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BIM Contributions to Promotion of Sustainable Practices in the Construction Sector: Interfaces with the Agenda 2030

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Contribuições do BIM para a Sustentabilidade na Construção Civil: Alinhamento com os Objetivos da Agenda 2030

RESUMO

Objetivo – Este trabalho tem como objetivo analisar de que forma a tecnologia Building Information Modeling (BIM) pode contribuir para a promoção de práticas sustentáveis na construção civil, em alinhamento com os Objetivos de Desenvolvimento Sustentável (ODS) da Agenda 2030.

Metodologia – Com base em uma abordagem bibliométrica, foram selecionados os 10 artigos mais citados sobre o tema, na base Scopus, publicados entre 2016 e 2025, utilizando os descritores “BIM”, “construction” e “(SDG or sust*)”. A metodologia envolveu a triagem dos artigos e análise de conteúdo com base em critérios binários e descritivos, incluindo alinhamento com os ODS, áreas da engenharia envolvidas e impactos para a sustentabilidade atribuídos ao BIM.

Relevância – A integração entre o BIM e os ODS, com foco específico no setor da construção civil. A escolha por uma abordagem sistemática, associada a critérios qualitativos e à análise das contribuições efetivas do BIM para a sustentabilidade, confere à pesquisa um caráter inovador, especialmente ao considerar o alinhamento com as metas da Agenda 2030. A relevância reside na atualidade do tema e na urgência de se avançar com práticas construtivas mais responsáveis, eficientes e ambientalmente integradas, contribuindo para o debate científico e técnico sobre o papel das tecnologias digitais na transformação do setor da construção civil.

Resultados – Os resultados revelam que o BIM tem desempenhado papel relevante na integração de critérios de sustentabilidade ao longo do ciclo de vida das construções, com destaque para a eficiência energética, economia de recursos, inovação tecnológica e planejamento urbano sustentável. Houve maior incidência dos ODS 9, 11, 12 e 13, indicando uma convergência entre as potencialidades do BIM e os compromissos globais da Agenda 2030.

Contribuições teóricas e metodológicas – As contribuições teóricas do estudo incluem o mapeamento atualizado das interfaces entre BIM e sustentabilidade, além da organização de categorias analíticas aplicáveis a futuras pesquisas. Metodologicamente, o trabalho propõe uma abordagem replicável para análise crítica da literatura técnico-científica com base nos ODS.

Contribuições sociais e ambientais – Do ponto de vista social e ambiental, a pesquisa reforça o papel do BIM como instrumento de apoio à tomada de decisão na construção civil, com potencial para fomentar práticas construtivas mais eficientes, resilientes e alinhadas aos princípios do desenvolvimento sustentável.

PALAVRAS-CHAVE: BIM. ODS. Sustentabilidade. Construção Civil. Engenharia.

BIM Contributions to Promotion of Sustainable Practices in the Construction Sector: Interfaces with the Agenda 2030

ABSTRACT

Objective – This study aims to analyze how Building Information Modeling (BIM) can contribute to promoting sustainable practices in the construction sector, in alignment with the Sustainable Development Goals (SDGs) of the UN 2030 Agenda.

Methodology – Based on a bibliometric approach, the ten most cited articles on the topic were selected from the Scopus database, published between 2016 and 2025, using the descriptors “BIM,” “construction,” and “(SDG or sust*).” The methodology involved article screening and content analysis based on binary and descriptive criteria, including alignment with SDGs, engineering areas involved, and sustainable impacts attributed to BIM.

Relevance – The study advances the integration between BIM and the SDGs, with a specific focus on the construction sector. By adopting a systematic approach combined with qualitative criteria and an analysis of BIM’s effective contributions to sustainability, this research provides an original perspective, particularly when considering the alignment with the UN 2030 Agenda targets. The relevance lies in the timeliness of the topic and the urgency of advancing more responsible, efficient, and environmentally integrated construction practices, contributing to the scientific and technical debate on the role of digital technologies in the sustainable transformation of cities.

Results – The findings reveal that BIM has played a significant role in integrating sustainability criteria throughout the building life cycle, with emphasis on energy efficiency, resource economy, technological innovation, and sustainable urban planning. There was a higher incidence of SDGs 9, 11, 12, and 13, indicating a convergence between BIM’s potential and the global commitments of the 2030 Agenda.

Theoretical and Methodological Contributions – The study offers an updated mapping of the interfaces between BIM and sustainability, as well as the organization of analytical categories applicable to future research. Methodologically, it proposes a replicable approach for the critical analysis of technical-scientific literature based on the SDGs.

Social and Environmental Contributions – From a social and environmental perspective, the research highlights BIM's role as a decision-support tool in the construction sector, with the potential to foster more efficient, resilient, and sustainability-aligned building practices.

KEYWORDS: BIM. SDGs. Sustainability. Civil Construction. Engineering.

BIM y la Promoción de Prácticas Sostenibles en el Sector de la Construcción: Interfaces con la Agenda 2030 de la ONU

RESUMEN

Objetivo – Este estudio tiene como objetivo analizar cómo el Modelado de Información para la Construcción (BIM) puede contribuir a promover prácticas sostenibles en el sector de la construcción, en alineación con los Objetivos de Desarrollo Sostenible (ODS) de la Agenda 2030 de la ONU.

Metodología – Con base en un enfoque bibliométrico, se seleccionaron los diez artículos más citados sobre el tema en la base de datos Scopus, publicados entre 2016 y 2025, utilizando los descriptores "BIM", "construction" y "(SDG or sust*)". La metodología incluyó la selección de artículos y el análisis de contenido con base en criterios binarios y descriptivos, incluyendo alineación con los ODS, áreas de la ingeniería involucradas e impactos sostenibles atribuidos al BIM.

Relevancia – El estudio avanza en la integración entre BIM y los ODS, con un enfoque específico en el sector de la construcción. Al adoptar un enfoque sistemático combinado con criterios cualitativos y un análisis de las contribuciones efectivas del BIM a la sostenibilidad, la investigación ofrece una perspectiva original, especialmente al considerar la alineación con las metas de la Agenda 2030. La relevancia reside en la actualidad del tema y en la urgencia de avanzar en prácticas constructivas más responsables, eficientes y ambientalmente integradas, contribuyendo al debate científico y técnico sobre el papel de las tecnologías digitales en la transformación sostenible de las ciudades.

Resultados – Los resultados revelan que el BIM ha desempeñado un papel significativo en la integración de criterios de sostenibilidad a lo largo del ciclo de vida de las construcciones, con énfasis en la eficiencia energética, la economía de recursos, la innovación tecnológica y la planificación urbana sostenible. Hubo una mayor incidencia de los ODS 9, 11, 12 y 13, lo que indica una convergencia entre el potencial del BIM y los compromisos globales de la Agenda 2030.

Contribuciones Teóricas y Metodológicas – El estudio ofrece un mapeo actualizado de las interfaces entre BIM y sostenibilidad, así como la organización de categorías analíticas aplicables a futuras investigaciones. Metodológicamente, propone un enfoque replicable para el análisis crítico de la literatura técnico-científica con base en los ODS.

Contribuciones Sociales y Ambientales – Desde la perspectiva social y ambiental, la investigación destaca el papel del BIM como herramienta de apoyo a la toma de decisiones en el sector de la construcción, con el potencial de fomentar prácticas constructivas más eficientes, resilientes y alineadas con los principios del desarrollo sostenible.

PALABRAS CLAVE: BIM. ODS. Sostenibilidad. Construcción Civil. Ingeniería.

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1 INTRODUCTION

The construction sector is recognized for its high demand for natural resources and the generation of environmental impacts. Recent studies indicate that the construction industry accounts for about one-third of the world's energy and approximately one-third of global CO_2 emissions related to energy and industrial processes (Li et al., 2025; Zhao et al., 2025). According to Li et al. (2025), the carbon footprint of construction is expected to double by 2050, driven by increased consumption of energy-intensive materials such as cement and steel, and by unplanned urban expansion.

These challenges are discussed in light of the United Nations (UN) 2030 Agenda, which proposes 17 Sustainable Development Goals (SDGs) to guide global development strategies until 2030 (UN, 2015). Given this scenario, there is a growing need for civil engineering to rethink its processes and technologies, promoting more efficient, resilient, and environmentally sustainable construction practices (Nnadi et al., 2025; Altaf et al., 2025). This alignment requires innovation, integration between different areas, and the adoption of tools capable of incorporating sustainability criteria from the initial stages of projects.

Civil engineering plays an important role in the implementation of the SDGs, especially those related to infrastructure, energy, urbanization, and climate action. Recent studies have highlighted the convergence between SDGs 7 (clean and affordable energy), 9 (industry, innovation and infrastructure), 11 (sustainable cities and communities), 12 (responsible consumption and production), and 13 (climate action), with practices and techniques in the construction sector (Li et al., 2024; Teng; Shen; Tutuko, 2025; Widjaja; Rachmawati; Kim, 2025).

In this context, the advancement of digital technologies applied to civil construction has consolidated itself as a strategic path to sustainability. Among these technologies, Building Information Modeling (BIM) has stood out as a tool capable of integrating data and processes throughout the entire life cycle of a building, optimizing resource management, reducing waste, and promoting more integrated decisions (Volk et al., 2014; Akanbi et al., 2019). Several studies highlight the potential of BIM to promote sustainable practices through energy simulations, retrofits, life cycle analyses, circular economy, and material traceability (Abdirad; Pishdad-Bozorgi, 2020; Naghshbandi; Rezaie, 2022).

Zhao et al. (2025) emphasize that the lack of standardization in accounting for emissions hinders global monitoring, and that considering the entire life cycle of a building can increase current estimates by up to 25%. The study also highlights the potential of using digital technologies, such as BIM, to reduce waste and improve energy efficiency. And they emphasize that construction emissions have grown by 13% in the last decade, especially in emerging countries.

The incorporation of BIM into sustainable strategies has been discussed in the literature. Kaewunruen and Xu (2018) explored its application in digital twins for the maintenance and retrofit of railway stations, while Abanda and Byers (2016) analyzed its impact on the energy efficiency of buildings. Other studies, such as those by Teisserenc and Sepasgozar (2021) and Liu et al. (2019), have broadened this debate by integrating BIM with emerging technologies such as blockchain and "smart contracts," reinforcing its role in material traceability and intelligent lifecycle management of projects. As already mentioned, BIM has

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proven effective in supporting sustainable decision-making and incorporating environmental, social, and economic criteria from the design to the operation and maintenance of buildings and infrastructure (Rezaei et al., 2025; Abdirad; Pishdad-Bozorgi, 2020).

This study is justified by the relevance of systematizing and critically analyzing the state of the art on the contributions of BIM to sustainability in civil construction, from a perspective aligned with the SDGs. The originality of the research lies in the integration of a systematic and qualitative analysis of the scientific production indexed in the Scopus database, with a comparative focus between the 10 most cited articles and the 10 most recent articles on the subject. Thus, the guiding question of this work was "How can BIM technology contribute to the promotion of sustainable practices in civil construction, in alignment with the themes of the 2030 Agenda objectives?". The answer to this question allows us to understand how the use of BIM in civil construction can contribute to global challenges, leading to more sustainable, integrated, and innovative construction practices.

2 OBJECTIVE

To analyze how BIM technology has been used to promote sustainable practices in civil construction, aligned with the SDGs of the 2030 Agenda.

3 METHODOLOGY

This study adopted a Systematic Literature Review (SLR) approach based on scientific publications. This research was conducted in two stages: (1) screening of articles and (2) analysis of the selected content, seeking to answer the proposed research question, following the guidelines of the PRISMA 2020 protocol (PAGE et al., 2021).

3.1 Data Collection

3.1.1 Search and selection of articles

The search was conducted in the Scopus database using the following terms (or phrase) in the title, abstract, and keywords fields: “BIM AND construction AND (SDG OR sust*)”. The following inclusion criteria were defined: (i) open access scientific articles, (ii) published in English, (iii) related to the field of engineering, and (iv) with a time frame from 2016 to 2025. This period was defined based on the validity of the 2030 Agenda, whose implementation began in 2016. The initial search result identified 288 articles. For in-depth analysis, the 10 most cited articles and the 10 most recent articles were selected, totaling 20 articles. It is worth mentioning that one of the most cited articles in the database was published in 2014 with 189 citations, and this was maintained in the selection made.

3.2 Analysis procedure

The 20 selected articles were organized in an Excel spreadsheet, where data corresponding to the two stages of the analysis were entered: Stage 1 - initial screening and

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Stage 2 - full-text reading. In Stage 1, the title and abstract of each article were read to identify its adherence to the central criteria of the study. Five questions with binary answers (yes or no) were answered, indicating the presence of the themes: BIM, sustainability, civil construction, and relationship with the SDGs (Table 1). Only the articles that answered positively to all questions proceeded to Stage 2.

Table 1. Stage 1 – Initial screening of articles.

Question	Type of answer
1. Does the article mention BIM?	Yes / No
2. Is sustainability present?	Yes / No
3. Does it refer to civil construction?	Yes / No
4. Is there a relationship with the SDGs?	Yes / No
5. If so, which SDG?	With 17 options

Source: Authors, 2025.

In stage 2, the articles were read in full, with the aim of identifying the sustainable aspects addressed, the direct or indirect alignment with the SDGs and their targets, the thematic area of engineering to which they referred, the positive impacts attributed to the use of BIM, as well as the main results and conclusions (Table 2). The thematic areas were categorized as follows: (1) buildings and vertical constructions (SDGs 11 and 12), (2) infrastructure and transport (SDGs 9 and 11), (3) basic sanitation and water management (SDGs 6, 11 and 13), (4) urban and territorial planning (SDGs 11 and 16), (5) energy and energy efficiency (SDGs 7 and 13), (6) materials and technologies (SDG 12), (7) occupational safety and health (SDG 8), (8) education, training and governance (SDGs 4 and 17), and (9) operation and maintenance (SDG 12).

Table 2. Stage 2 – Questions that guided the analysis of the articles, according to the research question.

Question	Type of answer
What sustainability aspects were addressed?	Descriptive Answer
Is there direct alignment with the SDGs? If so, which ones?	Descriptive Answer
Is there indirect alignment with the SDGs? If so, which ones?	Descriptive Answer
Which SDG target(s) are mentioned or inferred?	Descriptive Answer
What thematic area of engineering does the article address?	1. Buildings and Vertical Constructions; 2. Infrastructure and Transportation; 3. Basic Sanitation and Water Management; 4. Urban and Territorial Planning; 5. Energy and Energy Efficiency; 6. Materials and Technologies; 7. Occupational Safety and Health; 8. Education, Training, and Governance; 9. Operation and Maintenance
What positive impacts of BIM on sustainability are highlighted?	Descriptive Answer
What are the main results?	Descriptive Answer
What are the authors' conclusions?	Descriptive Answer

Source: Authors, 2025.

To answer the questions in Table 2, a qualitative content analysis technique was applied, with a mixed-methods approach, of the deductive-inductive type (Mayring, 2014). The inductive stage focused on identifying passages in which the articles explicitly mentioned practices or impacts related to the use of BIM in connection with the 2030 Agenda. The deductive stage was based on previous categories linked to the SDGs and their targets, allowing the identification of both direct alignments and indirect associations. The process involved categorizing the most relevant passages from each publication, coded according to the objectives and targets of the 2030 Agenda. This approach followed the methodological basis of Gaudereto (2023), adapting it to the context of the articles and the specific scope of this research.

The procedure followed the recommendations of Mayring (2014). Initially, the material was described: each article was analyzed in terms of its authors, objectives, and central themes. Next, an inductive coding was applied, in which the texts were read in full and the passages related to sustainability practices, engineering areas, or mentions of the 2030 Agenda were highlighted. Each occurrence was recorded and classified according to categories created throughout the reading.

Subsequently, deductive coding was carried out, supported by a coding guide derived from the goals and objectives of the SDGs. For each article, it was verified whether there was a correspondence between the highlighted passages and the goals and objectives of the 2030 Agenda, even indirectly. Whenever the presence of terms or expressions related to a specific SDG was identified, the sentence was evaluated according to previously established rules, in order to ensure consistency in categorization. This step allowed the results to be organized systematically, revealing both explicit alignments and gaps or implicit mentions, composing an integrated analysis of the articles from the perspective of sustainability.

4 RESULTS AND DISCUSSION

To address the research question—How can BIM technology contribute to promoting sustainable practices in civil construction, aligned with the 2030 Agenda?—a structured content analysis was conducted on the selected articles. Four key analytical dimensions were defined: (i) sustainable practices; (ii) SDGs and/or specific targets mentioned or inferred; (iii) civil engineering themes addressed; and (iv) positive sustainability impacts attributed to BIM.

The articles were organized into three blocks, the first referring to the most cited articles, which represent the maturation of the academic debate and highlight consolidated contributions. The second block includes the most recent articles, which indicate trends, new methodological approaches and emerging technologies. Finally, an integration of the results was carried out, in order to compare the two groups of articles, highlighting convergences, divergences and potential gaps in the literature.

4.1 Consolidated contributions: analysis of the most cited articles

The analysis of the ten most cited articles selected for this research allowed us to identify alignment with the SDGs, sustainable practices promoted, and the contributions of BIM technology in civil construction.

4.1.1 SDGs and targets mentioned or inferred from the most cited articles

Table 3 presents the SDGs cited directly (in green) and indirectly (in blue). This analysis identified how scientific studies addressed, albeit in a non-uniform way, the SDG guidelines in the context of sustainable civil construction and the use of BIM technology. It should be noted that all 17 SDGs were considered in the analysis, but, for reasons of space, it was decided to present only those that had results, direct or indirect. The absence of direct mention of the SDGs

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in some articles does not indicate irrelevance, but rather indirect inference from the topics covered, such as energy sustainability, circular economy and waste reduction.

SDG 11 (Sustainable cities and communities) is the most recurrent among the analyzed articles (Table 3), appearing directly (Alwan et al., 2017; Akanbi et al., 2019; Teisserenc; Sepasgozar, 2021) and indirectly (Kaewunruen; Lian, 2019; Charef et al., 2018; Olawumi et al., 2018; Olawumi; Chan, 2018; Kaewunruen; Xu, 2018; Carvalho et al., 2019; Liu et al., 2019) in all articles, when discussing urban strategies based on retrofit, smart planning and sustainable urban logistics.

Table 3. SDGs evidenced directly or indirectly in the most cited articles.

Reference	SDG1	SDG3	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG16	SDG17
Kaewunruen and Lian (2019)				[blue]	[green]	[blue]	[blue]	[blue]	[green]		
Alwan et al. (2017)	[blue]		[blue]	[blue]	[green]		[green]	[green]	[green]		
Charef et al. (2018)		[blue]			[blue]		[blue]				
Akanbi et al. (2019)					[green]		[green]	[green]	[green]		
Olawumi et al. (2018)			[blue]		[blue]		[blue]				
Olawumi and Chan (2018)			[blue]		[blue]		[blue]	[blue]			
Kaewunruen and Xu (2018)	[blue]				[blue]		[blue]				
Carvalho et al. (2019)			[blue]				[blue]	[blue]			
Teisserenc and Sepasgozar (2021)	[blue]		[blue]		[green]	[blue]	[green]	[green]		[blue]	[blue]
Liu et al. (2019)					[blue]		[blue]			[blue]	

* Articles that mention the SDGs in the text are in green, and those that indirectly address SDG themes are in blue.
Source: Authors, 2025.

SDG 9 (Industry, innovation and infrastructure) also appears prominently in nine out of ten articles, mainly because it addresses technological innovations such as BIM in the construction sector and the modernization of infrastructure systems. SDG 12 (Responsible consumption and production) stands out in six publications, aligned with the perspective of circular economy, building decommissioning and construction waste management (Alwan et al. 2017; Olawumi; Chan, 2018; Akanbi et al., 2019; Carvalho et al. 2019; Kaewunruen; Lian, 2019; Teisserenc; Sepasgozar, 2021). Furthermore, five articles address SDG 7 (Affordable and Clean Energy), demonstrating the use of BIM in energy consumption simulation and thermal planning in buildings (Alwan et al., 2017; Carvalho et al., 2019; Olawumi et al. 2018; Olawumi et al. 2018).

SDG 13 (Climate Action) appears directly in three studies that discuss the reduction of CO_2 emissions and the efficient use of energy (Alwan et al., 2017; Akanbi et al. 2019; Kaewunruen; Lian, 2019). Other objectives such as SDG 1 (No Poverty), SDG 3 (Good Health and Well-being), SDG 16 (Peace, Justice and Strong Institutions) and SDG 17 (Partnerships for the Goals) appear in a more specific way.

This analysis demonstrates that BIM, when incorporated as a tool to support the design, operation, and management of constructions, has the potential to contribute significantly to the implementation of global sustainability goals. Furthermore, the effort of the scientific

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community to involve civil engineering, integrating technology such as BIM with global sustainability goals, is observed.

It is worth mentioning that all articles align with the goals of the 2030 Agenda. The mapping carried out in this study allowed us to identify the multidimensionality of BIM's contributions to sustainability, demonstrating that the SDGs are often research topics, but are not directly mentioned in scientific articles, as shown in Table 3.

4.1.2 Sustainable practices of the most cited articles

Regarding sustainable practices (Table 4), BIM's contributions to reducing CO_2 emissions (Kaewunruen; Lian, 2019), the life cycle management of building components (Kaewunruen; Xu, 2018; Charef et al., 2018), and the promotion of the circular economy, with emphasis on the reuse of materials and sustainable dismantling (Alwan et al., 2017; Akanbi et al., 2019; Teisserenc; Sepasgozar, 2021), are observed.

In buildings, the studies highlighted the evaluation and optimization of energy and thermal performance from the early stages of the project. The integration of BIM with evaluation systems (SBToolPT-H) demonstrated that the orientation of the building impacts energy consumption, allowing the selection of alternatives with lower energy use through parameterized simulations (Carvalho et al., 2019).

In railway infrastructure, two studies have demonstrated the feasibility and usefulness of 6D BIM/Digital Twin for evaluating emissions, costs, and schedules throughout the lifecycle, focusing on carbon reduction and maintenance optimization. One study involved a track switching device with a detailed lifecycle analysis and identification of emission hotspots embedded in the manufacturing phase and higher reconstruction costs (Kaewunruen; Lian, 2019); and another on the requalification of existing stations, where retrofit scenarios were compared and the solution combining thermal insulation and fire barriers proved to be more effective in environmental and economic terms (Kaewunruen; Xu, 2018).

Table 4 – Summary of the most cited articles regarding Sustainable Practices, SDG targets, Engineering Areas and BIM's contributions to sustainability.

Reference	No. of Citations	Sustainable Practices	SDG | Goals	Engineering Area(s)	Contributions of BIM
Kaewunruen; Lian (2019)	214	CO_2 reduction, life cycle management, materials efficiency, energy saving	1.5, 7.3, 8.4, 9.4, 11.6, 12.5	Infrastructure and transportation; Workplace safety; Operation and maintenance	Life cycle assessment, resource optimization, maintenance support, emissions and cost reduction.
Alwan; Jones; Holgate (2017)	204	Waste reduction, dematerialization, rational use of resources, energy efficiency, modular construction	1.5, 7.3, 8.4, 9.4, 11.6, 12.5	Buildings; Infrastructure; Energy; Occupational health; Operation	Waste reduction, life cycle control, resource conservation, integration with sustainable policies.
Charef; Alaka; Emmitt (2018)	189	Sustainable performance evaluation, a model for performance evaluation – BIM	3.9, 9.4, 11.6	Infrastructure; Occupational health	Inclusion of environmental data in the BIM model, supporting sustainability throughout the life

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Reference	No. of Citations	Sustainable Practices	SDG |Goals	Engineering Area(s)	Contributions of BIM
					cycle.
Akanbi et al. (2019)	183	Reuse and recycling of materials, circular economy, reduction of construction waste, life cycle.	9.4, 11.6, 12.5	Infrastructure; Operation and maintenance	Support for circular design, material reuse, and sustainable decisions with BIM plug-in.
Olawumi et al. (2018)	178	Integration of sustainability criteria into the project, environmental impact assessment.	7.3, 9.5, 11.6	Infrastructure; Energy	Simulation of sustainable alternatives, potential for integration with environmental criteria.
Olawumi; Chan (2018)	161	Energy and materials efficiency, waste reduction, life cycle control.	7.3, 9.4, 11.6, 12.5	Infrastructure; Energy; Operation	Waste reduction, decision support, greater environmental and economic control.
Kaewunruen; Xu (2018)	151	Retrofit, renovation, energy efficiency, safety and maintenance	1.4, 9.1, 9.4, 9.5, 11.2, 11.3, 11.6, 11.7	Buildings; Infrastructure; Urban planning	Simulation of retrofit scenarios, maintenance support, energy savings.
Carvalho; Bragança; Mateus (2019)	148	Thermal performance, passive comfort, energy consumption	7.3, 11.6, 12.5	Buildings; Energy	Decision-making for energy efficiency, simulations in the project.
Teisserenc; Sepasgozar (2021)	125	Waste reduction, traceability, circular economy, energy efficiency	1.5, 7.3, 9.5, 10.2, 12.5, 16.6, 17.6	Infrastructure; Energy; Urban planning; Governance	Support for the circular economy, secure data integration, collaboration, traceability.
Liu et al. (2019)	109	Energy and resource reduction, smart contracts, traceability	9.4, 11.6, 16.6	Energy and resource reduction, smart contracts, traceability	Transparency, stakeholder integration, and support for sustainability with blockchain.

Source: Authors, 2025.

Additionally, a strategic study in the United Kingdom showed that combining BIM with the Framework for Strategic Sustainable Development (FSSD) enables bottom-up sustainability strategies (waste reduction, dematerialization, rational use of resources, and modular construction), with gains in collaboration and integration with policies (Alwan et al., 2017).

In the life cycle and circular economy, the development of a plug-in (D-DAS) for dismantling and deconstruction highlighted BIM's ability to anticipate and optimize end-of-life decisions. In comparative scenarios, steel structures showed greater reuse potential (93%), followed by wood (65%) and concrete (42%), demonstrating the role of BIM in design for dismantling and reuse (Akanbi et al., 2019).

Regarding the dimensions of BIM beyond 3D, a systematic review surveying European professionals found consensus for 4D (time) and 5D (cost), but a lack of standardization for 6D and 7D. Even so, 6D was widely associated with sustainability and 7D with facility management,

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reinforcing the need for clear regulations to avoid diluting benefits (Charef et al., 2018).

The Delphi/AHP studies synthesized international perceptions, such as prioritized benefits of BIM+sustainability integration, for the efficient use of resources, robust decision support, and reduction of environmental impacts, while technical, organizational, and human barriers (lack of training, culture, and standards) still limit widespread adoption (Olawumi et al., 2018; Olawumi; Chan, 2018).

Finally, two conceptual articles proposed architectures that integrate BIM with technologies such as blockchain and digital twins to strengthen trust, traceability, transparency, and data security, with a view to the circular economy and energy efficiency (Teisserenc; Sepasgozar, 2021; Liu et al., 2019). These frameworks (e.g., DDTC) organize layers of connection, data management, computing, and blockchain, offering ways to overcome legal and/or operational obstacles and expand the governance of sustainability information.

From a technical point of view, the main contributions of BIM are associated with the development of 6D models, which incorporate environmental dimensions into projects, simulating emissions, energy consumption, and thermal behavior (Alwan et al., 2017; Carvalho et al., 2019). The integration with Blockchain and Digital Twins, as proposed by Liu et al. (2019) and Teisserenc and Sepasgozar (2021), expands the possibilities for traceability, transparency and data-driven decision making in sustainable projects.

Another relevant contribution from the literature is BIM's support for strategic decision-making via multi-criteria methods, such as the Analytic Hierarchy Process (AHP), which emphasizes the hierarchical structuring of BIM's sustainability benefits (Olawumi and Chan, 2018b). In addition, identifying institutional and technical barriers to adopting sustainable practices is highlighted as essential for developing effective public policies in this field (Olawumi et al., 2018).

The articulation between SDGs and areas of civil engineering, such as urban planning, waste management, energy efficiency, construction systems and project management, demonstrates the thematic scope of the contributions analyzed. This diversity of approaches reveals that BIM is a technology with the potential to promote sustainable practices, varying according to the context, the level of digital maturity and the integration with other technologies (such as blockchain or environmental simulation tools).

4.1.3 Engineering fields covered in the most cited articles.

The results reveal that the areas of civil engineering (Table 4) covered by the studies are diverse and complementary, encompassing Infrastructure and Transportation, Buildings, Energy and Energy Efficiency, Operation and Maintenance, Urban and Territorial Planning, Occupational Safety, and Governance. This diversity confirms that BIM is a cross-cutting resource, capable of operationalizing sustainable practices in different contexts of civil construction.

In infrastructure studies, the focus was on reducing emissions and optimizing the life cycle of railway assets (Kaewunruen; Lian, 2019; Kaewunruen; Xu, 2018). In buildings, the analyses prioritized energy efficiency and rational use of resources (Alwan et al., 2017; Carvalho et al., 2019). In urban planning, the association of BIM with blockchain and digital twins proved fundamental to expanding governance and traceability (Teisserenc; Sepasgozar, 2021; Liu et al.,

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2019). Already in operation and maintenance, BIM has shown the ability to anticipate costs, emissions, and retrofit scenarios, in addition to supporting circular economy strategies (Akanbi et al., 2019).

When connected to the SDGs, these areas demonstrate how BIM makes it possible to align technical practices in civil engineering with the global goals of the 2030 Agenda, especially with regard to infrastructure modernization (SDG 9.4), sustainable cities (SDG 11), resource efficiency (SDG 12), and climate action (SDG 13). Therefore, the analysis of the engineering areas confirms that BIM fulfills its role as a design tool and acts as a strategic informational infrastructure for sustainability, capable of integrating environmental, economic, and social variables in the decision-making process of civil construction.

4.1.4 Positive impacts attributed to BIM in relation to the sustainability of the most cited articles.

The positive impacts observed answer the research question by demonstrating that BIM operationalizes sustainable practices aligned with the 2030 Agenda. There is evidence of reduced emissions and energy consumption through 6D modeling and retrofit analyses (Kaewunruen; Lian, 2019; Kaewunruen; Xu, 2018; Carvalho; Bragança; Mateus, 2019), waste minimization and increased reuse in deconstruction strategies (Akanbi et al., 2019), and support for multi-criteria decision-making (cost–time–carbon–energy) with benefits prioritized by experts (Olawumi; Chan, 2018).

Integration with strategic frameworks and enabling technologies (FSSD, blockchain, digital twins) enhances data governance and transparency (Alwan et al. 2017; Teisserenc; Sepasgozar, 2021; Liu et al., 2019). However, the lack of consensus on dimensions above 5D and barriers to capacity building and standardization suggest an agenda for institutional consolidation to scale up these impacts (Charef et al., 2018; Olawumi et al., 2018).

4.2 Emerging trends: analysis of the most recent articles

The analysis of the ten most recent articles, all published in 2025, indicates the emerging directions in which BIM is being discussed and applied as a tool to support sustainability in civil construction. Following the analysis criteria defined in the methodology, Table 5 indicates the alignment of the most recent articles with the themes of the 17 SDGs.

4.2.1 SDGs and targets mentioned or inferred from the most recent articles.

Table 5 highlights the predominance of SDG 9 (Industry, Innovation and Infrastructure), identified in all ten articles analyzed, and SDG 11 (Sustainable Cities and Communities), present in seven of them. The works of Sistos Sescosse et al. (2025) and Lau et al. (2025) stand out, as they simultaneously addressed eight SDGs, representing the most comprehensive studies at the interface between BIM and the themes of the 2030 Agenda. The results indicate a thematic concentration on specific objectives, while five SDGs were not addressed in any article and four had only one occurrence in the sample.

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Table 5. SDGs evidenced directly or indirectly in the most recent articles.

Reference	SDG3	SDG4	SDG6	SDG7	SDG8	SDG9	SDG10	SDG11	SDG12	SDG13	SDG16	SDG17
Li; Feng (2025)				■	■	■		■	■	■		■
Sistos-Sescosse et al. (2025)			■	■	■	■		■	■	■	■	
Widjaja et al. (2025)						■		■				
Xiao et al. (2025)						■	■					
Veerendra et al. (2025)				■	■	■		■	■			
Altaf et al. (2025)					■	■		■	■			
Lau et al. (2025)	■			■	■	■	■	■	■		■	
Teng et al. (2025)				■		■		■				
Abdelrheem et al. (2025)				■		■						
Nguyen et al. (2025)		■				■						

Source: Prepared by the authors.

In the most recent articles analyzed, no direct mentions of the 2030 Agenda or the SDGs were found. The references identified mostly correspond to themes, practices, and indicators related to the SDGs, identified through qualitative content analysis. The result shows that in the most recent articles, despite the current discussion about possible contributions of BIM to sustainable practices, there was no attempt by the authors to relate the discussion to the 2030 Agenda.

4.2.2 Sustainable practices from the most recent articles

The analysis of the articles, presented in "Table 6", indicates that sustainable practices associated with the use of BIM encompass different dimensions of the building lifecycle. Among the main results, the efficient management of data and materials stands out, favoring traceability and reducing waste, as well as optimizing the use of structural resources and interdisciplinary coordination to minimize rework and environmental impacts. Initiatives focused on energy efficiency were also recurrent, both in new projects and retrofits, with an emphasis on simulations for lighting, ventilation, insulation, and thermal comfort.

Table 6 – Summary of the most recent articles regarding Sustainable Practices, SDGs, Engineering Areas and BIM's contributions to sustainability.

Reference	Sustainable Practices	Goals - SDG	Engineering Area(s)	Contributions of BIM
Li; Feng (2025)	Urban data management, material traceability, and waste reduction.	7.2, 8.4, 9.4, 11.6, 12.5, 13.2, 17.16	Buildings and vertical constructions; Materials and technologies; Energy and energy efficiency	Data integration and interoperability, enabling resource tracking and supporting decision-making in sustainable cities.
Sistos-Sescosse et al.	Life cycle environmental	6.3, 7.3,	Buildings and vertical constructions;	Secure data integration and interoperability, enabling

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Reference	Sustainable Practices	Goals - SDG	Engineering Area(s)	Contributions of BIM
(2025)	assessment of buildings	8.4, 9.4, 11.6, 12.5, 13.2, 16.6	Materials and technologies; Operation and maintenance	resource tracking and supporting decision-making in sustainable cities.
Widjaja et al. (2025)	Optimizing the use of materials in structural elements.	9.4, 11.6	Infrastructure and transportation; Urban and territorial planning	Optimizing the use of materials and eliminating errors through process automation and the accurate generation of models and documents.
Xiao et al. (2025)	Interdisciplinary coordination, energy efficiency and mitigation of impacts in tunnels.	9.4, 10.2	Buildings and vertical constructions; Energy and energy efficiency	Integration between project and operation phases, with asset digitization and support for lifecycle management.
Veerendra et al. (2025)	Energy efficiency and environmental analysis of university buildings.	7.3, 8.4, 9.5, 11.6, 12.5	Infrastructure and transport; Materials and Technologies	Advanced environmental simulations for decisions regarding thermal comfort, natural lighting, and energy efficiency.
Altaf et al. (2025)	Life cycle cost analysis and economic sustainability in projects.	8.4, 9.4, 11.6, 14.1	Basic sanitation and water management; Urban and territorial planning	Integrating Life Cycle Assessment (LCCA) with BIM reduces errors, supports early-stage decision-making, and standardizes economic and environmental analyses.
Lau et al. (2025)	Circular economy strategies in construction (reuse, recycling and modularity).	3.9, 7.3, 8.4, 9.4, 10.2, 11.6, 12.5, 16.6	Vertical buildings and constructions; Materials and Technologies	Traceability of materials and support for circularity, with digital integration and encouragement of modularity and disassembly.
Teng et al. (2025)	Energy simulation for retrofit and insulation efficiency.	7.3, 9.4, 11.6	Buildings and vertical constructions; Energy and energy efficiency	Detailed energy simulations for comparisons of materials, costs, and emissions based on real-world data.
Abdelrheem et al. (2025)	Optimized design of structures with reduced environmental impact.	7.2, 9.4	Infrastructure and transport; Energy and energy efficiency	Interdisciplinary coordination and integrated simulations, optimizing structural resources and reducing rework.
Nguyen et al. (2025)	Digitization and optimization of operations to reduce emissions and energy consumption.	4.a, 9.4	Infrastructure and transport; Education, Training and Governance	BIM (digital twin) integration with IoT, providing real-time data for operational decisions and emissions reduction.

Source: Authors, 2025.

Furthermore, BIM facilitates the integration of circular economy principles—such as reuse, modularity, and recyclability—alongside life-cycle cost analysis and economic sustainability considerations in decision-making. Collectively, these elements highlight the diverse approaches and extensive role of BIM in advancing sustainable construction practices.

With regard to the goals associated with the SDGs, the articles analyzed reinforce the

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predominance of goal 9.4, linked to technological modernization and process efficiency, present in most of the sample. Goal 11.6 also appears recurrently, focusing on reducing environmental impacts in urban contexts, as does 7.3, aimed at energy efficiency. Other goals appear less frequently, such as 8.4, related to the efficient use of resources, 12.5, aimed at reducing waste, and 13.2, which deals with the integration of measures to address climate change. There were also specific instances identified related to SDGs 4, 10, 14, 16, and 17, indicating that, although the focus is on certain objectives, BIM has been explored in conjunction with different dimensions of sustainability.

4.2.3 Engineering fields covered in recent articles

The analysis of the ten most recent articles demonstrates a thematic concentration around infrastructure and transportation, present in all works, which indicates the centrality of this area in the debate on the application of BIM from a sustainable perspective. In the background, energy and energy efficiency and occupational safety and health stand out, both recurring in different articles, suggesting a convergence between the technological discussion and concerns related to both the energy transition and worker protection. References to operation and maintenance and education, training and governance were also identified, which, although less frequent, reveal a movement to incorporate aspects of management and knowledge transfer in the use of BIM.

On the other hand, themes traditionally associated with sustainability, such as basic sanitation and water management and urban and territorial planning, appear in smaller numbers, although present in some articles, denoting a space for expansion for future research. The absence of significant recurrence of areas such as materials and technologies or buildings and vertical constructions reinforces this gap. This overview suggests that, although BIM is being explored in areas critical to infrastructure and energy efficiency, the research agenda does not yet cover all fields of application aligned with the SDGs in a balanced way, especially those related to the integrated urban dimension and the management of natural resources.

4.2.3 Positive impacts attributed to BIM in relation to sustainability are discussed in recent articles

BIM's contributions to sustainability are evident on several fronts, including the automation of environmental analyses, such as Life Cycle Assessment (LCA) and Life Cycle Cost Analysis (LCCA), energy performance simulations, material circularity assessment, and integration with emerging digital technologies, such as digital twins, IoT, and advanced structural modeling. Sistos-Sescosse et al. (2025) applied BIM in conjunction with life cycle analysis to support environmental decisions, while Altaf et al. (2025) used it in the systematization of life cycle costs. Abdelrheem et al. (2025) explore its integration with structural simulations for resource optimization. Nguyen et al. (2025) suggest its potential in conjunction with digital twins and IoT to reduce emissions in real time. These examples demonstrate the consolidation of BIM as an integrating platform, capable of supporting multiple levels of analysis and decision-making in sustainability.

Another aspect that stands out is the presence of practices related to the circular

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economy, such as modularity, reuse, and traceability of materials, particularly in the studies by Lau et al. (2025) and Li and Feng (2025). This approach broadens the discussion beyond energy performance, incorporating strategies focused on managing material flows and reducing waste, aligned with contemporary demands for more circular construction processes.

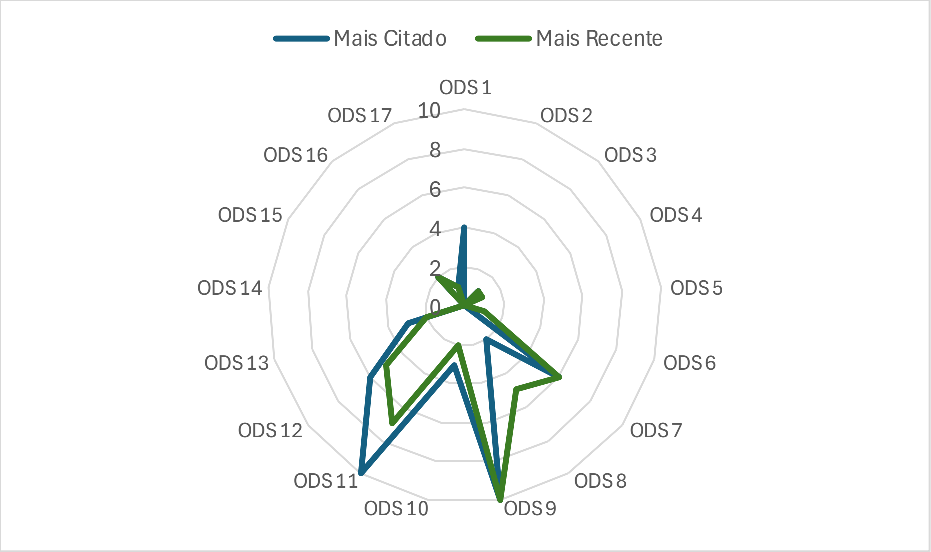
The results of the most recent articles indicate that BIM has been used as a collaborative environment for integrating data and tools, allowing the simultaneous consideration of technical, environmental, economic, and governance aspects. The multiplicity of applications observed suggests an advance in the use of the technology in different stages of the construction life cycle, reinforcing its role as support for planning, execution, and management guided by sustainability criteria.

4.3 Integration of results: patterns and gaps in the literature

Comparing the most cited and most recent articles allows us to visualize the evolution and direction of research integrating BIM with sustainable practices in civil construction, in alignment with the SDGs.

The integrated analysis of the 20 selected articles (10 most cited and 10 most recent) demonstrates relevant patterns and emerging gaps in the relationship between BIM and the SDGs. The radar chart (Figure 1) illustrates that the adherence of the studies is not distributed homogeneously among the 17 SDGs, concentrating on a specific set of objectives linked to urban sustainability and technological innovation, as well as energy efficiency.

Figure 1. Distribution of SDGs in BIM research in the construction industry.



Source: Authors, 2025.

The most cited articles show a strong convergence towards SDGs 9 (Industry, innovation and infrastructure) and 11 (Sustainable cities and communities), both mentioned in 10 studies. This predominance confirms the relevance of BIM as a strategic tool to modernize infrastructure, improve urban planning processes and support more resilient cities

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(Kaewunruen; Lian, 2019; Alwan et al., 2017; Akanbi et al., 2019).

In addition, objectives such as SDG 7 (Clean and affordable energy) and SDG 12 (Responsible consumption and production) also appear prominently, suggesting that classic works prioritized dimensions of energy efficiency, waste reduction and technological integration (Olawumi; Chan, 2018; Carvalho et al., 2016). However, the low incidence of mentions of SDGs of a social nature, such as SDG 4 (Quality Education) and SDG 5 (Gender Equality), demonstrates that the consolidated literature has focused on predominantly technical and environmental aspects, leaving aside social dimensions of sustainability.

In the most recent articles, a pattern of continuity and at the same time thematic expansion is observed. SDGs 9 and 11 remain central, reinforcing the relevance already identified in the most cited studies (Widjaja et al., 2025; Xiao et al., 2025). However, trends emerge of greater attention to SDG 8 (Decent Work and Economic Growth), mentioned in five articles, and to SDG 13 (Climate Action), cited in four recent articles (Li; Feng, 2025; Sistos-Sescosse et al., 2025). This change indicates a shift toward integrating BIM not only with technical efficiency but also with climate mitigation agendas and the socioeconomic impacts of the construction sector.

Another relevant contribution from recent literature was the inclusion of previously underexplored SDGs, such as SDG 4 (Quality Education) and SDG 6 (Clean Water and Sanitation), suggesting efforts to associate BIM with professional training practices and sustainable water management (Nguyen et al., 2025; Sistos-Sescosse et al., 2025). Although these mentions are still specific, they reveal potential lines of research that can broaden the scope of BIM toward more holistic and interdisciplinary solutions.

most recent articles, in turn, broaden this scope by incorporating SDG 8 (Decent work and economic growth), SDG 13 (Climate action), and, to a lesser extent, SDG 4 (Quality education) and SDG 6 (Clean water and sanitation). This evolution suggests that the current research agenda has sought to align BIM not only with technical aspects, but also with socioeconomic and climate dimensions, expanding its potential impact in the context of the 2030 Agenda.

However, a gap remains in the most cited and most recent articles, related to SDGs 2 (Zero hunger and sustainable agriculture), 5 (Gender equality), 14 (Life below water), and 15 (Life on land), which have not been significantly explored. This demonstrates that the interface between BIM and broader social dimensions, or those related to biodiversity, still lacks studies. This result reinforces the perception that, although BIM is recognized as a catalyst for technological innovation and environmental efficiency, its integration with the social pillars of the 2030 Agenda remains a challenge.

In summary, the results reveal a pattern of continuity around SDG 9 and SDG 11 as structuring axes of the relationship between BIM and sustainability, while also highlighting research gaps related to the social and ecological SDGs. This trend suggests that future investigations should seek greater transversality, expanding the potential of BIM as a tool to support not only sustainable construction, but also the promotion of social justice, education and environmental preservation.

5 CONCLUSION

This research explains the contributions of Building Information Modeling (BIM) to the advancement of sustainable practices in civil construction, aligned with the Sustainable Development Goals (SDGs) proposed in the United Nations' 2030 Agenda. A double-sampling bibliometric synthesis—comprising the ten most cited peer-reviewed articles and the ten most recent peer-reviewed articles, all indexed in Scopus and situated in the field of engineering studies—facilitated the delimitation of both consolidated knowledge patterns and emerging research trajectories at the BIM-sustainability interface.

The systematization of the data based on four analytical criteria (sustainable practices addressed, SDGs and associated goals, thematic areas of engineering and contributions attributed to BIM) revealed that the use of BIM has been consolidated as a strategic tool for the planning, execution and operation of sustainable projects. The most cited articles focus on themes already matured in the literature, such as reducing environmental impact, responsible consumption and production (SDG 12), and mitigating climate change (SDG 13). The most recent articles demonstrate the expansion of the scope of BIM's application, with a greater presence of themes such as energy efficiency (SDG 7), infrastructure innovation (SDG 9), and sustainable cities (SDG 11), indicating an emerging trend towards more complex and interdisciplinary applications.

There is a growth in the number of studies focused on engineering areas such as buildings and vertical constructions, energy efficiency, and operation and maintenance, suggesting that BIM is being used in an increasingly comprehensive and transversal way. The technology has demonstrated the ability to support the complete life cycle of projects, with emphasis on integrated planning, environmental performance modeling, simulation of construction scenarios, data traceability, and the management of material and energy resources.

In short, the analysis indicates that BIM contributes to sustainable practices mainly by modernizing construction processes, reducing waste, optimizing the use of energy and resources, and supporting sustainable urban planning. However, for its application to align with the 2030 Agenda, it is necessary to advance research that explores the cross-cutting nature of BIM, expanding its interface with the social, ecological, and educational dimensions of sustainability. For future work, it is suggested that databases be diversified for the collection of articles.

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REFERENCES

ABANDA, F. H.; BYERS, L. An investigation of the impact of building orientation on energy consumption in a domestic building using emerging BIM (Building Information Modelling). **Energy**, 2016. https://doi.org/10.1016/j.energy.2015.10.103.

ABDELRHEEM, A. E.; EL-HELLOTY, A.; EHAB, A. Integrated FEM, CFD, and BIM Approaches for Optimizing Pre-Stressed Concrete Wind Turbine Tower Design. **Civil Engineering Journal (Iran)**, v. 11, n. 2, p. 523–543, 2025. Salehan Institute of Higher Education.

ABDIRAD, H.; PISHDAD-BOZORGI, P. Barriers to the integration of Building Information Modeling and sustainability practices in construction. **Journal of Cleaner Production**, 2020. https://doi.org/10.1016/j.jclepro.2020.121730.

AGENDA 2030. Transformar Nosso Mundo: A Agenda 2030 para o Desenvolvimento Sustentável. 2015. Disponível em < https://gtagenda2030.org.br/wp-content/uploads/2015/08/odstraduzidos.pdf> Acesso em 02.05.2025.

AKANBI, L. A. et al. Disassembly and deconstruction analytics system (D-DAS) for construction in a circular economy. **Journal of Cleaner Production**, v. 223, p. 386–396, 2019. DOI: https://doi.org/10.1016/j.jclepro.2019.03.172.

ALTAF, M.; JAFFARI, R.; ALALAOUL, W. S.; MUSARAT, M. A.; AMMAD, S. Developing automated strategy of life cycle cost analysis (LCCA) with building information modeling (BIM) integration for building projects. **Results in Engineering**, v. 25, 2025. Elsevier B.V.

ALWAN, Z.; JONES, P.; HOLGATE, P. Strategic sustainable development in the UK construction industry through the framework for strategic sustainable development, using Building Information Modelling. **Journal of Cleaner Production**, v. 140, p. 350–358, 2017. DOI: https://doi.org/10.1016/j.jclepro.2015.12.085.

CARVALHO, J. P.; BRAGANÇA, L.; MATEUS, R. Optimising building sustainability assessment using BIM. **Automation in Construction**, v. 102, p. 170–182, 2019. DOI: https://doi.org/10.1016/j.autcon.2019.02.021.

CHAREF, R.; ALAKA, H.; EMMITT, S. Beyond the third dimension of BIM: A systematic review of literature and assessment of professional views. **Journal of Building Engineering**, v. 19, p. 242–257, 2018. DOI: https://doi.org/10.1016/j.jobe.2018.04.028.

GAUDERETO, G. L. **Planejamento estratégico do setor de energia brasileiro na perspectiva dos objetivos de desenvolvimento sustentável**., 11. dez. 2023. Tese de Doutorado, São Paulo: Universidade de São Paulo. Disponível em: <https://www.teses.usp.br/teses/disponiveis/3/3147/tde-03012024-095621/>. .

KAEWUNRUEN, S.; LIAN, Q. Digital Twin aided Sustainability-based Lifecycle Management for Railway Turnout Systems. **Journal of Cleaner Production**, v. 228, p. 1537–1551, 2019. DOI: https://doi.org/10.1016/j.jclepro.2019.04.156.

KAEWUNRUEN, S.; XU, N. Digital twin for sustainability evaluation of railway station buildings. **Frontiers in Built Environment**, v. 4, p. 77, 2018. Disponível em: <https://doi.org/10.3389/fbuil.2018.00077>.

LAU, E. K. S.; CHAN, D. W. M.; OLULEYE, B. I.; OLAWUMI, T. O. Towards Circular Buildings in Hong Kong: A New Integrated Technology–Material–Design (TMD) Circularity Assessment Framework. **Buildings**, v. 15, n. 5, 2025. Multidisciplinary Digital Publishing Institute (MDPI).

LI, Chaohui; PRADHAN, Prajal; CHEN, Guoqian; KROPP, Jürgen P.; SCHELLNHUBER, Hans Joachim. Carbon footprint of the construction sector is projected to double by 2050 globally. **Communications Earth & Environment**, [S.l.], v. 6, n. 1, p. 831, 2025. DOI: 10.1038/s43247-025-02840-x

LIU, Z. et al. Building information management (BIM) and blockchain (BC) for sustainable building design information management framework. **Electronics**, v. 8, n. 7, p. 724, 2019. Available at <https://doi.org/10.3390/electronics8070724>.

MAYRING, Philipp. **Qualitative Content Analysis: theoretical foundation, basic procedures and software solution**. Klagenfurt: SAGE OpenSSOAR open Access Repository, 2014. Available at: https://doi.org/10.1177/2158244014522633.

NAGHSHBANDI, M.; REZAIE, M. Identifying and prioritizing the benefits of integrating Building Information Modeling and sustainability in construction projects using hybrid MCDM approach. **Journal of Cleaner Production**, 2022. https://doi.org/10.1016/j.jclepro.2022.131241.

NGUYEN, T. D. H. N.; AHN, Y.; KIM, B. Integrated Digital-Twin-Based Decision Support System for Relocatable Module Allocation Plan: Case Study of Relocatable Modular School System. **Applied Sciences (Switzerland)**, v. 15, n. 4, 2025. Multidisciplinary Digital Publishing Institute (MDPI).

NNADI, E. O. et al. Towards circular buildings: Technology–Material–Design (TMD) circularity assessment framework. **Sustainability**, v. 17, n. 1, 2025. https://doi.org/10.3390/su17010412.

OLAWUMI, T. O. et al. Barriers to the integration of BIM and sustainability practices in construction projects: A Delphi survey of international experts. **Journal of Building Engineering**, v. 20, p. 60–71, 2018. DOI: https://doi.org/10.1016/j.jobe.2018.06.017.

OLAWUMI, T. O.; CHAN, D. W. M. Identifying and prioritizing the benefits of integrating BIM and sustainability practices in construction projects: A Delphi survey of international experts. **Sustainable Cities and Society**, v. 40, p. 16–27, 2018. DOI: https://doi.org/10.1016/j.scs.2018.03.033.

ONU, ORGANIZAÇÃO DAS NAÇÕES UNIDAS. Agenda 2030: Objetivos de Desenvolvimento Sustentável. 2015. Disponível em: www.agenda2030.com.br. Acesso em: 04 jan. 2025

PAGE, M.J. et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ, London, v. 372, n. n71, 2021. Disponível em https://doi.org/10.1136/bmj.n71

REZAEI, R. et al. Integrated digital-twin-based decision support system for improving productivity and sustainability in infrastructure projects. **Sustainability**, v. 17, n. 1, 2025. https://doi.org/10.3390/su17010628.

SEPASGOZAR, S. M. E.; KARAN, E. P.; HARMAN, A. Exploring blockchain and smart sustainable city: A systematic literature review to map future research trends. **Journal of Cleaner Production**, 2022. https://doi.org/10.1016/j.jclepro.2022.133879.

SISTOS-SESCOSSE, G.; ATUAHENE, B. T.; AJULO, O.; ADAMS, I. Examining the Decision Criteria for BIM–LCA: A Case Study. **Construction Economics and Building**, v. 25, n. 1, p. 203–220, 2025. Australian Institute of Quantity Surveyors.

TEISSERENC, B.; SEPASGOZAR, S. Adoption of blockchain technology through digital twins in the construction industry 4.0: A PESTELS approach. **Buildings**, v. 11, n. 12, p. 670, 2021. Available at <https://doi.org/10.3390/buildings11120670>.

TENG, X.; SHEN, Z.; TUTUKO, D. C. S. Evaluating the Impact of Insulation Materials on Energy Efficiency Using BIM-Based Simulation for Existing Building Retrofits: Case Study of an Apartment Building in Kanazawa, Japan. **Buildings**, v. 15, n. 4, 2025. Multidisciplinary Digital Publishing Institute (MDPI).

VEERENDRA, G. T. N.; DEY, S.; MANTLE, E. J.; MANOJ, A. V. P.; PADAVALA, S. S. A. B. Building information modeling – simulation and analysis of a University Edifice and its environs – A sustainable design approach. **Green Technologies and Sustainability**, v. 3, n. 2, 2025. KeAi Communications Co.

VOLK, R.; STENGEL, J.; SCHULTMANN, F. Building Information Modeling (BIM) for existing buildings—Literature review and future needs. **Automation in Construction**, v. 38, p. 109-127, 2014. Available at < https://doi.org/10.1016/j.autcon.2013.10.023>

WIDJAJA, D. D.; RACHMAWATI, T. S. N.; KIM, S. A BIM-based intelligent approach to rebar layout optimization for reinforced concrete columns. **Journal of Building Engineering**, v. 99, 2025. Elsevier Ltd.

XIAO, F., CHEN, X., ZHU, Y., XIE, P., SALIMZADEH, S., ZHANG, QB. Multi-LoD BIM integrated design framework for pressurised tunnel systems. **Tunnelling and Underground Space Technology**, v. 158, p. 2025. https://doi.org/10.1016/j.tust.2024.105371.

ZHAO, Q ZHANG, L.; LI, X.; WANG, Y.; LIU, J.; WANG, X.; DONG, S. Exploring Carbon Emissions in the Construction Industry: A Review of Accounting Scales, Boundaries, Trends and Gaps. **Buildings**, v. 15, n. 11, p. 1900, 2025. DOI:10.3390/2075-5309/15/11/1900

DECLARATIONS

CONTRIBUTION OF EACH AUTHOR

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

- **Study conception and design**: Ana Paula Branco do Nascimento and Guilherme Leite Gaudereto
- **Data curation**: Guilherme Leite Gaudereto and Ana Paula Branco do Nascimento
- **Methodology**: Victor Agostinho Conceição
- **Formal analysis**: Ana Paula Branco do Nascimento and Cláudia Kniess
- **Investigation**: Victor Agostinho Conceição
- **Writing – original version**: Victor Agostinho Conceição
- **Critical review**: Cláudia Kniess
- **Review and final editing**: Ana Paula Branco do Nascimento
- **Supervision**: Ana Paula Branco do Nascimento
- **Obtaining funding**: *It doesn't apply*

DECLARATION OF CONFLICTS OF INTEREST

We, **Victor Agostinho Conceição, Guilherme Leite Gaudereto, Cláudia Terezinha Kniess**, and **Ana Paula Branco do Nascimento**, declare that the manuscript entitled "**Contributions of BIM to Sustainability in Civil Construction: Alignment with the Objectives of the 2030 Agenda**":

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