brown and Vergragt, 2013).

FIGURE 1
Interface between lifestyle and innovation systems for sustainability transitions



Authors' elaboration.

3 LIFESTYLES AND INNOVATION SYSTEMS IN G20 COUNTRIES

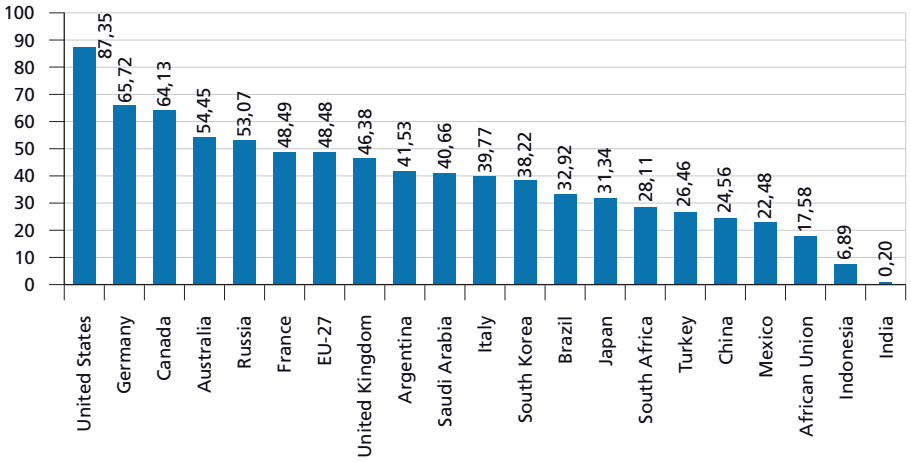
3.1 Consumption and lifestyles in G20 countries

To understand the state of lifestyles and consumption for G20 countries, the European Union and the African Union, a composite index and indices on consumption sectors (such as food, transport, residential, and waste management) have been developed. This builds on the methodology of TERI (2022). After standardizing the values, the scores were then converted to arrive at scores proportionate to 100 and depicted graphically in figure 2. Higher scores indicate higher consumption in per capita terms for the individual.

When considering sustainable lifestyles, it is important to consider equitable consumption and underconsumption. In the Lifestyles and Consumption Index, the United States has the highest consumption among G20 entities, while India has the lowest consumption. The developing countries in the G20 have scored much lower than most of their developed counterparts.

It is important to mention that the scores presented here only indicate the present level of consumption; they do not indicate the normative direction of lifestyles and consumption. As mentioned earlier, these metrics are constrained by data availability, especially concerning indicators that relate to downstream segments of resource value chains. The index has been developed without accounting for differences in per capita incomes. As the point of the index is not to indicate a normative direction, this index can be standardized in future using per capita incomes to determine how efficient or sustainable 1 passenger-km or 1 kilocalorie is across countries.

FIGURE 2
Lifestyles and consumption index for G20



Source: TERI (2023).

TABLE 1
Indicators considered in lifestyles and consumption index for G20

Country	TFC in transport sector (PJ/capita)		TFC in residential sector (PJ/capita)		Meat supply (kg/year/capita)		Plastic waste generation (tonne/capita)		Composite index	Score
	Value	Index	Value	Index	Value	Index	Value	Index		
United States	0.08	0.00	0.03	0.18	126.74	0.00	0.12	0.32	0.13	87.35
Germany	0.03	0.68	0.03	0.31	79.18	0.39	0.18	0.00	0.34	65.72
Canada	0.06	0.18	0.04	0.13	90.20	0.30	0.03	0.83	0.36	64.13
Australia	0.05	0.37	0.02	0.61	120.72	0.05	0.04	0.79	0.46	54.45
Russia	0.03	0.68	0.04	0.00	77.07	0.41	0.04	0.79	0.47	53.07
France	0.03	0.66	0.03	0.41	79.20	0.39	0.07	0.61	0.52	48.49
European Union-27	0.02	0.71	0.02	0.48	78.26	0.40	0.10	0.47	0.52	48.48
United Kingdom	0.02	0.73	0.02	0.46	80.09	0.38	0.08	0.58	0.54	46.38
Argentina	0.02	0.82	0.01	0.75	110.55	0.13	0.07	0.64	0.58	41.53
Saudi Arabia	0.05	0.39	0.02	0.69	53.23	0.60	0.06	0.70	0.59	40.66
Italy	0.02	0.70	0.02	0.51	71.32	0.45	0.05	0.74	0.60	39.77
South Korea	0.03	0.64	0.02	0.64	77.67	0.40	0.04	0.79	0.62	38.22
Brazil	0.02	0.81	0.01	0.97	98.85	0.23	0.06	0.68	0.67	32.92
Japan	0.02	0.75	0.01	0.74	53.95	0.60	0.06	0.67	0.69	31.34
South Africa	0.01	0.88	0.01	0.93	60.28	0.54	0.09	0.52	0.72	28.11
Turkey	0.01	0.84	0.01	0.79	37.35	0.73	0.08	0.58	0.74	26.46

(Continues)

(Continued)

Country	TFC in transport sector (PJ/capita)		TFC in residential sector (PJ/capita)		Meat supply (kg/year/capita)		Plastic waste generation (tonne/capita)		Composite index	Score
	Value	Index	Value	Index	Value	Index	Value	Index		
China	0.01	0.90	0.01	0.81	61.89	0.53	0.04	0.77	0.75	24.56
Mexico	0.01	0.88	0.01	0.95	72.69	0.44	0.03	0.83	0.78	22.48
African Union	0.00	0.99	0.01	0.84	16.46	0.90	0.08	0.57	0.82	17.58
Indonesia	0.01	0.93	0.00	1.00	18.00	0.89	0.02	0.90	0.93	6.89
India	0.00	1.00	0.00	0.99	4.54	1.00	0.00	1.00	1.00	0.20

Source: TERI (2023).

With respect to equity, a key question is whether G20 countries give a quality of life to their citizens without increasing environmental degradation and compromising the resource needs of future generations? In this regard, it is crucial to consider the role of innovation systems.

3.2 Innovation systems in G20 countries

G20 countries consist of a mix of high-income and emerging economies, each with a Human Development Index (HDI) value of 0.7 or higher (India: 0.64). High-income countries, known for their strong R&D capabilities, highly skilled workforces, and advanced technological infrastructure, have established robust innovation systems. These systems foster the creation, diffusion, and commercialization of new knowledge and technologies, involving collaboration among universities, research institutions, private firms, and government agencies. Significant investments in innovation, through public R&D funding, tax incentives, and supportive policies, have enabled these countries to develop new products, services, and business models that drive economic growth and improve social welfare.

Conversely, innovation systems in low-income countries are often underdeveloped due to limited resources, infrastructure, and access to technology. To address these challenges, governments and international organizations have implemented initiatives to promote innovation and economic growth. These initiatives include providing access to finance, creating incentives for R&D, and encouraging public-private collaboration. Programs like the Global Innovation Fund are also supporting innovators in low-income countries, creating an environment conducive to innovation and economic improvement.

The G20 has been recognized as a key platform for science, technology, and innovation (STI). The G20 Research and Innovation Initiative (G20 RIIG),

launched during the Indonesian and Indian presidencies, focuses on sustainability issues. These include research and innovation related to biodiversity, eco-innovations for the energy transition, the circular bioeconomy, the blue sustainable economy, and materials for sustainable energy. Under the Brazilian presidency, the G20 RIIG Meeting, now functioning as a working group, aims to enhance technology access and transfer to developing countries, reduce inequalities, and promote inclusive, fair, and sustainable development.

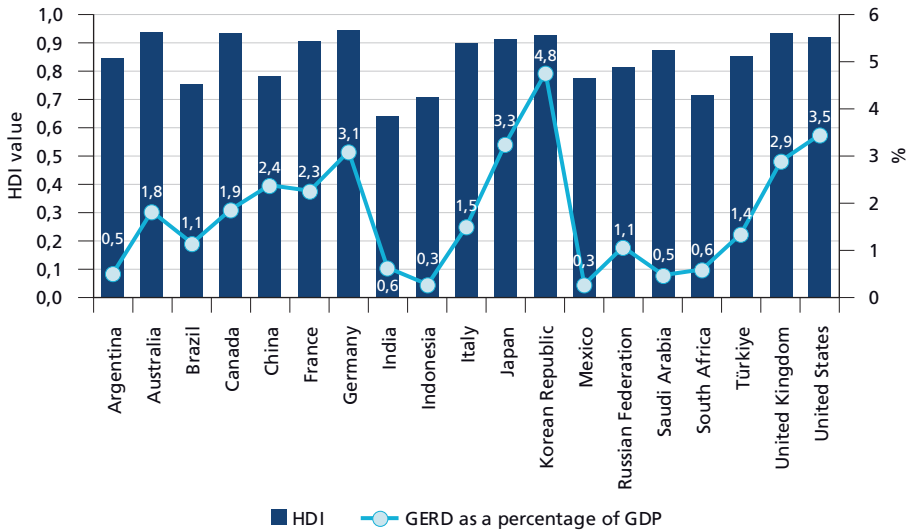
The STI competence of G20 countries is clearly demonstrated by their substantial investments in R&D and their ability to generate and disseminate knowledge. These countries vary significantly in their R&D expenditure relative to gross domestic product (GDP), reflecting their different levels of commitment and capacity to foster innovation.

Leading in R&D expenditure relative to GDP, the Republic of Korea allocates a remarkable 4.8% of its GDP to R&D, underscoring its robust focus on technological advancement and innovation (figure 3). The United States follows with an R&D expenditure of 3.5% of GDP, showcasing its extensive research infrastructure and innovation-driven economy. Japan and Germany also make substantial investments, dedicating 3.3% and 3.1% of their GDP to R&D, respectively. These high percentages indicate strong national priorities towards science and technology, facilitating significant technological breakthroughs and economic growth.

Most other G20 members also prioritize R&D, with expenditures exceeding 1% of their GDP. This group includes countries like the United Kingdom, France, and China, which have developed significant research capabilities and innovation systems, contributing to their global competitiveness.

However, some G20 countries invest relatively less in R&D, reflecting different economic priorities and developmental challenges. Argentina, India, Saudi Arabia, and South Africa allocate approximately 0.6% to 0.8% of their GDP to R&D. These lower investments highlight the need for enhanced support and policies to boost their innovation ecosystems. Mexico and Indonesia spend around 0.3% of their GDP on R&D, indicating even greater challenges in developing robust STI frameworks.

FIGURE 3
Human Development Index (HDI 2022) and gross expenditure on R&D (GERD) as a proportion of GDP (GERD 2020) in G20 countries



Source: UNESCO (2024); UNDP (2024).
Authors' elaboration.
Note: Available data for GERD in Australia is for the year 2019.

Despite these disparities, the overall R&D investments among G20 countries play a crucial role in global knowledge generation and technological progress. The high levels of investment in leading countries contribute to significant spillovers of knowledge and technology, benefiting not only their own economies but also fostering innovation globally. For countries with lower R&D investments, international collaborations, knowledge transfer, and targeted policy interventions can help enhance their STI capacities and integrate them more effectively into the global innovation network.

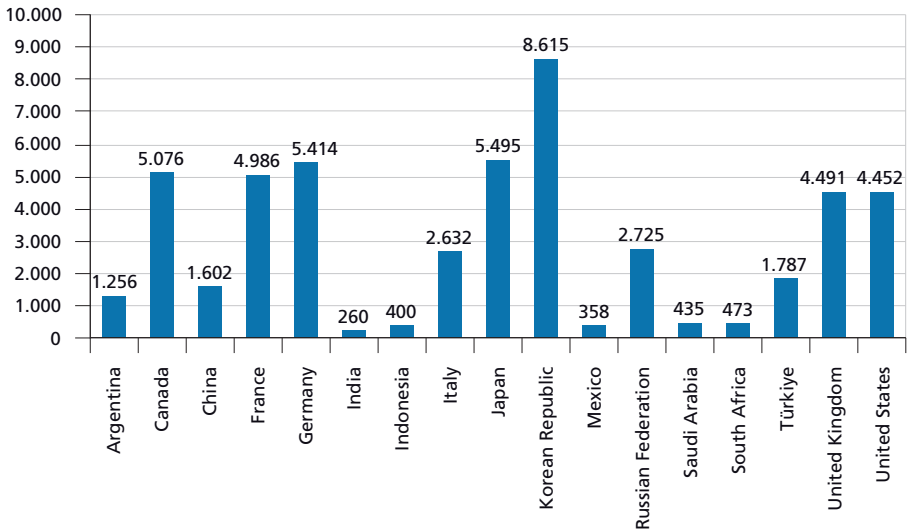
In G20 countries, the number of researchers per million inhabitants averages 2,968, significantly higher than the global average of 1,326. This indicator highlights the disparity in research capacity among G20 members. For instance, the Republic of Korea boasts the highest number of researchers per million inhabitants at 8,614, followed by Japan with 5,495, Germany with 5,413, and Canada with 5,076. These figures reflect strong investments in higher education and R&D infrastructure, resulting in a high density of skilled researchers.

On the other end of the spectrum, some G20 countries have considerably fewer researchers per capita. Mexico, India, and Indonesia have less than 400 researchers per million inhabitants. This stark contrast underscores the challenges

these countries face in building robust research ecosystems, often due to limited funding, infrastructure, and access to advanced training and education.

The variation in the number of researchers per million inhabitants among G20 countries illustrates the uneven distribution of scientific capacity and innovation potential (figure 4). High numbers of researchers are generally associated with greater innovation output, higher technological advancements, and stronger economic growth. In contrast, countries with fewer researchers may struggle to keep pace with rapid technological changes and may need to implement policies that bolster their research and innovation sectors to improve their global competitiveness.

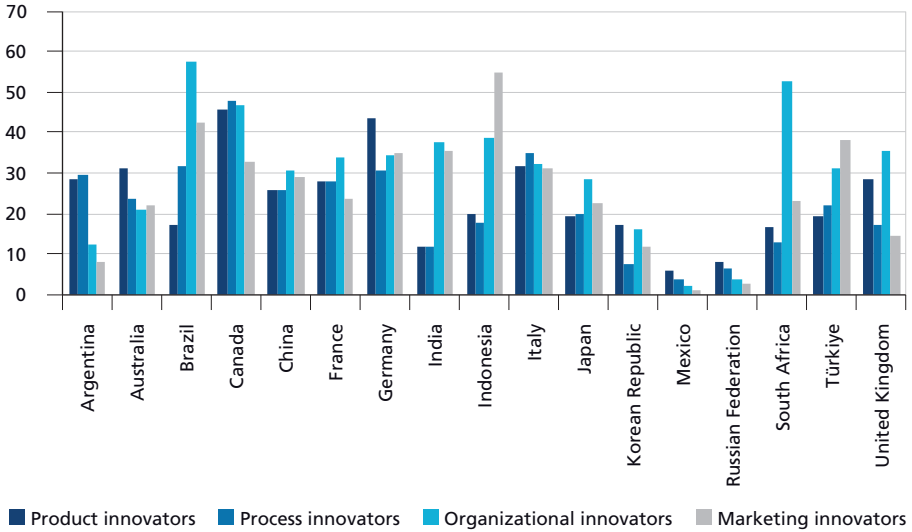
FIGURE 4
Number of researchers per million inhabitants in G20 countries (2020)



Source: UNESCO (2024).
Authors' elaboration.

Innovation significantly influences the development, adoption, and diffusion of new technologies and their broader impacts. In Germany, for example, around 44% of manufacturing firms are product innovators, the highest share among six countries, followed by Australia, the United States, the Republic of Korea, the Russian Federation, and Mexico. Organizational innovation prevails in Brazil and South Africa, where 58% and 53% of manufacturing firms, respectively, are organizational innovators (figure 5). In Canada, around 48% of firms are process innovators, with similar percentages for organizational and product innovators. In Indonesia and Turkey, marketing innovation is the most common, with 55% and 38% of firms, respectively, being marketing innovators.

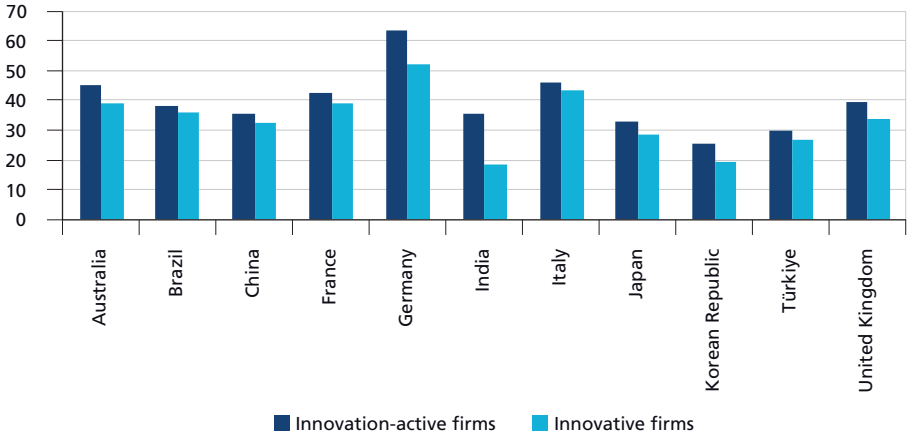
FIGURE 5
Innovators in G20 countries as a percentage of manufacturing firms
(In %)



Source: UNESCO (2017).
Authors' elaboration.

An innovative firm is defined as one that has successfully implemented a new or significantly improved product, process, or service during the specified review period. In contrast, an innovation-active firm is one that has engaged in innovation activities within the same period, encompassing efforts that are ongoing, completed, or even abandoned. Regarding the proportion of product or process innovation-active and innovative firms in G20 countries, data indicates that in many of these nations, the percentage of firms actively involved in innovation activities closely aligns with the share of innovative firms, except in Germany and India (figure 6).

FIGURE 6
Product or process innovation-active and innovative firms in G20 countries as a percentage of manufacturing firms
(In %)



Source: UNESCO (2017).
Authors' elaboration.

3.3 Performance of innovation systems in the G20 and sustainability

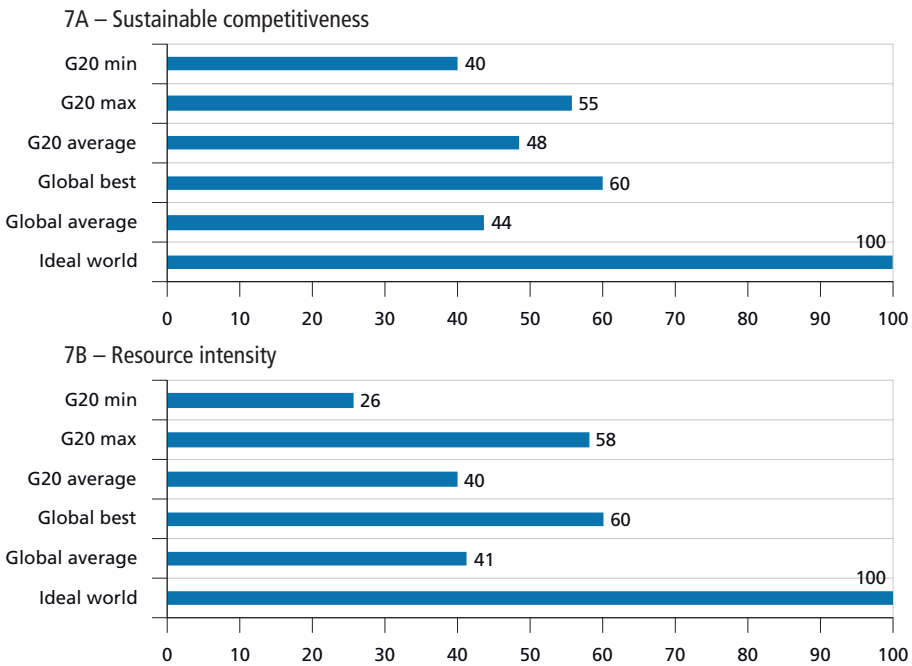
Sustainable competitiveness refers to the capacity to generate and maintain inclusive wealth without compromising the ability to sustain or increase future wealth levels. The figure illustrates the overall performance of G20 countries in sustainable competitiveness, resource intensity, and intellectual capital scores based on the Global Sustainable Competitiveness Index (GSCI).[3] The average sustainable competitiveness score is 43.7, less than 50% of the possible best score (figure 7). Sweden, with the highest score of 59.6, demonstrates that even the leading nations are far from being truly sustainable and competitive. The G20 average score is 48.4, which is better than the global average but shows a significant disparity between the maximum (55.3, Japan) and minimum (39.6, South Africa) scores, highlighting the need for greater sustainability measures to improve the G20 average and close the inter-country gap.

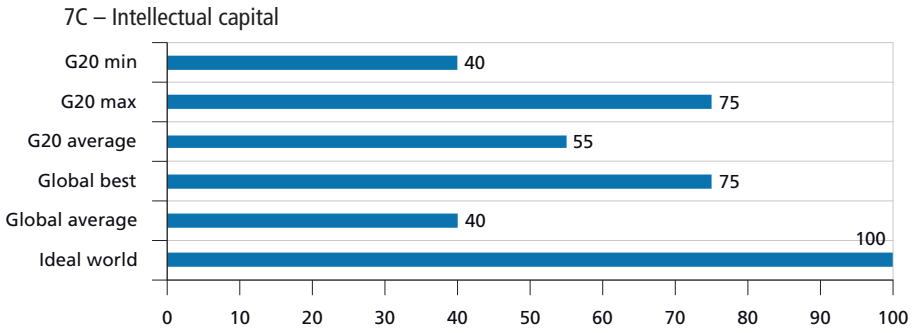
The Resource Intensity and Efficiency Index combines per-capita measurements (intensity) and measurements against total economic output, such as water usage per unit of GDP (economic efficiency; resource usage per unit of value generated). Countries with low resource consumption per capita and per

3. GSCI is based on over 200 quantitative indicators derived from international organizations and grouped into 6 sub-indexes: Natural Capital, Resource Efficiency and Intensity, Social Cohesion, Intellectual Capital, Economic Sustainability, and Governance Efficiency. This benchmark is used to track countries' progress towards sustainability and competitiveness.

dollar typically achieve higher intensity scores, while industrial economies with modern efficient production processes tend to achieve higher efficiency scores. Consequently, both developed and lesser-developed nations can rank highly on the Resource Intensity/Efficiency Index. Lesser-developed countries rank higher on the Intensity Index (per capita resource consumption), while highly developed economies transitioning to service economies rank higher on the Resource Efficiency Index (per unit of value generated resource consumption). The United Kingdom, Australia, and France are leading in Resource Intensity score, suggesting stronger deployment of SCP strategies. Russia, Turkey and Saudi Arabia are in the bottom 3 countries indicating the need to improve resource efficiency and sustainability practices.

FIGURE 7
Sustainable competitiveness, resource intensity and intellectual capital scores of G20 countries





Source: SolAbility (2023).

The Intellectual Capital Index covers the quality and availability of past education, which indicates today's R&D and innovation capabilities, while today's education performance reflects future innovation capabilities. Robust R&D activities are crucial for developing value-added technologies and services. Therefore, educational performance indicators are vital for estimating sustained innovation and competitiveness. Countries with high Sustainable Competitiveness generally have high Intellectual Capital, indicating a strong relationship between the two. However, some countries like South Korea and China show a significant disparity, highlighting areas for potential policy focus or further investigation. European countries tend to have balanced profiles, while many developing nations have lower scores in both areas, suggesting a need for development in both competitiveness and intellectual resources. This will also include technology cooperation, technology access and technology transfer through models of South-South, North-South and triangular cooperation within the G20 countries. This also includes cooperation on innovation systems concerned with promoting sustainable lifestyles.

4 ROLE OF G20 COUNTRIES IN PROMOTING SUSTAINABILITY-ORIENTED LIFESTYLES AND INNOVATION SYSTEMS

To address the most pressing sustainability challenges of the twenty-first century and achieve a sustainable transformation of production and consumption systems, it is evident from the analysis of G20 countries, that there is a greater need for innovation systems to be sustainability oriented. This means focusing on aspects of resource efficiency, the development of renewable energy sources, as well as our lifestyles and social institutions. To successfully transition toward a truly sustainable future and achieve the twin sustainability goals of decreased resource use and enhanced individual and societal well-being, the innovation system also needs to prioritize innovation in economic policies, socio-technical systems of production and consumption, and dominant social practices.

G20 has increasing emerged as a norm influencing forum. It can play a crucial role with respect to international norms concerning sustainable lifestyles. Table 2 depicts key developments in G20 forum concerning sustainable lifestyles. Initially, G20 discussions, focused on resource efficiency and circular economy aspects of sustainable consumption production systems and not on individual behaviours. In 2022, the G20 Bali Leaders' Declaration considered lifestyles alongside resource efficiency and the circular economy for the first time. India's G20 Presidency saw a further momentum on sustainable lifestyles and saw the launch of the G20 High Level Principles on Lifestyles for Sustainable Development (India, 2023). The G20 New Delhi Leaders' Declaration saw a large focus on sustainable lifestyles as being a key means to achieve green development.

TABLE 2
Key developments in G20 forum concerning sustainable lifestyles

2017	G20 Leaders' Declaration from the Hamburg Summit	G20 Resource Efficiency Dialogue
2019	The G20 Osaka Leaders' Declaration	Circular economy, sustainable materials management, the 3Rs
2020	The Leaders' Declaration of the G20 Riyadh Summit	Circular Carbon Economy (CCE) Platform and 4Rs framework
2021	The G20 Rome Leaders' Declaration	Circular economy approaches for climate mitigation and adaptation
2022	G20 Bali Leaders' Declaration	Lifestyles, resource efficiency and circular economy
2023	G20 New Delhi Leaders' Declaration	Mainstreaming Lifestyles for Sustainable Development (Life) and circular economy

Source: G20 outcome documents.
Authors' elaboration.

Under the G20 Brazilian Presidency, a new Research and Innovation Working Group has been formed under the Sherpa track, with the mandate to focus on "Innovation Open to Fair and Sustainable Development". A key objective is to advance technology access and transfer to developing countries.

As a part of the Sherpa Track of Environment and Climate Sustainability Working Group, in June 2024, under Brazil's G20 presidency, the G20 pre-approved a document on waste management and the circular economy. The Brazilian Presidency has also constituted a Task Force for Global Mobilization against Climate Change, which aims to enhance global macroeconomic and financial alignment for achieving the goals of the United Nations Framework Convention on Climate Change and the Paris Agreement.

In the latest global indicator framework for the SDGs, the indicator used for monitoring SDG Target 12.a is "installed renewable energy generating capacity in developing and developed countries (in watts per capita)" (UN, 2024). This metric for monitoring Target 12.a – which overlaps with monitoring SDG 7.b

under SDG 7 (sustainable energy) – does not capture the target on strengthening scientific and technological capacities in developing countries regarding SCP. The G20 can play an important role in driving the discourse.

One of the main challenges in linking sustainable lifestyles with innovation systems is ensuring coordination among diverse stakeholders. Integrated approaches that involve cross-sectoral collaboration and multi-level governance are necessary for achieving systemic changes. The G20 should assist in norm diffusion by bringing together diverse stakeholders together to promote holistic and integrated approaches that involve innovation systems and sustainable lifestyles.

Sustainable lifestyles must be integrated into innovation systems to promote mutual learning and knowledge development. This integration involves creating networks and linkages between various actors, such as businesses, research institutions, policy makers and consumers. These connections facilitate the flow of goods, R&D partnerships, knowledge sharing, and producer-consumer relationships, all of which are essential for coordinated action and effective transformation.

Companies play a crucial role in developing and implementing new technologies and practices that support sustainability. Consumers are equally important in driving this transformation. Their willingness to adopt sustainable products and change consumption patterns is vital. Educating consumers about the benefits of sustainable lifestyles and encouraging practices such as sharing economies, recycling, and mindful consumption can significantly reduce resource use and environmental impact. Policymakers need to create an enabling environment that supports sustainable innovation. This includes implementing regulations and policies that incentivize green practices, providing funding for sustainable R&D, and fostering collaborations between different sectors. Governments can also play a key role in raising public awareness about sustainability issues and promoting sustainable behaviours through campaigns and education programs.

By systematically integrating sustainable lifestyles into innovation systems, it is possible to effectuate a positive impact on a broader population, thereby enhancing their willingness to transition away from oil-based economies and mass consumption patterns. This transformation is expected to not only mitigate environmental degradation but also foster long-term economic stability and enhance the overall quality of life.

Ultimately, the transition to sustainable production and consumption systems requires a comprehensive approach that engages all stakeholders in collaborative efforts. Through strategic partnerships, educational initiatives, and the widespread adoption of sustainable practices, G20 countries are

well-positioned to lead the global movement toward a more sustainable and resilient economy.

5 CONCLUSION

Resource management focuses on optimizing the use of available resources – natural, human, and financial – regardless of their abundance. Effective resource utilization, whether sourced domestically or imported, is vital for enhancing a nation's competitiveness and wealth. Overexploitation of natural resources can deplete a country's natural capital, hindering its ability to sustain its population and economy in the long term.

Countries with lower per capita and per dollar resource consumption generally achieve higher intensity scores, while industrialized nations with efficient production processes tend to score higher in resource efficiency. Consequently, both developed and developing nations can excel on the Resource Intensity/Efficiency Index, with developing countries ranking higher in resource intensity (per capita consumption) and developed countries, especially those moving toward service economies, ranking higher in resource efficiency (value generated per unit of resource consumed).

The analysis suggests that enhancing intellectual capital through investment in education, research, and innovation is critical for G20 countries. This will enable the development of new technologies and practices that promote sustainability. Countries should focus on improving resource efficiency to reduce resource intensity scores through better management practices, the adoption of sustainable technologies, and the promotion of circular economy principles. Governments need to implement policies that support sustainable practices and raise public awareness about the importance of sustainability. Additionally, incentives for sustainable products and services can drive consumer behaviour toward more sustainable lifestyles.

Developing comprehensive strategies that integrate sustainability into all aspects of economic and social life is essential. This includes promoting sustainable lifestyles, encouraging green innovations, and ensuring equitable access to resources. By comprehending the link between sustainable competitiveness, intellectual capital, and resource intensity, policymakers can enhance the design of strategies that encourage sustainable lifestyles and practices while bolstering and guiding innovation systems towards sustainability. Achieving this requires a combination of innovation, policy support, public education, and collaboration among G20 countries.

Sharing best practices and technologies globally can help lower-performing countries enhance their sustainable competitiveness through innovation systems

that incorporate sustainable lifestyles. Models of cooperation should consider technology cooperation, access, and transfer through South-South, North-South, and triangular collaboration among G20 countries. Additionally, these models should encompass collaboration on innovation systems aimed at promoting sustainable lifestyles. As a norm influencer and agenda setter, the G20 can play a significant role in strengthening these efforts.

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