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Diagnostic Engineering as an Ally for Implementing Accessibility and Achieving the 2030 Agenda SDGs

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A Engenharia Diagnóstica como Aliada para a Implementação da Acessibilidade e a Concretização dos ODS da Agenda 2030

RESUMO

Objetivo – Este artigo examina as principais etapas da avaliação da acessibilidade no ambiente construído, com base em uma análise documental da legislação e normas técnicas vigentes. Ressalta a importância de integrar considerações de acessibilidade durante as fases de projeto, diagnóstico e implementação de projetos de construção. O estudo identifica Objetivos de Desenvolvimento Sustentável (ODS) específicos diretamente influenciados pela implementação eficaz da acessibilidade e avalia as principais metas da Agenda 2030 para suprir lacunas na indústria da construção civil brasileira.

Metodologia – A pesquisa emprega uma abordagem qualitativa, utilizando análise documental de regulamentações, legislações e normas relacionadas à acessibilidade e à engenharia civil diagnóstica. Essa integração permite a identificação de lacunas de implementação e o desenvolvimento de diretrizes técnicas para melhorias na acessibilidade.

Originalidade/Relevância – As informações analisadas preenchem uma lacuna teórica ao alinhar práticas de engenharia diagnóstica, como inspeções e relatórios, com metas específicas dos ODS. Sua originalidade reside em contrastar requisitos regulatórios e legislativos com aplicações práticas de mercado, destacando a necessidade de intervenções qualificadas para atender aos objetivos da Agenda 2030.

Resultados – Os resultados fornecem ampla orientação técnica para aprimorar as práticas profissionais e contribuem para o desenvolvimento de políticas públicas e práticas sustentáveis no setor da construção.

Contribuições teóricas e metodológicas – O estudo propõe uma estrutura de diagnóstico interdisciplinar que integra padrões técnicos com metas globais de sustentabilidade.

Contribuições socioambientais – A pesquisa promove a equidade, a inclusão e a sustentabilidade no ambiente construído, posicionando a acessibilidade como um direito fundamental e um elemento-chave para o alcance dos ODS.

PALAVRAS-CHAVE: Acessibilidade. Engenharia diagnóstica. ODS. Normas Técnicas.

Diagnostic Engineering as an Ally for Implementing Accessibility and Achieving the 2030 Agenda SDGs

ABSTRACT

Objective – This article examines the main stages for assessing accessibility in the built environment, based on a documentary analysis of current legislation and technical standards. It underscores the importance of integrating accessibility considerations during the design, diagnosis, and implementation phases of construction projects. The study identifies specific Sustainable Development Goals (SDGs) directly influenced by effective accessibility implementation and evaluates key 2030 Agenda targets to address gaps in Brazil's construction industry.

Methodology – The research employs a qualitative approach utilizing documentary analysis of regulations, legislation, and standards related to accessibility and diagnostic civil engineering. This integration enables the identification of implementation gaps and the development of technical guidelines for accessibility improvements.

Originality/Relevance – The analyzed information fills a theoretical gap by aligning diagnostic engineering practices, such as inspections and reports, with specific SDG targets. Its originality lies in contrasting regulatory and legislative requirements with practical market applications, highlighting the need for qualified interventions to meet the 2030 Agenda's objective.

Results – The fidings provide vast technical guidance to improve professional practices and contributes to the development of public policy and sustainable practices in the construction sector.

Theoretical and methodological contributions – The study proposes an interdisciplinary diagnostic framework that integrates technical standards with global sustainability goals.

Social and environmental contributions – The research promotes equity, inclusion, and sustainability in the built environment positioning accessibility as both a fundamental right and a key element for achieving the SDGs.

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KEYWORDS: Accessibility. Diagnostic engineering. SDGs. Technical standards.

La ingeniería diagnóstica como aliada para implementar la accesibilidad y alcanzar los ODS de la Agenda 2030

RESUMEN

Objetivo – Este artículo examina los principales pasos para evaluar la accesibilidad en el entorno construido, basándose en un análisis documental de la legislación vigente y las normas técnicas. Destaca la importancia de integrar las consideraciones de accesibilidad durante las fases de diseño, diagnóstico e implementación de los proyectos de construcción. El estudio identifica Objetivos de Desarrollo Sostenible (ODS) específicos directamente influenciados por la implementación efectiva de la accesibilidad y evalúa las principales metas de la Agenda 2030 para abordar las deficiencias en el sector de la construcción brasileño.

Metodología – La investigación emplea un enfoque cualitativo, utilizando el análisis documental de la normativa, la legislación y las normas relacionadas con la accesibilidad y el diagnóstico de la ingeniería civil. Esta integración permite la identificación de deficiencias en la implementación y el desarrollo de directrices técnicas para mejorar la accesibilidad.

Originalidad/Relevancia – La información analizada cubre una laguna teórica al alinear las prácticas de ingeniería de diagnóstico, como las inspecciones y los informes, con las metas específicas de los ODS. Su originalidad reside en contrastar los requisitos regulatorios y legislativos con las aplicaciones prácticas del mercado, lo que resalta la necesidad de intervenciones cualificadas para cumplir con los objetivos de la Agenda 2030.

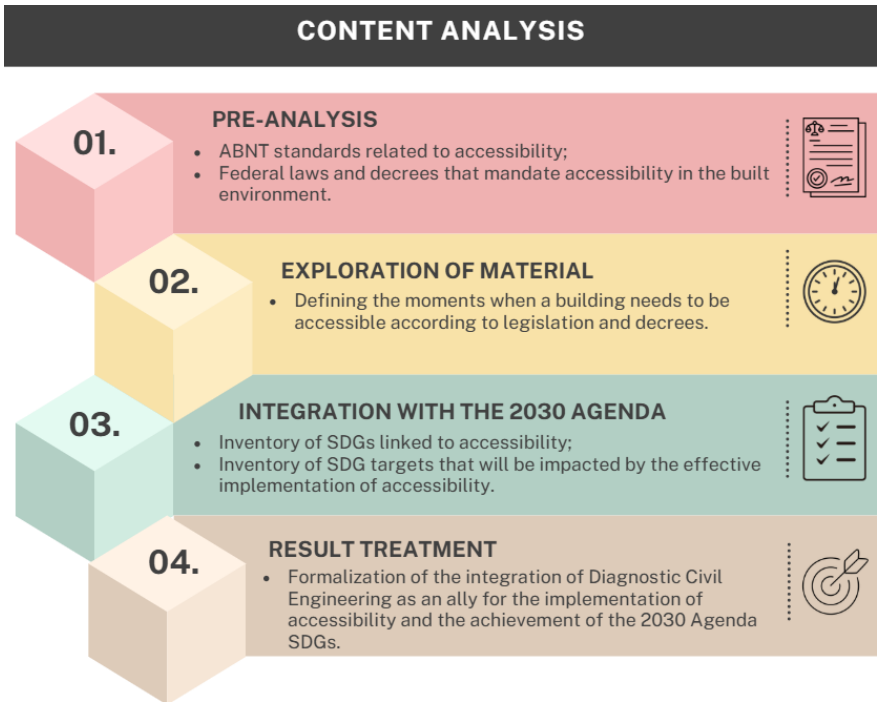
Resultados – Los resultados proporcionan una amplia orientación técnica para mejorar las prácticas profesionales y contribuir al desarrollo de políticas públicas y prácticas sostenibles en el sector de la construcción.

Contribuciones teóricas y metodológicas – El estudio propone un marco de diagnóstico interdisciplinario que integra las normas técnicas con los objetivos globales de sostenibilidad.

Aportes socioambientales – La investigación promueve la equidad, la inclusión y la sostenibilidad en el entorno construido, posicionando la accesibilidad como un derecho fundamental y un elemento clave para alcanzar los ODS.

PALABRAS CLAVE: Accesibilidad. Ingeniería de diagnóstico. ODS. Estándares técnicos.

GRAPHIC SUMMARY



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1 INTRODUCTION

Accessibility in the built environment is internationally recognized as a fundamental human right, integrated into the UN 2030 Agenda goals for inclusive and sustainable cities. However, despite regulatory advances, physical, architectural, and urban barriers persist that compromise the right to movement and limit the full inclusion of people with disabilities or reduced mobility. (Gupta; Yadav; Nayak, 2025) demonstrate that accessible public spaces increase urban equity and directly contribute to the SDG 11 targets, while (Eisenberg et al., 2024) highlight that urban accessibility plans are essential for reducing mobility inequalities and aligning infrastructure projects to climate goals.

In the Brazilian context, accessibility is a legal right and is decisive to promoting social inclusion and equity among citizens. The Brazilian Law for the Inclusion of Persons with Disabilities (LBI (Statute of Persons with Disabilities) No. 13,146, 2015) establishes guidelines to ensure the full and effective participation of persons with disabilities in society, on an equal basis with others. In the construction industry, accessibility requires alignment to specific technical standards that guide everything from the conception of architectural projects to the execution of construction and maintenance of buildings, such as the technical standard, a reference on accessibility for buildings, furniture, spaces, and urban equipment (ABNT NBR 9050, 2020), and the technical standard that establishes guidelines for the development of projects and installation of tactile signage (ABNT NBR 16537, 2024).

The Decree ("DF No. 5,296", 2004), for example, established important milestones, determining that all buildings constructed after its publication must be designed to be fully accessible, while previous buildings must promote adaptations in renovations that interfere with the interconnections between spaces (Guedes; Silva, 2017). However, alignment to these guidelines is not always guaranteed (Rodrigues; Bernardi, 2024), resulting in physical, architectural, and urban barriers that compromise the right of people with disabilities or reduced mobility to come and go (Lucchine et al., 2015; Santiago et al., 2024). In this sense, studies show that "NBR 9050/2020 is not fully complied with, showing a high discrepancy between the built environment and the standard" (Cuquejo et al., 2023; Guedes; Silva, 2017). This gap reveals technical problems that should not occur if technical standards are met, reinforcing the importance of training professionals responsible for projects and execution of works and inspections (Santana; Moraes, 2020; Staut; Bernardi, 2017).

In this context, diagnostic civil engineering emerges as a promising tool for identifying nonconformities (Buzalo et al., 2021) and supporting the implementation of solutions that promote accessibility in built spaces (Caldas; Moreira; Sposto, 2015). Diagnostic practices, applied through technical inspections, enable the assessment of existing conditions, identification of flaws, and guidance on corrective or preventive interventions based on technical and regulatory criteria (Junqueira et al., 2021). The field of diagnostic engineering, traditionally focused on analyzing pathology in civil construction, also encompasses the assessment of accessibility in buildings. This practice demonstrates that technical inspections comply with regulatory requirements established by law. However, the literature still lacks systematizations that address, in an integrated manner, the role of diagnostic engineering in promoting accessibility throughout the different stages of the life cycle of buildings, with the

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most cited aspect being environments that do not meet the minimum mandatory requirements stipulated by standards and legislation (Cuquejo et al., 2023; Staut; Bernardi, 2017).

There is also an important relationship with the Sustainable Development Goals (SDGs) of the United Nations (UN) 2030 Agenda, which establish global targets for building a more just world (SDGs, 2016). This study focuses specifically on SDGs 3 (Good Health and Well-being), 4 (Quality Education), 9 (Industry, Innovation and Infrastructure), 10 (Reduced Inequalities), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), 16 (Peace, Justice and Strong Institutions), and 17 (Partnerships for Achievement), demonstrating how technical compliance with accessibility standards directly impacts the achievement of these goals.

Given the incomplete implementation of accessibility (Santana; Moraes, 2020; Staut; Bernardi, 2017) and the urgency of implementing actions that meet the goals of the 2030 Agenda, this study sought to answer the following research question: What goals are impacted by the appropriate implementation of accessibility in the built environment? Based on a documentary analysis, we sought to identify the importance of integrating accessibility into the technical planning of buildings, contributing to the consolidation of the 2030 Agenda.

2 OBJECTIVE

The objective was to analyze, from the perspective of diagnostic engineering, the main moments in the life cycle of buildings in which accessibility must be diagnosed, highlighting its relevance as a strategic tool to guarantee inclusive, safe environments aligned with the Sustainable Development Goals (SDGs) of the 2030 Agenda.

3 METHODOLOGY

The study is based on secondary data, such as normative and legal documents, NBR 9050:2020, NBR 16537:2024, Decree No. 5,296/2004, Brazilian Inclusion Law 13,146/2015, and official documents of the UN 2030 Agenda. The data obtained were analyzed qualitatively, focusing on identifying categories related to the role of diagnostic engineering in diagnosing accessibility deficiencies in buildings with specific goals of the 2030 Agenda.

3.1 Data Collection

3.1.1 Legislation Survey

The table below chronologically organizes the most relevant laws addressing accessibility in Brazil. The table's objective is to systematize the legal framework that underpins accessibility in the built environment, which addresses accessibility as a fundamental right and mandatory guideline in buildings, urban spaces, and services.

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Quadro 1 – Principais legislações relacionadas a acessibilidade no ambiente construído

Year	Title	Relationship with Accessibility
1948	Universal Declaration of Human Rights	It guarantees fundamental rights, including equality and dignity for all people, which includes accessibility.
1998	Constitution of the Federative Republic of Brazil	It establishes the rights of people with disabilities, including accessibility in public and private spaces.
2000	Federal Law 10.048	It prioritizes care for people with disabilities, the elderly, pregnant women, and breastfeeding women in public and private services.
2000	Federal Law 10.098	It establishes standards to eliminate architectural barriers and ensure accessibility in urban spaces, buildings, and transportation.
2003	Elderly Statute, Federal Law 10.741	It ensures accessibility and priority care for the elderly in various services.
2004	Federal Decree 5,296	It regulates Laws No. 10,048/2000 and No. 10,098/2000, detailing accessibility standards in buildings, transportation, and communications.
2009	Federal Decree 6,949	It enacts the International Convention on the Rights of Persons with Disabilities, reinforcing accessibility as a fundamental right.
2010	Law 12,378	It regulates the profession of architect and urban planner, including guidelines for accessibility in urban projects.
2012	Law 12,587	It establishes the National Urban Mobility Policy, guaranteeing accessibility on public transportation.
2015	Statute of Persons with Disabilities, Federal Law 13,146	It defines rights and guarantees for people with disabilities, including accessibility in public and private spaces.
2018	Federal Decree 9,451	It regulates accessibility in private multi-family buildings.
2018	Federal Decree 9,296	It establishes accessibility standards for hotels, inns, and similar structures.

Source: Authors, 2025.

3.1.2 Survey of technical standards

The framework brings together a set of ABNT, ISO, and CONTRAN resolutions that establish fundamental technical requirements to ensure accessibility, safety, and inclusion in buildings and urban spaces. This survey aims to identify the technical standards that regulate the practical and safe application of accessibility, guiding design, construction, equipment installation, and accessible communication.

Table 2 – Main technical standards and resolutions related to accessibility in the built environment.

Title	Relationship with Accessibility
NBR 14718 Guardrails for Buildings	It defines requirements for guardrails in buildings, ensuring safety and accessibility.
NM NBR 313 Passenger Elevators – Safety Requirements for Construction and Installation – Specific Requirements for Accessibility for People, Including People with Disabilities	It specifies safety requirements for passenger elevators, including accessibility for people with disabilities.
NBR 15599 Accessibility – Communication in Service Provision	It addresses accessible communication in service provision, ensuring the inclusion of people with disabilities.
NBR 16537 Accessibility — Tactile Floor Signage — Guidelines for Design and Installation	It defines guidelines for the installation of tactile floor signage, essential for the mobility of people with visual impairments.

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NBR 9050 Accessibility to buildings, furniture, spaces, and urban equipment	It establishes criteria for accessibility in buildings, furniture, spaces, and urban equipment.
NBR ISO 9386-1 Powered lifting platforms for people with reduced mobility – Requirements for safety, dimensions, and functional operation, Part 1: Vertical lifting platforms	It establishes safety and operational requirements for vertical lifting platforms intended for people with reduced mobility.
NBR ISO 9386-2 Powered lifting platforms for people with reduced mobility – Requirements for safety, dimensions, and functional operation, Part 2: Stairlifts for seated, standing, and wheelchair users, moving on an inclined plane	It regulates inclined lifting platforms for seated, standing, or wheelchair users.
Resolution 303	It regulates exclusive parking spaces for seniors, ensuring accessibility.
Resolution 304	It establishes rules for parking spaces designated for vehicles transporting people with disabilities.
Brazilian Traffic Sign Manual	It defines horizontal signage standards, contributing to road accessibility.
Normative Instruction – IPHAN No. 001	It establishes guidelines for accessibility in listed cultural assets, ensuring inclusion without compromising historical preservation.

Source: Authors, 2025.

3.1.3 SDG Survey

The framework aims to link the issue of accessibility in the built environment with the global goals of the UN 2030 Agenda. It highlights how promoting accessibility directly contributes to achieving several SDGs, reinforcing its role as a key element for sustainable, social, environmental, and governance development.

Table 3 - Relationship between research and the Sustainable Development Goals (SDGs)

SDG	Title	Relationship with Accessibility
SDG 03	Health and Well-Being	Promoting accessibility in the built environment directly contributes to the physical and mental health of people with disabilities, the elderly, and other vulnerable groups, ensuring safety, autonomy, and well-being.
SDG 04	Quality Education	The research highlights the need for adequate training in undergraduate and graduate programs in engineering and architecture to ensure technical mastery of accessibility standards and principles.
SDG 09	Industry, Innovation, and Infrastructure	It encourages innovation in project development, diagnostic methodologies, and the redevelopment of urban and building infrastructure, promoting accessible and sustainable solutions.
SDG 10	Reducing Inequalities	Accessibility is an essential tool for ensuring social inclusion and equity, enabling the full exercise of rights by all people, regardless of their physical or sensory limitations.
SDG 11	Sustainable Cities and Communities	Implementing accessibility in existing and future buildings contributes to the development of more inclusive, resilient, and sustainable cities.
SDG 12	Responsible Consumption and Production	The correct application of standards and legislation prevents waste of materials and resources, contributing to more efficient construction with a lower environmental impact.
SDG 16	Peace, Justice, and Effective Institutions	It emphasizes the importance of complying with legislation and technical standards through effective oversight and institutions committed to guaranteeing accessibility rights.

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SDG 17	Partnerships and Means of Implementation	It reinforces the importance of collaboration among various stakeholders—such as universities, professionals, public agencies, and civil society—to advance accessible practices in the construction sector.

Source: Authors, 2025.

3.1.4. Survey of Specific Goals

The survey aims to highlight which goals, within each selected SDG, are directly related to the accessibility theme addressed in the research, demonstrating the extent to which inclusion and universal access to rights are included in the goals of the UN 2030 Agenda.

SDG 3: Of the 7 topics, the 2 below are linked to accessibility.

- 1.3 Implement, at the national level, adequate social protection measures and systems for all, including minimum wages, and by 2030 achieve substantial coverage of the poor and vulnerable
- 1.4 By 2030, ensure that all men and women, particularly the poor and vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technologies, and financial services, including microfinance

SDG 4: Of the 10 topics, the 9 below are linked to accessibility.

- 4.1 By 2030, ensure that all girls and boys complete free, equitable, and quality primary and secondary education that leads to relevant and effective learning outcomes
- 4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care, and pre-primary education so that they are ready for primary education
- 4.3 By 2030, ensure equal access for all men and women to affordable, quality technical, vocational, and higher education, including university
- 4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent work, and entrepreneurship
- 4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the most vulnerable, including persons with disabilities, indigenous peoples, and children in vulnerable situations
- 4.6 By By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy
- 4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, the promotion of a culture of peace and non-violence, global citizenship, and the appreciation of cultural diversity and culture's contribution to sustainable development
- 4.a Build and improve child-, disability-, and gender-sensitive education facilities that provide safe, non-violent, inclusive, and effective learning environments for all

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- 4.c By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training, in developing countries, especially least developed countries and small island developing States.

SDG 9: Of the 8 topics, the 4 below are linked to accessibility.

- Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
- 9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly increase the share of industry in employment and GDP, in accordance with national circumstances, and double its share in least developed countries
- 9.4 By 2030, modernize infrastructure and rehabilitate industries to make them sustainable, with increased resource efficiency and greater adoption of clean and environmentally sound technologies and industrial processes; with all countries acting within their respective capacities
- 9.c Significantly increase access to information and communication technologies and strive to provide universal and affordable internet access in least developed countries by 2020

SDG 10: Of the 10 topics, the 5 below are linked to accessibility.

- 10.1 By 2030, progressively achieve and sustain income growth for the poorest 40% of the population at a rate higher than the national average
- 10.2 By 2030, empower and promote the social, economic, and political inclusion of all, regardless of age, gender, disability, race, ethnicity, national origin, religion, economic, or other status
- 10.3 Ensure equal opportunities and reduce inequalities of outcomes, including by eliminating discriminatory laws, policies, and practices and promoting appropriate legislation, policies, and actions in this regard
- 10.4 Adopt policies, especially tax, wage, and social protection, and progressively achieve greater equality
- 10.5 Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations

SDG 11: Of the 10 topics, the 6 below are linked to accessibility.

- 11.1 By 2030, ensure access for all to safe, adequate, and affordable housing and basic services, and upgrade slums.
- 11.2 By 2030, provide access to safe, accessible, sustainable, and affordable transport systems for all, improving road safety through the expansion of public transport, with special attention to the needs of people in vulnerable situations, women, children, persons with disabilities, and older persons.
- 11.3 By 2030, increase inclusive and sustainable urbanization and capacities for participatory, integrated, and sustainable human settlements planning and management in all countries.

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- 11.7 By 2030, provide universal access to safe, inclusive, accessible, and green public spaces, particularly for women and children, older persons, and persons with disabilities.
- 11.a Support positive economic, social, and environmental linkages between urban, peri-urban, and rural areas by strengthening national and regional development planning.
- 11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans for inclusiveness, resource efficiency, climate change mitigation and adaptation, and disaster resilience; and develop and implement, in accordance with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels

SDG 12: Of the 11 topics, the 5 below are linked to accessibility.

- 12.2 By 2030, achieve the sustainable management and efficient use of natural resources
- 12.4 By 2020, achieve environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water, and land, to minimize their negative impacts on human health and the environment
- 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse
- 12.6 Encourage businesses, especially large and transnational corporations, to adopt sustainable practices and integrate sustainability information into their reporting cycle
- 12.8 By 2030, ensure that people everywhere have relevant information and awareness for sustainable development and lifestyles in harmony with nature

SDG 16: Of the 12 topics, the 3 below are linked to accessibility.

- 16.3 Promote the rule of law, at the national and international levels, and ensure equal access to justice for all
- 16.7 Ensure responsive, inclusive, participatory, and representative decision-making at all levels
- 16.b Promote and enforce non-discriminatory laws and policies for sustainable development

SDG 17: Of the 19 topics, 1 below is linked to accessibility.

- Enhance global macroeconomic stability, including through policy coordination and coherence (Policy and Institutional Coherence)

3.2 Data Analysis

The methodology adopted for this study was qualitative in nature, with a descriptive and analytical focus, structured in four main stages, aiming to understand the relationship between accessibility in the built environment and meeting the Sustainable Development Goals (SDGs) of the 2030 Agenda.

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a) The first stage consisted of a documentary survey, covering the analysis of current legislation, Brazilian and international technical standards related to accessibility in the built environment, as well as the identification of the SDGs and their respective specific targets. This phase aimed to map the normative and institutional framework that underpins the right to accessibility.
b) The second stage involved establishing a relationship between the identified items and the accessibility principles applied to the built environment. This analysis focused on understanding how each legal and regulatory provision contributes to promoting accessibility, from the perspective of diagnostic engineering, considering everything from the design phase to the use and maintenance phases of buildings.
c) The third stage focused on assessing the impacts of this normative relationship on the achievement of the global goals of the 2030 Agenda, identifying which goals are directly influenced by the implementation or lack thereof of accessibility in the built environment. To this end, a cross-section of the SDG targets and the technical and legal elements that comprise the accessibility diagnosis was structured.
d) As a final stage, the work allowed for a critical reflection on the importance of diagnostic civil engineering as a tool to ensure the effective implementation of accessibility, in compliance with current technical standards and legislation. The analysis demonstrated the relevance of considering accessibility from the project design phase, through the implementation of the works, to the period of use and post-delivery, not only to meet legal requirements, but also as a strategic contribution to the commitments of the 2030 Agenda, promoting social inclusion, equity, and sustainability.

4 RESULTS AND DISCUSSION

The results obtained in this study confirm that the appropriate application of accessibility requirements in the built environment is associated with the SDG targets related to social inclusion, resilient infrastructure, and reduced inequalities, especially SDGs 3, 4, 9, 10, 11, and 12. This finding converges with the argument by (Eisenberg et al., 2024) that accessibility should not be treated solely as a technical requirement, but as a strategic vector of urban sustainable development, integrating technology, governance, and social participation to promote inclusive cities.

Furthermore, the systematic cross-referencing of SDG targets and building lifecycle stages carried out in this study is similar to the approach proposed by Gupta et al. (2025) in the Digitainability Assessment Framework (DAF), which advocates the creation of replicable methodologies to assess the direct, indirect, and interconnected impacts of SDG interventions. Thus, the results presented here suggest that diagnostic engineering can function as a tool analogous to DAF, aimed at assessing and continuously monitoring the contribution of accessibility to the SDGs in the construction sector.

On the other hand, the data highlight gaps such as the low diversity of integrated systems and the absence of long-term metrics, which limit the measurement of the real impact of accessibility on the 2030 Agenda goals. This lack of indicators is mentioned by Eisenberg et al. (2024), who point to the need for more robust public policies and intersectoral governance that

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articulates technical standards, oversight, and incentives to ensure that built environments are effectively accessible and contribute to social and environmental sustainability.

Thus, the results and literature suggest that integrating diagnostic engineering with continuous and participatory assessment systems could enhance the observed benefits, reinforcing the strategic role of accessibility as a cross-cutting axis of the 2030 Agenda (Staut; Bernardi, 2017). Based on the analysis of Decree No. 5,296/2004, it was observed that accessibility must be guaranteed in two main regulatory frameworks:

(i) in existing buildings, which, when undergoing renovations, must ensure the interconnection of all common and public areas (BRASIL, 2004, art. 11, §1°);

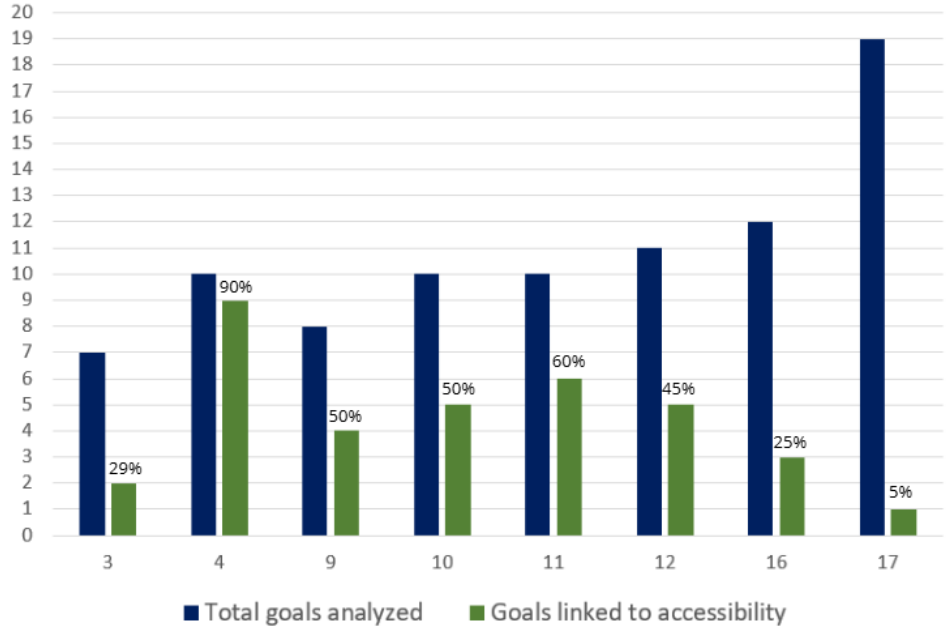
(ii) in new buildings, which must be conceived, designed, and constructed in accordance with the principles of universal accessibility (BRASIL, 2004, art. 11, §2°)

This establishes a continuous flow of accessibility implementation, distributed across three fundamental phases of the building lifecycle: 1. Conception, with technical accessibility provision already in the design phase; 2. Implementation, through execution in accordance with standards and adequate supervision during construction; and 3. Diagnosis, with periodic inspections and assessments of existing or renovated buildings, aiming to verify compliance with legal and regulatory parameters.

This approach is in line with the principles of diagnostic engineering, which acts as a strategic tool for identifying flaws, assessing compliance, and proposing solutions for technical and legal adjustments that promote inclusion (Santiago et al., 2024). The relationship between accessibility and the Sustainable Development Goals (SDGs) of the 2030 Agenda was analyzed based on the specific targets of each goal.

Figure 1 presents a graph with a quantitative analysis of the relationship between the Sustainable Development Goals (SDGs) and the respective specific targets that directly connect with accessibility.

Figure 1 – Specific goals versus link to accessibility.



Source: Prepared by the authors.

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The graph demonstrates that accessibility is strongly linked to several SDGs, especially those related to education, social inclusion, infrastructure, and sustainable cities. Graphical analysis allows us to identify where accessibility already has a consolidated presence and where there is still room for advancement, serving as a useful visual tool for supporting proposals, public policies, certifications, and projects aimed at promoting the rights of persons with disabilities within the 2030 Agenda (Cano, 2017; Picharillo et al., 2023).

4.1 Accessibility in the Built Environment

Accessibility in the built environment is a right guaranteed by several legal frameworks in Brazil. Decree No. 5,296/2004, which regulates Laws No. 10,048/2000 and No. 10,098/2000, establishes technical criteria and deadlines for adapting public and private spaces to the needs of people with disabilities or reduced mobility. The Brazilian Law for the Inclusion of Persons with Disabilities (LBI) — Law No. 13,146/2015 — expands this concept, treating accessibility as an essential condition for the exercise of citizenship and social inclusion, reinforcing the responsibility of construction professionals in eliminating architectural barriers.

In the technical field, NBR 9050:2020, from the Brazilian Association of Technical Standards (ABNT), stands out as the main standard establishing accessibility parameters for buildings, furniture, spaces, and urban facilities. It guides the development of projects and the execution of accessible works, being a mandatory reference for legal and functional compliance.

4.2 Diagnostic Engineering Applied to Accessibility

Diagnostic engineering is a technical field focused on identifying, analyzing, and resolving faults and pathologies in buildings, including failures to meet accessibility requirements. It uses methodologies based on inspections, audits, testing, and document analysis to evaluate the performance of buildings at different stages of their life cycle.

When applied to accessibility, this approach allows for verification of compliance with legal and regulatory requirements from the design phase, through construction execution, building acceptance, warranty inspections, periodic building inspections, renovations, changes of use, and permit renewals (Kato, 2020). The preventive work of the diagnostic civil engineer helps avoid irregularities and rework, promoting inclusive and efficient environments.

The lack of trained professionals and the absence of specific technical diagnoses during the critical phases of the construction process result in inadequate constructions, which do not meet the needs of all users and fail to comply with laws and regulations (Costa; Meira, 2009; Santos et al., 2016).

4.3 Connections between Accessibility and the 2030 Agenda SDGs

Accessibility is connected to the Sustainable Development Goals (SDGs) proposed by the United Nations (UN) 2030 Agenda (Boschco, 2021). By ensuring that environments are safe, accessible, and functional for all, we contribute to the achievement of several global goals, as shown in Table 4, directly connecting to the specific goals and analysis of accessibility application:

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Table 4 - Relationship between research and Specific Goals.

SDG	Selected Specific Goals	Topics	Accessibility Application Analysis
SDG 03	1.3 e 1.4	Of the 7 topics, 2 are related to accessibility.	Accessible environments contribute to accident prevention, mental health promotion, and the full inclusion of people with disabilities, the elderly, and children. This reflects a more specific, yet important, contribution to the well-being of people with disabilities.
SDG 04	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.a e 4.c	Of the 10 topics, 9 are related to accessibility.	The training of construction professionals should include specific knowledge about accessibility, ensuring the execution of projects that respect the rights of all citizens. This highlights the central role of accessibility in ensuring inclusive and equitable education.
SDG 09	9.1, 9.2, 9.4 e 9.c	Of the 8 topics, 4 are related to accessibility.	Diagnostic engineering, by proposing technical and innovative solutions to accessibility problems, strengthens urban infrastructure and project quality.
SDG 10	10.1, 10.2, 10.3, 10.4 e 10.5	Of the 10 topics, 5 are related to accessibility.	Promoting accessibility is one of the most direct ways to reduce inequalities in access to urban spaces and services.
SDG 11	11.1, 11.2, 11.3, 11.7, 11.a e 11.b	Of the 10 topics, 6 are related to accessibility.	Accessible buildings are the foundation for sustainable urban development, with a focus on inclusion and mobility for all.
SDG 12	12.2, 12.4, 12.5, 12.6 e 12.8	Of the 11 topics, 5 are related to accessibility.	Correcting poorly designed projects wastes resources; taking appropriate action from the beginning of the building's life cycle reduces costs and environmental impacts.
SDG 16	16.3, 16.7 e 16.b	Of the 12 topics, 3 are related to accessibility.	Legislative enforcement and the application of technical standards promote spatial justice and respect for the rights of people with disabilities.
SDG 17	17.13	Of the 19 topics, 1 is linked to accessibility.	Implementing accessible solutions requires cooperation between different stakeholders, such as the government, the private sector, educational institutions, and civil society. This SDG has the most targets analyzed (19), but only one is linked to accessibility, indicating a field with potential for greater coordination and inclusion of the topic. Thus, the connection between accessibility, diagnostic engineering, and the SDGs highlights the strategic role of the construction industry in promoting inclusive, equitable, and sustainable cities.

Source: Authors, 2025.

5 FINAL CONSIDERATIONS

This study demonstrates that accessibility in the built environment is both a fundamental right and a strategic technical requirement for promoting inclusive and sustainable urban development. The analysis of legal and regulatory provisions, including Decree No. 5,296/2004, the Brazilian Inclusion Law (LBI), and ABNT standards, reveals a solid foundation that, when systematically applied, guides and supports more equitable construction practices.

Currently, technical accessibility verification predominantly occurs post-construction, in a reactive process that involves a diagnostic report, adaptation project development, approval

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by the appropriate agencies, budgeting, execution, and issuance of a final certificate. This approach, in addition to being more costly and time-consuming, limits the positive impact on the initial quality of projects. Furthermore, specialized consulting during the design phase remains sporadic and limited to select initiatives, reinforcing the lack of standardization and proactive accessibility integration at this stage.

The research also revealed a clear link between effective accessibility implementation and the 2030 Agenda's Sustainable Development Goals (SDGs), particularly those related to health (SDG 3), education (SDG 4), industry and infrastructure (SDG 9), reduced inequalities (SDG 10), sustainable cities (SDG 11), and responsible consumption and production (SDG 12). This connection highlights accessibility as more than a regulatory obligation—it is a vital instrument for fulfilling global sustainability commitments.

Furthermore, the study highlighted that diagnostic engineering emerges as a powerful tool for ensuring technical compliance throughout the building lifecycle, from design to occupancy. It facilitates the identification of nonconformities, proposes corrective and preventive measures, and ensures inclusive environments.

Finally, the study consistently reveals a significant gap between accessibility standards and their real-world application reinforcing the need to integrate accessibility within urban planning and construction processes. This integration is not merely a legal requirement, but a continuous commitment to human, social, and sustainable development. Future research could benefit from a greater focus on developing and assessing practical and sustainable solutions, conducting longitudinal studies, and delving deeper into the causes of non-compliance, as well as expanding the scope to include more comprehensive ergonomic and user comfort considerations. It could also benefit from a deeper analysis of long-term impact indicators and international comparisons, strengthening the empirical basis for more integrated public policies and professional practices.

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DECLARATIONS

CONTRIBUTION OF EACH AUTHOR

When describing each author's contribution to the manuscript, use the following criteria:

- **Study Conception and Design:** Bianca Fernandez Gonçalves
- **Data Curation:** Ana Paula Branco do Nascimento
- **Formal Analysis:** Bianca Fernandez and Ana Paula Branco do Nascimento
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- **Investigation:** Bianca Fernandez
- **Methodology:** Bianca Fernandez and Claudia Terezinha Kniess
- **Writing - Initial Draft:** Bianca Fernandez
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- **Review and Final Editing:** Ana Paula Branco do Nascimento
- **Supervision:** Claudia Terezinha Kniess and Ana Paula Branco do Nascimento

DECLARATION OF CONFLICTS OF INTEREST

We, Bianca Fernandez Gonçalves, Ana Paula Branco do Nascimento, and Claudia Terezinha Kniess, declare that the manuscript entitled "Accessibility in the Life Cycle of Buildings: The Strategic Role of Diagnostic Engineering and Its Connection with the Sustainable Development Goals":

1. **Financial Relationships:** No financial relationships that could influence the results or interpretation of the work. No institution or funding entity was involved in the development of this study.
2. **Professional Relationships:** No professional relationships that could impact the analysis, interpretation, or presentation of the results. No professional relationships relevant to the content of this manuscript have been established.
3. **Personal Conflicts:** No personal conflicts of interest related to the content of the manuscript have been identified.