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Sustainability metrics, methods, and production processes

Métricas, métodos e processos de produção de sustentabilidade

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Informações do Artigo

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Abstract:

This research aims to conduct a literature review on the impact of sustainability metrics on industry methods and production processes, regarding environmental technical requirements, voluntary or not, under the consensus of the International Organization for Standardization (ISO) or the respective governments. For this purpose, a gravity model is used, to avoid possible technical barriers to trade, or obstacles of a technical nature to trade, within the scope of the Technical Barriers Agreement of the World Trade Organization (WTO), aiming to meet the 2030 Agenda for sustainable development of the United Nations (UN). An action plan is sought to achieve a balance between economic, social, and environmental development, through a set of objectives and goals, specifically concerning Sustainable Development Goal - 9, which deals with industry, innovation, and infrastructure, improving the country's quality infrastructure and good regulatory practices.

Resumo

Esta pesquisa tem como objetivo realizar uma revisão da literatura sobre o impacto das métricas de sustentabilidade nos métodos da indústria e nos processos de produção, no que diz respeito aos requisitos técnicos ambientais, voluntários ou não, sob o consenso da Organização Internacional de Normalização (ISO) ou dos governos respectivos. Para esse fim, é utilizado um modelo gravitacional, a fim de evitar possíveis barreiras técnicas ao comércio ou obstáculos de natureza técnica ao comércio, no âmbito do Acordo sobre Barreiras Técnicas ao Comércio da Organização Mundial do Comércio (OMC), com o objetivo de cumprir a Agenda 2030 para o desenvolvimento sustentável das Nações Unidas (ONU). Busca-se um plano de ação para alcançar um equilíbrio entre o desenvolvimento econômico, social e ambiental, por meio de um conjunto de objetivos e metas, especificamente relacionados ao Objetivo de Desenvolvimento Sustentável - 9, que trata da indústria, inovação e infraestrutura, visando melhorar a infraestrutura de qualidade do país e as boas práticas regulatórias.

1. Introduction

In the interdependent world of today, international relations, so complex in themselves, are being increasingly sorted in international organizations, the most varied and numerous, whose deliberations strongly penetrate national borders.

The concept of sustainable development, which spread so quickly, has contributed to the world being considered as a whole. By advocating meeting the needs of the present without compromising the ability of future generations to meet their own, it leads to the predominance of an internationalist vision for solving global problems.

2. The United Nations

Playing a key role, the United Nations (UN), created on October 24, 1945, with headquarters in Geneva, Switzerland, constantly develops actions to help countries overcome sustainability challenges [1].

The 2030 Agenda for sustainable development is an action plan to achieve a balance between economic, social, and environmental development, committing to work tirelessly for its full implementation by 2030, through a set of objectives, called Sustainable Development Goals (SDGs), also known as the Global Goals, as shown in Figure 1.

Figure 1 – The 2030 Agenda and the SDGs

Source: Nações Unidas Brasil [2]

Seventeen transformative steps are urgently needed to set the world on a sustainable and resilient path [3]. Truly transformational goals, as they are indivisible and universal [4].

The SDGs represent an ambitious plan to increase peace and prosperity, eradicate poverty and protect the planet, and are recognized globally as essential for the planet's future sustainability [5].

Such an action plan requires contributions from all elements of society, including local and national governments, businesses, industries, and individuals, and to be successful, the process requires consensus, collaboration, and innovation [5].

Although recognized as fundamental, the SDGs have been criticized for not being based on a strong conceptual model of sustainability, in which the three main forms of social, economic, and environmental capital are independent and irreplaceable, and in a more balanced and integrated set [6].

In particular, as a resource provider, the environment is perceived as relevant only to the objective of safe water and sanitation [6].

Since the adoption of the 2030 Agenda by the 193 Member States of the United Nations in September 2015, there has been unprecedented momentum around the world towards achieving the respective Sustainable Development Goals [4].

The High-Level Political Forum (HLPF) on Sustainable Development, which meets annually under the auspices of the General Assembly and the United Nations Economic and Social Council, plays a central role in monitoring and reviewing the implementation of the 2030 Agenda around the world. [4].

Some recurring challenges remain, such as finding the financial resources and securing cross-sectoral policies and budgets, but there are also encouraging trends, such as the role of technology in accelerating development outcomes [4].

Today, there are more complex and interconnected global challenges. Often even the most local problem has a wider dimension. This is why a multisectoral approach to sustainable development is

critical to guide collective work towards 2030 [4].

Partnerships, including the most unusual ones, are fundamental to achieving the SDGs. It is necessary to be aware of multistakeholder collaborations, where unexpected partners join forces to ensure that their diferente, but complementary experiences, allow the emergence of new solutions [4].

In addition to this knowledge diversity, funding sources must be diversified so that risks and opportunities can be shared, and programs can rely on regular funding [4]. There is an unprecedented dynamism to collaboration. The 2030 Agenda is about thinking and approaching things differently [4].

3. The International Organization for Standardization

The International Organization for Standardization's (ISO) long history of collaboration with the UN has been essential in tackling some of the world's most global challenges and will continue to be a transformative force in the future as the roadmap to 2030 is pursued [3].

At an international level, technical standards are issued by ISO, created on February 23, 1947, based in Geneva, Switzerland. Its purpose is to develop international technical standards, except in the electrotechnical and electronic areas, which are the responsibility of the International Electrotechnical Commission (IEC), which has existed since 1906.

There are also regional standardization organizations, such as the Pan American Commission for Technical Standards, the European Committee for Standardization, and the European Committee for Electrotechnical Standardization, for electrical and electronic matters. And Brazil's representative in these organizations is the Associação Brasileira de Normas Técnicas (ABNT), which has existed since 1940.

ABNT, a non-profit civil entity, is considered of Public Utility by Law Nº. 4,150 of November 21, 1962, and is part of the National Metrology, Standardization and Industrial Quality System (SINMETRO). Thus recognized as a Forum of the National Standardization System by Conmetro Resolution Nº. 14, of December 1983.

As an independent non-governmental organization, ISO plays a leading role in defining international technical standards concerning innovation, which is considered essential to accelerate results.

The process of defining a technical standard itself is the result of dialogue and partnership, in the spirit of the 2030 Agenda.

The technical standard is a document established by consensus and approved by a recognized organization, which provides, in common and repetitive use, rules, guidelines, or characteristics for activities or their results, aiming at obtaining an optimal degree of order in a given context.

The standardization activity, which means the elaboration, publication, and implementation of technical standards aims:

- economy, providing simplification or reduction of the growing variety of products and procedures;
- communication, standardizing the exchange of information between the manufacturer and the consumer, improving the reliability of commercial relationships and services;
- safety, protecting life and health;
- consumer protection, providing the means to verify the quality of products and services;
- elimination of technical and trade barriers, avoiding the existence of conflicting technical requirements on products and services in different countries;

Thus, trade exchange is allowed, which is particularly important for developing countries as it allows them to more easily compete in the global market [7].

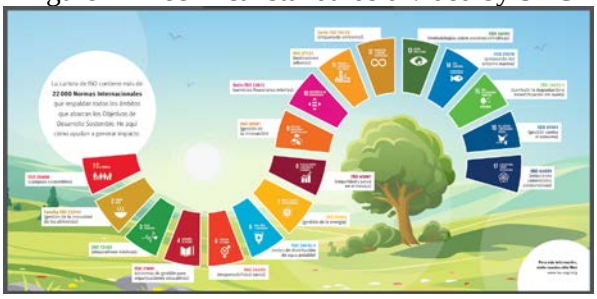
Covering virtually all sectors, technical standards give confidence to investors and consumers, creating an environment in which products and services can develop [7].

In particular, the ISO technical standards support sustainable industrialization through internationally agreed technical specifications that meet quality, safety, and sustainability requirements [7].

Additionally, a crucial element for the fulfillment of the 2030 Agenda, and its respective SDGs, is its monitoring and the measurement of its progress, and, in this domain, the ISO standards help to measure the success and to identify the challenges [7].

In this sense, to promote sustained economic growth and ensure sustainable production and consumption methods and processes [2], ISO has established, based on consensus and international collaboration, more than 22,000 international technical standards, which permeate all areas covered by the Sustainable Development Goals [3], as shown in figure 2:

Figure 2 - Technical standards divided by SDG



Source: ISO Focus [3]

Thus providing the essential tools for governments, industries, and consumers to contribute to the achievement of each of the SDGs and a solid foundation on which innovation can thrive [5].

4. Sustainable Development Goal – Nº 9

Among the Sustainable Development Goals with the highest number of technical standards established by ISO, industry, innovation, and infrastructure (SDG 9) stand out, with more than 13,000 international technical standards, as shown in Figure 3, enabling the construction of resilient infrastructures, promoting inclusive and sustainable industrialization, and fostering innovation.

Figure 3 - ISO contributes to the SDGs

Source: ISO Focus [3]

Encouraging innovation is essential for the sustainability and economic viability of the business [8].

Innovation is not just about brilliant new inventions or discoveries. It is a crucial business need as it relates to a company's ability to identify and pursue new areas of opportunity while understanding and responding to changing conditions in its environment [8].

According to the Organization for Economic Cooperation and Development (OECD), innovation goes far beyond research and development (R&D), and defines into four types: product, process, marketing, and organizational innovation [9], namely:

- Product innovation - a new or significantly improved good or service. This

includes relevant improvements in technical specifications, components, materials, in-product software, ease of use, or other functional characteristics.

- Process innovation - a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment, and/or software;
- Marketing innovation - a new marketing method that involves significant changes in product design or packaging, product positioning, product promotion, or pricing;
- Organizational innovation - a new organizational method in business practice, workplace organization, or external relations.

Innovation helps organizations create value while managing uncertainty and leveraging employees' knowledge and creativity [8].

In the context of the 2030 Agenda, sustainable development must be understood as the creation of innovative economies focused on people, taking into account their abilities, needs, and expectations regarding the world.

Promoting innovation is one of the main methods for resuming a long-lasting and sustainable growth trajectory. Government policy plays a major role in increasing innovation in the economy [10].

Measuring the level of innovation in the world's economies has been of interest to economic theorists and practitioners for several years. However, the actual level of innovation in world economies can be assessed based on a much more limited set of diagnostic resources available in official statistics [10].

In this sense, international ISO standards provide a platform to ensure interoperability. That is, the ability of different systems and organizations to work together, to ensure that people, organizations, and systems interact to exchange information effectively and efficiently, encouraging investment, and supporting innovation [7].

ISO has developed a large portfolio of international technical standards and guidance documents that enable an organization to align all its systems and processes to undertake innovation activities and initiatives, addressing all the factors that contribute to an organization being innovative. Thus ensuring the implementation of an effective system of innovation management [8].

According to these guidelines, an innovation is a new or improved product or process that significantly differs from previous products or processes, and is made available to users. This definition is in line with those found in ISO standards so that they can be useful tools to compare and assess innovation within and between organizations [8].

ISO's ongoing work on innovation management provides tried and tested frameworks that help organizations unlock their innovative potential, most notably the family of standards that address innovation management, such as ISO 56000 “Innovation Management - Fundamentals and Vocabulary”. This set includes ISO 56002 “Innovation Management - Innovation management system – Guidance”, and ISO 56003 “Innovation Management - Tools and methods for innovation partnership – Guidance” [3].

Technical standards are also important tools in building safe and resilient infrastructure. ISO has over a thousand technical standards for the construction industry, including not only minimum levels of safety and performance but also a range of resilience testing methods.

Furthermore, ISO has technical standards that facilitate business practices and relationships. This includes ISO 44001 “Collaborative Business Relationship

Management Systems - Requirements and Framework", on collaborative business relationship management systems, which provides a common platform to maximize the benefits of working collaboratively, and help companies establish healthy business relationships, within and between organizations supporting the 2030 Agenda.

Thus, SDG-9 benchmarks industrial performance, preserving the environment and promoting inclusion, and constitutes a valuable tool for policymakers and analysts [11].

5. The Quality Infrastructure

The development and implementation of technical specifications, standards, or technical regulations require a quality infrastructure, that is, a system constituted by private and public organizations that contribute to improving the quality and safety of products, services, and processes. Based on a set of best practices in metrology, standardization, conformity assessment, accreditation, and market surveillance [12], some concepts can be defined:

- metrology is the science of measurement and its applications, encompasses all theoretical and practical aspects of measurement, whatever the measurement uncertainty and knowledge field [13];
- standardization consists of the voluntary establishment of minimum requirements for products, processes, and services. In particular, the elaboration, dissemination, and implementation of standards [14];
- conformity assessment is a systematic process, with pre-evaluated rules, to provide an adequate degree of confidence in a product, process, or service. That is, fulfillment of pre-established requirements in rules or regulations [15];
- accreditation is the formal recognition of the competence of a conformity assessment institution to develop its activities under pre-established requirements [16];
- market surveillance is the set of measures and activities performed to monitor and verify whether products, inputs, and services meet the requirements established in the technical legislation within its competence [17].

In Brazil, the National Institute of Metrology, Quality, and Technology (INMETRO) is the Quality Infrastructure coordinator, which is central to the promotion and support of economic, environmental, and social development [18]. Therefore, it is fundamental to the country's competitiveness.

Inmetro, a federal autarchy, is the executive body of the National Metrology, Standardization, and Industrial Quality System (SINMETRO). The National Council of Metrology, Standardization, and Industrial Quality (CONMETRO) is Sinmetro's normative institution.

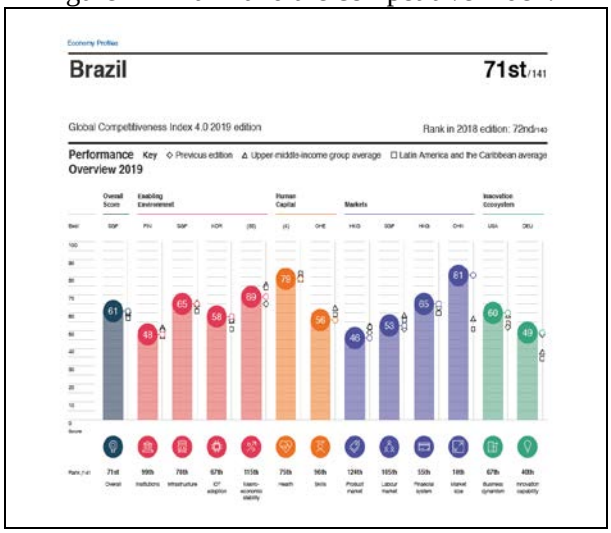
Competitiveness is understood as the attributes and qualities of an economy that allow a more efficient use of production factors. Thus, for productivity gains, the most important aspect of long-term economic growth [19].

In this sense, encompassing 141 economies, the Global Competitiveness Index (GCI), presented in The Global Competitiveness Report of the World Economic Forum (WEF), measures national competitiveness - defined as the set of institutions, policies, and factors that determine the productivity level. It is organized into twelve key productivity drivers: Institutions; Infrastructure; Information and Communication Technology; Health; Skills; Product Market; Employment Opportunities; Financial System; Market Scale; Business Dynamism; and Innovation Capacity. Also valuing factors that will grow in importance as the fourth Industrial Revolution gathers pace, such as: Human

Capital; Agility; Resilience; and Innovation [19].

In this ranking, Brazil occupies the 71st position, as shown in Figure 4. Just one position higher than the last evaluation, and the 8th position in the Latin America and Caribbean region [19].

Figure 4 - Brazil and the competitive index.



Source: Weforum [19]

Improving productivity in Brazil is critical to the country's social agenda. This year's GCI improvements, while limited, are a first step towards laying the groundwork for greater prosperity [19].

This result was mainly driven by a significant simplification of the rules for starting and closing companies, which boosted the business dynamism score [19].

In addition to these improvements, Brazil's competitive performance also benefits from its relatively high level of innovation capacity and the size of its market.

On the other hand, greater advances in macroeconomic stability must be accompanied by greater trade openness, especially regarding applied tariffs and non-tariff barriers [19].

Looking forward, as the global economy strives to become more inclusive and sustainable as envisioned in the 2030 Agenda, governments are increasingly expected to set the course for higher social and environmental standards. That is, long-term policies, essential to achieve these objectives [19].

6. World Trade Organization

The General Agreement on Tariffs and Trade (GATT), signed in Geneva by representatives of 23 countries in 1947, has evolved and, on January 10, 1995, gave rise to the current World Trade Organization (WTO).

From a mere provisional agreement on tariffs and trade, the GATT, after 48 years, has become the WTO, the broadest and most ambitious international trade agreement ever signed.

The WTO, intending to promote and regulate international trade rules, allows countries to establish their technical regulations, an important step in advancing new technologies and diffusing innovation. Reports should apply only to the extent necessary to protect human, animal, or plant life health, and should not arbitrarily or unreasonably discriminate against countries where the same or similar conditions prevail [20].

The technical regulation is a document that contains mandatory standards and is adopted by an authority, which establishes requirements aimed at ensuring aspects related to health, safety, and the environment.

With the increasing complexity of international trade regulation, one of the important areas of debate for possible WTO negotiations on environmental regulation, despite the substantial length of the respective agreements, is the Production Process and Methods (PPM). In other words, the way to extract the necessary natural resources and elaborate or obtain the product, mainly for developing countries.

Environmental motivations often stem from a desire to protect global environments and shared resources, which can mean new technical barriers, or obstacles of a technical nature, to international trade. Mainly for Brazil, holder of the greatest biodiversity in the world and whose exports have been losing strength with the demands of sustainability [21].

Thus, technical requirements on PPM guide how the products must be produced; prescribe specifications of methods to be used in the production process, considering the types of impact that can be caused to the environment, given the health, safety, and environment aspects to be adopted during the manufacture of a product; and assume relevance in international trade, complementing any gaps in the domestic sphere.

However, the interaction between trade and the environment has become controversial since the first GATT panel in 1991 declared that distinctions based on PPM were not welcome within its scope.

The broader interpretation of the PPM encompasses controversial international trade issues of contemporary interest:

- health and safety aspects of new technologies;
- depletion of resources, both renewable and non-renewable;
- environment pollution; and
- the use of child, forced, prison, and slave labor.

In Brazil, the National Confederation of Industry (CNI), concerned about the impact of non-tariff barriers on Brazilian exports, initiated a process of raising awareness in the private sector to identify technical, sanitary, and phytosanitary barriers, instead of automatically incorporating them into the product cost. It also identified restrictions that involve some of Brazil's main trading partners, such as the European Union and the United States, and affect some key products in Brazil's export basket, such as meat, sugar, and fruit juices. In addition, it concluded that non-tariff barriers, specifically technical barriers, and sanitary and phytosanitary measures to international trade, reduced Brazil's export capacity by 14%, or US$30 billion, in 2017 [22].

Recently published by the UN, the report Trade and Sustainable Development points out that world exports are also losing strength with sustainability requirements [22].

7. Gravitational Model

Commercial rivalries, when unavoidable or irreducible, can evolve into armed conflicts. As taught by the Prussian military thinker Carl von Clausewitz, “War is the continuation of politics by other means”. Needs for food, water, energy, and raw materials cause wars. In this context, there can be no sustainable development without peace, and there is no peace without sustainable development [2].

Thus, detailed quantitative information and analyses on trade policy are increasingly necessary. In recent years, globalization and trade openness have become increasingly controversial. Quantifying trade flows and policies makes it possible to describe, compare and monitor the evolution of these policies across countries or sectors, or over time.

Among the simulation methodologies used to predict the effects of trade and policies related to the respective flows, welfare, and income distribution, the gravity model stands out. This is one of the most successful and therefore widely used models for trade flows empirical analysis between countries, which can be approximated by a law called the “gravitational equation”, in analogy to Newton's gravitational theory.

Like planets, attracted to each other in proportion to their size and proximity, trade

relations between countries depend on their respective economies and distances.

In this sense, the trade flow between two countries will be directly proportional to their economic masses, generally measured by Gross Domestic Product (GDP), or other variables that can promote trade. The flow will also be indirectly proportional to distance and other trade barriers.

Thus, by similarity:

$$F_{ij} = G \frac{M_i^{\alpha} M_j^{\beta}}{D_{ij}^{\theta}}$$

F_{ij} = flow from origin i to destination j;
G = gravitational constant;
M_i e M_j = relevant economic measures of countries i and j;
D_{ij} = distance between countries i and j; and
α, β, θ = coeficients.

There is a return to Newton's equation when using $\alpha = \beta = 1$ and $\theta = 2$. The multiplicative nature of the gravitational equation allows the use of the logarithmic function, obtaining a linear relationship between the terms [23]. The remarkable success and popularity of the gravitational model as a simulation methodology for commerce can be explained by combining a few arguments.

First, the gravitational model is very intuitive. Using the metaphor of Newton's Law of Universal Gravitation, the model predicts that international trade (gravitational force) between two countries (objects) is directly proportional to the product of their sizes (masses) and inversely proportional to trade frictions (the square of the distance) between them.

Second, it is a structural model with solid theoretical foundations, making it particularly suitable for counterfactual analyses, such as quantifying trade policy effects.

Third, it represents a realistic general equilibrium environment that simultaneously accommodates multiple countries, industries, and even companies. As such, the gravitational frame can be used to capture the possibility that markets (countries, sectors, companies, etc.) are connected. Thus, changes in trade policy in a specific market will trigger ripple effects across the rest of the world.

Fourth, the gravitational configuration is a very flexible framework that can be integrated into a wide class of even broader general equilibrium models, allowing one to study the links between trade and the labor market, investment, environment, etc.

Finally, one of the most appealing properties is its predictive power. Empirical gravitational equations for trade flows consistently provide a remarkable fit of between 60 and 90 percent with aggregated or sectoral data for goods and services.

Thus, it proved to be a useful empirical model for understanding the distribution of goods and factors of production at scale. It is also the econometric model used for the analyzes of international trade flows to estimate the impact of a range of issues [24].

Thus, within the scope of the 2030 Agenda, highlighting the promotion of sustained economic growth and the guarantee of sustainable production and consumption methods and processes, and committing to work tirelessly for the full implementation of this agenda by 2030 [2], the metrics require indicators that can simultaneously measure sustainability in the three basic dimensions of sustainable development: environmental, social, and economic.

These indicators should measure, monitor and evaluate practices, allowing for estimating the environmental impacts arising from human activities and, consequently, evaluating and guiding policies for sustainable development.

In this sense, the method is indicated for analyzing the impact of technical barriers to international trade, through environmentalist technical requirements in the methods and productive processes inherent to industries, using sustainability metrics in a gravitational model, contributing to sustainable

development, improvement of quality infrastructure [18], and best regulatory practices in the country [25].

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