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02-016 – EsBIMClass: a spanish BIM classification system for air quality monitoring sensors in architecture and civil engineering projects – EsBIMClass: sistema de clasificación BIM español para sensores de calidad del aire en proyectos de arquitectura e infraestructuras

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English Spanish

Environmental pollution, particularly from particulate matter such as PM2.5 and PM10, presents a challenge for sustainability and well-being in built environments. Various studies show the exposure to high concentrations, even indoors. The BIM methodology, through the integration of IoT sensors, can contribute to air quality monitoring in AEC industry projects. However, national BIM classification systems in Spain do not include specific categories for classifying air quality monitoring devices, and international systems do not extensively address this either. In response to this need, the EsBIMclass classification system is presented as a unified framework that covers the classification of building elements and includes a specific node for environmental sensors. Sensor classification is based on location, sensor type, autonomy, and data storage, facilitating integration into BIM models. Additionally, an international version, AllBIMclass, available in English, has been developed, based on the same conceptual structure. This system, with API development, contributes to sustainability and facilitates the adoption of advanced technologies in the AEC industry.

Keywords: EsBIM**C***lass; AllBIMclass; BIM classification; Air quality sensors; Architecture and infrastructure; BIM integration API*

La contaminación ambiental, especialmente por partículas como PM2.5 y PM10, es un desafío para la sostenibilidad y el bienestar en entornos construidos. Diversos estudios evidencian la exposición a altas concentraciones, incluso en interiores. La metodología BIM, a través de la integración de sensores IoT, puede contribuir al monitoreo de la calidad del aire en proyectos de la industria AEC. Sin embargo, los sistemas de clasificación BIM nacionales (España) no incluyen categorías específicas para clasificar dispositivos de monitoreo de calidad del aire, y los internacionales tampoco lo hacen de forma extensiva. En respuesta a esta necesidad, se presenta el sistema de clasificación EsBIMclass, un marco unificado que abarca la clasificación de elementos constructivos y un nodo específico para sensores ambientales. La clasificación de sensores se realiza según la ubicación, el tipo de sensor, su autonomía, y el almacenamiento de datos, facilitando su integración en modelos BIM. Además, se ha desarrollado una versión internacional, AllBIMclass, disponible en inglés, basada en la misma estructura conceptual. Este sistema, con desarrollo API, contribuye a la sostenibilidad y facilita la adopción de tecnologías avanzadas en la industria AEC.

Palabras claves: EsBIM**C***lass; AllBIMclass; Clasificación BIM; Sensores de calidad del aire; Arquitectura e infraestructuras; API de integración BIM*

1. Introduction

Air quality is a key factor for health and well-being, both in urban and indoor environments, where it is estimated that we spend up to 90% of our daily activities (Farmer et al., 2019). Exposure to pollutants such as particulate matter (PM1, PM2.5, PM10) and harmful gases (CO_2, CO, NO_x, SO_2) poses a significant risk to both human health and the environment (Teumzghi et al., 2023). In this context, the integration of environmental quality sensors into the built environment has become an increasing necessity for efficient monitoring and spatial management.

Building Information Modeling (BIM) has transformed the architecture, engineering, and construction (AEC) sector by providing digital representations that support asset management throughout the entire lifecycle (Salzano et al., 2025a). During the modeling phase, the use of an appropriate classification system is essential to structure information, facilitate interoperability, and ensure traceability among stakeholders and platforms.

Classification systems enable the standardized organization of project elements. At the international level, prominent systems include CoClass (Sweden), OmniClass, MasterFormat, and UniFormat (USA), and Uniclass 2015 (United Kingdom). In addition, the Industry Foundation Classes (IFC) standard, although not a classification system itself, allows the association of model elements with external classification references.

In Spain, several systems have been developed for specific application contexts. GuBIMClass, promoted by the Catalonia BIM Users Group (GuBIMCat) and Infraestructures.cat, is the most widely adopted classification system in building projects (AEAS, 2025). AEAS BIM Class, developed by the Spanish Association for Water Supply and Sanitation (AEAS), focuses on hydraulic networks through a multi-table approach in accordance with ISO 12006-2. In the railway sector, SCFclass, developed by the Railway Innovation Hub, has recently been adopted by ADIF for public procurement processes (ADIF, 2023). More recently, in the road infrastructure domain, the Directorate-General for Roads has introduced RCEclass, applicable to any phase of the project lifecycle in contracts using BIM methodology (Dirección General de Carreteras, 2024).

Whereas some international systems, such as OmniClass and Uniclass 2015, include, albeit to varying degrees, specific nodes for environmental sensors (gases, particles, temperature, humidity, etc.), national systems lack a dedicated classification structure for such devices. This limitation hinders the inclusion of IoT sensors in BIM models, particularly in projects focused on sustainability, energy efficiency, or environmental monitoring (Schieweck et al., 2018).

In response to this gap and the increasing demand for solutions that support proper classification in phases such as operation and maintenance (Royano et al., 2023; Salzano et al., 2025b), this paper introduces EsBIMClass: a new Spanish classification system that incorporates a dedicated node for environmental sensors. It also provides extensive coverage for both buildings and civil works, and includes an additional node for preliminary works (topographic surveys, geotechnical studies, etc.), facilitating its use in all types of projects. An international version of the system is also available under the name AllBIMclass.

2. State of the Art

Over the past decades, various countries have developed their own classification systems, aligning them with international standards such as ISO 12006-2:2015, which establishes a common framework for organizing information in the construction sector. However, these systems differ significantly in terms of structure, level of detail, and scope of application, especially depending on the project phase (planning, design, execution, operation, or maintenance).

This section analyses the main classification systems at both the international and national (Spanish) levels, their ability to represent environmental sensors and IoT devices, and the role of the IFC standard as a structural support for classification. Lastly, emerging trends in the integration of sensor networks and environmental control within BIM environments are identified.

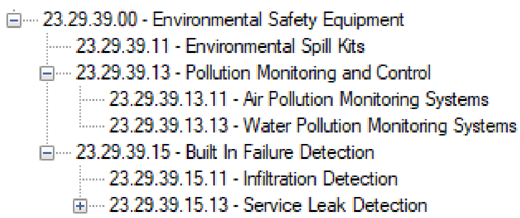
2.1 International BIM classification systems

Several internationally recognized classification systems exist, including OmniClass, MasterFormat, and UniFormat (USA), Uniclass 2015 (United Kingdom), CoClass (Sweden), CCS (Denmark), and the emerging CCI (Construction Classification International), promoted from Estonia with an international outlook. Most of these systems are fully or partially aligned with ISO 12006-2:2015. However, their structure, level of granularity, coding schemes, and scope of application are not uniform and vary across systems.

The following section describes in detail the three most widely adopted international systems today (Royano et al., 2023), along with a comparative summary presented in Table 1.

- OmniClass, developed by the Construction Specifications Institute (CSI) in the United States, is structured into 15 thematic tables, each dedicated to a specific aspect of the built environment. Table 23 (Site Products) allows for the classification of sensors as technological products within a construction system (Figure 1). Although it does not provide specific entries for environmental quality sensors, it allows their generic inclusion as electronic components or environmental monitoring systems.

Figure 1: Node 23.29 of OmniClass – Classification of environmental sensors.



Source: Autodesk (2025), OmniClass Taxonomy for Revit. Node imported from the OmniClassTaxonomy.txt file within the Revit environment. Image by the author.

- Uniclass 2015 is the classification system promoted by the National Building Specification (NBS) in the United Kingdom. It is a continuously updated system that aims to meet the demands of the digital environment and the principles of the BIM methodology. It is structured into 15 tables in its latest version and offers a dedicated products table (Pr), within which the group "Pr_75_50_76 – Sensors and detectors" (Figure 2) is structured. In it, we find detailed concepts for gas sensors, particulate matter sensors, temperature, humidity, etc., making it one of the most detailed classification systems with the highest capacity for classifying environmental IoT devices.

Figure 2: Excerpt from node Pr_75_50_76: "Pr" table (Products) – Uniclass 2015 for sensors.

Pr_75_50_76	Sensors and detectors
Pr_75_50_76_02	Air quality sensors
Pr_75_50_76_03	Air temperature sensors
Pr_75_50_76_04	Ambient noise level sensors
Pr_75_50_76_05	Air velocity sensors
Pr_75_50_76_10	Carbon dioxide sensors

Source: National Building Specification (NBS). XLSX file downloaded from the official website.

- CoClass, developed by Svensk Byggtjänst (SfB), is the national Swedish classification system for construction. It is aligned with ISO 12006-2 as well as with the ISO/IEC 81346-1, -2, and -12 series, which introduces a more functional and systems-oriented perspective. The structure of CoClass is based on the evolution of the BSAB system (1972, 1983, and 1996 editions), and it is designed to be applied throughout the entire lifecycle of built assets. In its latest version 3.16 (2025), CoClass consists of 9 tables (8 functional and 1 under development). The KO table (Components) includes sensor devices and even allows the definition of specific functions for monitoring systems (Figure 3), although its development level is less detailed than that of Uniclass 2015 in terms of pollutant types or environmental parameters.

Figure 3: View of sensor classification node – "KO" table (Komponenter), CoClass v.3.16.

Source: Svensk Byggtjänst. Screenshot taken from the official CoClass portal.

As shown in the summary table (Table 1), the main international classification systems share a mature structure, with a comparable number of hierarchically organized tables, active update mechanisms, API access, and a clear orientation throughout the asset lifecycle. In addition, their alignment with international standards such as ISO 12006-2 or the IEC/ISO 81346 series ensures interoperability and semantic consistency. Finally, to varying degrees, they include a dedicated table for the classification of environmental IoT devices. This convergence among international models stands in contrast to the Spanish context, which is analysed in detail in Section 2.3 of this paper.

Table 1: Comparison of the most widely adopted international classification systems.

	OmniClass	Uniclass 2015	CoClass
No. of tables	15	15	9 (8 funtional + 1 en development)
Environmental sensor classification	Partial (table 23)	Complete (Pr table)	Partial (KO table)

Underlying standard	ISO 12006-2:2015	ISO 12006-2:2015	ISO 12006-2:2015, ISO 81346-12:2018, IEC 81346-1:2022, IEC 81346-2:2019
Source tables	MasterFormat, UniFormat, EPIC	Uniclass, Uniclass 2	SfB, BSAB 72-96
API availability	Yes	Yes	Yes
PDF/XLSX access	Commercial	Free	Commercial
Last update year	Not specified	2023-2025	2025

2.2 IFC standard as a classification support

The IFC (Industry Foundation Classes) format, maintained by buildingSMART International, is the leading open standard for representing BIM models in an interoperable way. It is officially recognized as ISO 16739-1:2018, and adopted in Spain as UNE-EN ISO 16739:2020.

Although IFC is not a classification system per se, it allows the linking of model objects (such as IfcElement, IfcSpace, or IfcSensor) to external systems, such as OmniClass, Uniclass 2015, or CoClass, via entities like IfcClassification and IfcClassificationReference. This linkage can include attributes such as Identification, Name, ItemReference, or Location, which are useful for traceability and automated data processing.

However, IFC presents certain limitations. Its generic structure makes it difficult to distinguish the functional roles of elements (e.g., IfcWall used as an external enclosure or as an internal partition), which requires support from external classification systems (buildingSMART International, 2019). In addition, earlier versions such as IFC4 were not well suited for infrastructure projects. Although the recent IFC4.3 (ISO 16739-1:2024) improves this situation (El-Amraoui-Farssi et al., 2022), its implementation is still in the early stages. Furthermore, IFC does not include a dedicated taxonomy for environmental sensors, whose classification must be managed externally (Moraleda, 2023).

2.3 BIM classification systems in Spain

Unlike other European countries, which have developed fully structured national classification systems aligned with standards such as ISO 12006-2 and ISO/IEC 81346 (e.g., CoClass in Sweden or CCI in Estonia), the adoption of BIM classification systems in Spain has been more limited and fragmented. Although various initiatives exist, a unique and official system that comprehensively covers the entire project lifecycle and all project typologies has yet to be consolidated. This section describes the most relevant systems currently in use or under development in Spain, analyzes their applicability to the classification of environmental quality sensors, and presents a comparative summary in Table 2.

Table 2: Comparison of Spanish classification systems.

	GuBIMClass	AESAS BIM Class	SCFclass	RCEclass
No. of tables	1	4	19	10
Environmental sensor classification	No	No	No	No

Underlying standard	--	ISO 12006-2:2015	Railway standards	Roadway standards
Source tables	--	--	GuBIMClass	--
API availability	No	No	No	No
PDF/XLSX access	Free	Free	Free	Free
Last update year	2017	2025	2022	2024

GuBIMClass is the most widely adopted BIM classification system in Spain. It was initiated by the Grup d'Usuaris BIM de Catalunya (GuBIMCat) in collaboration with Infraestructures.cat in 2014.The current version (v1.2) was published in 2017 and consists of a single table, organized by the constructive function of the element, structured into nine chapters focused on building projects. Key features include: classification based on the primary function of the element and its construction sequence; independence from lifecycle phases or BIM uses; and a scalable, homogeneous, and easy-to-apply coding system. It has been recommended in various public tenders and has served as the basis for the development of other sector-specific systems, such as the SCFclass railway system. However, its coverage is limited for infrastructure and specific sectors like water (AEAS, 2025), and it currently does not include specific classes for air quality sensors or IoT devices, beyond a generic classification such as "50.90.50.20 - Special detectors" and "50.90.50.30 - Special sensors" (Figure 4).

Figure 4: Node 50.90.50 of GuBIMClass – Generic classification of sensors and detectors.

50.90.50	Dispositivos de maniobra y control
50.90.50.10	Mandos
50.90.50.20	Detectores especiales
50.90.50.30	Sensores especiales
50.90.50.40	Otros dispositivos de maniobra y control especiales

Source: GuBIMClass v.1.2 (2017). Node extracted from the official XLSX file distributed on the GuBIMCat website.

- SCFclass (Rail Innovation Hub). SCFclass is a system developed in 2020 by the Rail Innovation Hub, with a specific focus on railway infrastructure. For its development, regulatory references included Law 38/2015 of September 29, on the railway sector; Royal Decree 2387/2004 of December 30, which approves the Railway Sector Regulations; and Law 38/1999 of November 5, on the organization of building.

  In its first version (v.1), the system used 12 tables. In the most recent version (v.2, 2022), this was expanded to 19 tables, organized into four groups: standard tables, template tables, registry tables, and support tables. Similarly to GuBIMClass, SCFclass does not include specific nodes for the classification of IoT sensors or environmental control devices. Instead, it replicates the generic categories found in GuBIMClass (compare Figures 4 and 5).

Figure 5: Screenshot of the "Functions" classification table of SCFclass v.2 for sensors.

FUN.ISI.130	Dispositivos de maniobra y control
FUN.ISI.130.010	Mando
FUN.ISI.130.020	Detector especial
FUN.ISI.130.030	Sensor especial
FUN.ISI.130.040	Otro dispositivo de maniobra y control especiales

Source: Rail Innovation Hub (2022). Document downloaded from the official website.

- AEAS BIM Class. Developed by the Spanish Association for Water Supply and Sanitation (AEAS), this system is focused on classifying elements and processes related to hydraulic networks. It is a multi-table system, structured following the example of classification systems such as OmniClass and Uniclass 2015, as well as the recommendations of ISO 12006-2. In its latest version, AeasBIMClass.v02 (January 2025), the system consists of four tables: Objects (classified by typology), Processes (according to the function or stage in which they intervene), Pipe Materials (type of material), and Fluids (type of transported fluid). Currently, it does not include environmental sensor devices, nor does it address in detail the civil works components, whose classification is referred to existing systems such as GuBIMClass or OmniClass (AEAS, 2025).
- RCEclass (State Road Network). RCEclass is the BIM classification system developed by the General Directorate of Roads (DGC), applicable to any phase of the lifecycle of contracts that implement BIM methodology in the road infrastructure sector (Dirección General de Carreteras, 2024). The system is structured into 10 tables, with the main table, called "Functions", including 1,279 elements that serve as an inventory of possible road elements based on sectorial regulations, asset management systems, and the DGC's supporting Price Database (OC 4/2023). The system lacks specific names for sensors related to environmental parameter monitoring.
- ADIF BIM System. ADIF, as the manager of railway infrastructure in Spain, has adopted the BIM classification system proposed by the Railway Innovation Hub (SCFclass) to ensure the standardization of BIM models in its contracts. This is stated in the official document "BIM Clauses Annex for Works" (ADIF, 2023), which indicates that all model objects must be classified according to the tables provided by ADIF, using a functional structure. The system is intended for internal use and has not been published as an open standard or sectorial proposal, which is why it has been excluded from the comparison in Table 2.

Table 2 summarizes the main characteristics of the national systems analyzed. As shown, none of these systems currently include specific classification structures for IoT sensors related to air quality or other environmental variables. Furthermore, they show limited technological maturity in their development due to the lack of APIs. This gap represents a significant limitation in the face of increasing demands for sustainability, digitalization, and environmental control in the built environment. In this context, proposals like EsBIMClass aim to extend and complement existing systems by integrating new categories that address these emerging needs.

2.4 Recent trends in BIM + IoT and environmental quality

The digitalization of the built environment has driven the evolution of the BIM methodology, which has shifted from being a purely representational model to an active tool for the analysis and optimization of spaces. In this process, IoT technologies have gained prominence, particularly in the monitoring of environmental variables such as temperature, humidity, CO_2, particulate matter (PM1, PM2.5, PM10), and volatile organic compounds (VOCs) (Schieweck et al., 2018). Their integration into BIM is especially useful in areas such as public health, energy efficiency, and comfort (Xu et al., 2025), making the proper classification of these devices essential.

However, challenges remain. From an interoperability standpoint, standards such as IFC do not include a specific taxonomy for environmental sensors, relying instead on generic classes like IfcSensor with custom properties. Furthermore, international classification systems rarely include specific codes to represent various types of sensors through their properties, such as the observed environmental parameter (gases, particles, noise, or solar radiation), monitoring technologies (internal storage, IoT data transmission, or direct reading), or application contexts (indoor, outdoor, or mobile). This gap is particularly evident in Spanish systems.

The lack of classification structures limits automation in the design and maintenance of environmental control systems. Therefore, the incorporation of specific nodes, such as the one developed in the EsBIMClass system, is proposed. It offers a hierarchical and interoperable classification for IoT sensors focused on environmental control in both indoor and outdoor environments.

3. Methodology

The development of the EsBIMClass classification system has been based on a technical and regulatory approach to ensure its applicability in real BIM environments. The main criteria adopted in its definition are described below.

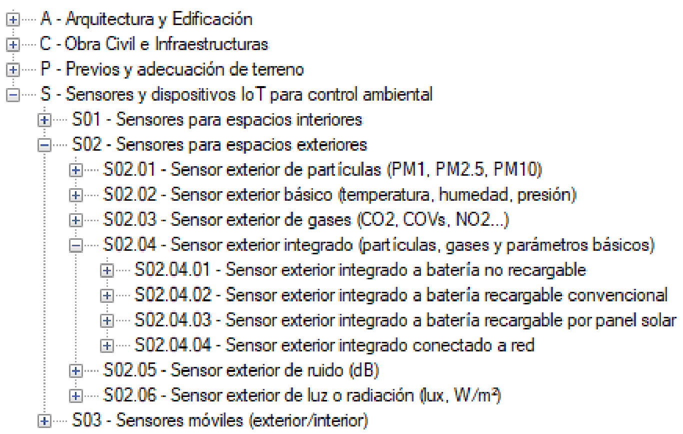
3.1 Regulatory alignment

The system has been structured according to the principles of ISO 12006-2:2015, which establishes a framework for the classification of information in the construction sector. EsBIMClass is based on a classification by functions of the built environment, falling under the category of “Construction result”, similar to other systems such as UniFormat or GuBIMClass. However, its scope also extends to categories such as “Resources”, by including sensors for environmental monitoring. Additionally, its interoperable linkage with the IFC standard (ISO 16739-1:2018) is considered, as well as its alignment with the framework recommended by UNE-EN 17412-1:2021, concerning the definition of the Level of Information Need (NIN), which explicitly establishes the use of classification systems for the proper semantic description of BIM objects.

3.2 Structure and criteria employed

In contrast to the multi-table models used in systems such as OmniClass, Uniclass, or AEAS BIM Class, EsBIMClass adopts a single hierarchical table structured into four levels (Figure 6). This decision is driven by several factors: on one hand, the need to ensure stability and consistency in its evolution (as recommended by AEAS, 2025), and on the other hand, the optimization of the author's resources within an individual academic initiative.

Figure 6: Screenshot of the EsBIMClass v.1.0 classification index.



Source: Author’s own work. Example downloaded from the official website https://www.allbimclass.com/esbimclass/.

The system currently contains 1,306 unique concepts, which are detailed in Table 3, requiring a significant effort in review and standardization to ensure the internal consistency of the set.

Table 3: Description of EsBIMClass v.1.0 nodes and conceptual equivalence.

Node	Description	Concepts	Conceptual Equivalence
A	Architecture and Building	409	Elements / Systems (Tables 21/22/23 of OmniClass; Ss, EF, Pr in Uniclass)
C	Civil Works and Infrastructure	559	Construction Systems / Civil Engineering Products
P	Preliminary Works and Site Preparation	76	Processes / Activities (ISO 12006-2, Table 32 OmniClass)
S	Sensors and IoT Devices for Environmental Control	262	Technological Products / Instrumentation (Table 23 OmniClass; TE in Uniclass)

The proposed table features a scalable alphanumeric coding system, designed to be compatible with BIM software such as Revit, Archicad, etc., and allows for future segmentation or sectoral expansion if deemed necessary.

Although its structure is unitary, the various nodes it comprises correspond to conceptually distinct functions, similar to what occurs in systems like CoClass, where a single classification encompasses products, processes, or technologies. In this sense, EsBIMClass constitutes a composite table system and combines nodes oriented towards:

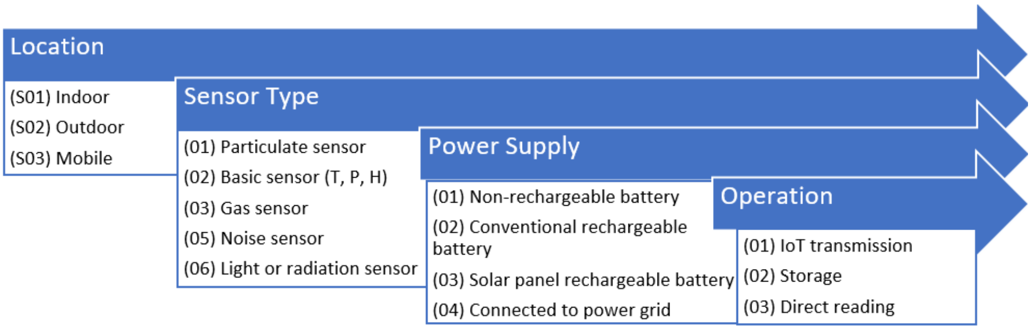
- “Processes and activities” (e.g., topographic surveys).
- “Construction elements” (building and infrastructure).
- “Technological devices” (IoT sensors and environmental control equipment).

3.3 Proposed classification node for environmental control sensors and IoT devices

In response to the limitations identified in national and international classification systems, a specific node has been designed within the EsBIMClass system for classifying sensors and IoT devices focused on environmental monitoring. The structure of the node follows a hierarchical logic that combines four main dimensions (Figure 7):

- Device location: Classified as being installed indoors, outdoors, or in a mixed environment.
- Sensor type: Distinguishing between particulate sensors (PM1, PM2.5, PM10), gas sensors (CO_2, VOCs, NOx, etc.), basic sensors (temperature, humidity, and pressure), integral sensors (multivariable), noise sensors, and light or radiation sensors.
- Power supply system: Identifying sensors powered by non-rechargeable (replaceable) batteries, conventional rechargeable batteries (USB, etc.), rechargeable via solar panels, or those requiring a constant connection to the power grid.
- Storage method: Differentiating between sensors with internal storage and recording, IoT transmission of records, or direct reading.

Figure 7: Organization of the environmental control sensor classification node.



The selection of categories included in this node is based on a review of the types of sensors most commonly used in environmental monitoring environments, both in residential buildings and public buildings and infrastructure. It aligns with the recommendations of organizations such as the World Health Organization (WHO, 2021) and the U.S. Environmental Protection Agency (EPA, 2022), which prioritize sensors for $PM_{2.5}$, PM_{10}, CO_2, VOCs, temperature, and humidity in residential, workplace, and urban environments (Table 4). Various recent studies also highlight the systematic presence of PM particulate sensors, CO_2, VOCs, temperature, and humidity sensors in IoT-based projects applied to BIM and digital twins (Schieweck et al., 2018; Xu et al., 2025; Salzano et al., 2025b).

Table 4: Sensor types included and justifying references.

Sensor type	Main application	Relevant references
Particulate sensor (PM1, PM2.5, PM10)	Indoor and outdoor air quality	WHO (2021), EPA (2023), Schieweck et al. (2018)
Gas sensor (CO_2, VOCs, NO_2, etc.)	Environmental monitoring, occupational health	WHO (2010), EPA (2022), Xu et al. (2025)
Basic sensor (temperature, humidity, pressure)	Thermal comfort control, ventilation, and climate	ASHRAE Standard 55, EN 16798-1, Xu et al. (2025)
Noise sensor (dB)	Evaluation of acoustic pollution	WHO (2018), Directive 2002/49/EC on Environmental Noise
Light or radiation sensor (lux, W/m²)	Natural/artificial lighting, energy control	EN 12464-1, ISO 8995-1, LEED v4 (Daylight credits)

This classification will enable better traceability of devices and sensors in BIM models, as well as effective integration into platforms that require automated environmental control. For example, an indoor sensor, integrated (particulate PM, gases, temperature and pressure, etc.), with a rechargeable battery (e.g., via USB), with data transmission through IoT (e.g., to a server that forwards data to a mobile application or a home automation system), will be classified as S02.04.02.01. The implementation of this node, as well as the others, has been carried out in a way that is compatible with classification standards in Revit or Archicad, allowing for immediate use in digital workflows.

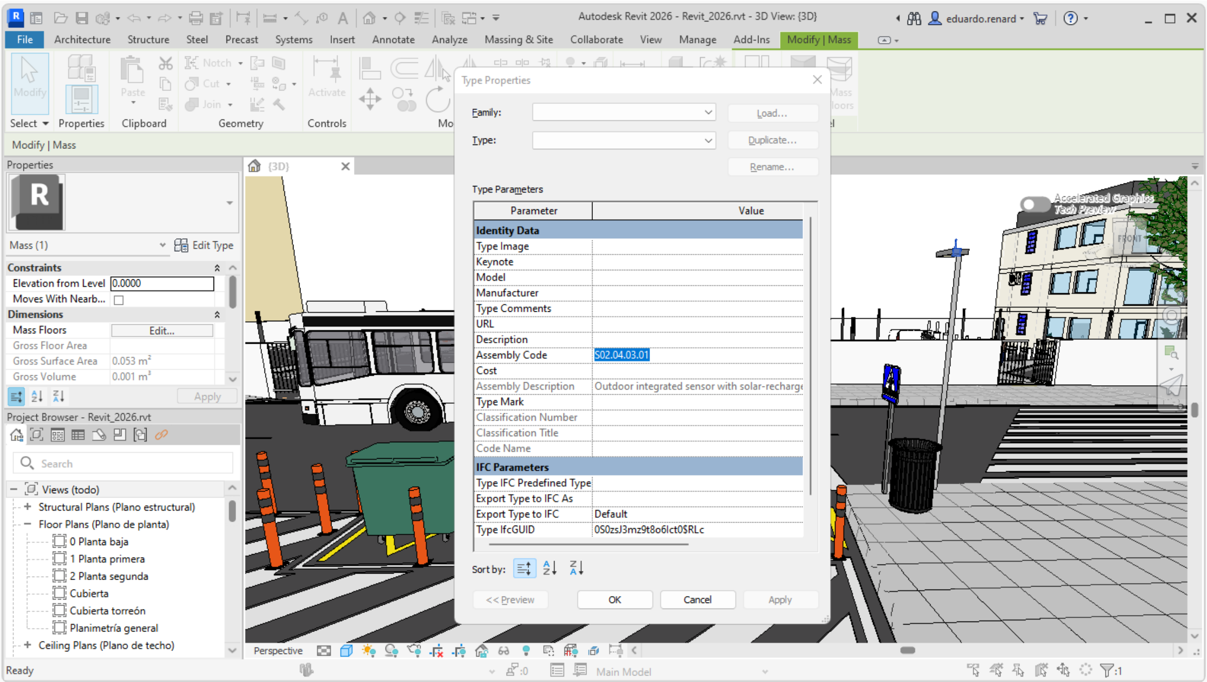
3.4 Practical application example

To validate its applicability, a classification file in .txt format, compatible with Autodesk Revit, has been generated, as described in the following section. The format allows assigning EsBIMClass system codes to object families, including environmental sensors modeled through, for example, conceptual masses or families.

Figure 8 shows a test case in which the EsBIMClass classification system was imported into an architectural project with exterior urbanization, developed in Autodesk Revit 2026 (version 26.6.4.409, build 20250227_1515, 64-bit). In the project, an object (type) simulating a particulate and gas sensor for outdoor use, powered by a rechargeable battery via solar panel, was modeled. The sensor is placed at the top of a streetlight. Its properties were then edited, assigning the classification code (assembly code) “S02.04.03.01”, and the associated description “Outdoor integrated sensor with solar-rechargeable battery and IoT transmission” was correctly retrieved

The resulting model was exported as an IFC4.3 file using the predefined "IFC4x3" template from the Autodesk Revit exporter. The IFC file was then opened using BIMvision 3.0.1 (64-bit), confirming the correct geometry of the object and its associated properties. In particular, the classification was recorded as an IfcClassificationReference entity, with the Name and Description attributes showing the code "S02.04.03.01" and the description "Outdoor integrated sensor with solar-rechargeable battery and IoT transmission", respectively, verifying the correct linkage to the EsBIMClass system.

Figure 8: Classification system applied to IoT sensor (Revit 2026).



4. Results

As a result of the work developed, version 1.0 of the EsBIMClass system has been created, structured into a single hierarchical table of four levels and consisting of 1,306 concepts classified in the areas of building, infrastructure, preliminary works, and environmental sensors. This system has been implemented and presented in Excel (.xlsx) format, with optimized coding compatible with real BIM workflows, and can be freely downloaded from its official Spanish website: https://www.allbimclass.com/esbimclass.

For practical integration, versions in .txt format for direct use in Autodesk Revit, and in .xml format adapted for Archicad, as well as a .pdf descriptive file for documentation purposes, have also been generated. All of these formats have been validated in their respective environments, ensuring correct hierarchical and functional interpretation, with special attention given to the environmental sensors node, which allows for clear traceability by location, sensor type, power source, and operation method.

During the development of the system, and in order to facilitate its use and consultation in international environments, a fully English version, named AllBIMclass, has been created, based on the same conceptual structure as EsBIMClass. This version has been published under a registered domain, https://www.allbimclass.com, where it can be freely downloaded in all the mentioned formats. The name AllBIMclass is currently in the process of being registered as a trademark with the Spanish Patent and Trademark Office (OEPM).

Additionally, the development of a RESTful API has begun to allow the dynamic integration of the system into BIM platforms. This API will provide real-time access to the classification table, custom queries, and automatic code assignment, facilitating interoperability with external databases, digital twins, and asset management systems. It will include complete technical documentation for developers.

As part of its practical validation, EsBIMClass has been used in real educational contexts during the 2023/2024 and 2024/2025 academic years. It was utilized in exercises with Autodesk Revit within the Official Master's Degree in BIM Methodology for Infrastructure (UPCT) and in the BIM Modeling Professional Master's Degree at CIFP Politécnico de Murcia, where it was also used in Archicad. Although usage metrics were not collected, its application allowed for validating its understanding, usability, and applicability with diverse academic and professional profiles.

Finally, the system includes a public version control, available for consultation on its official website. Periodic updates are planned, including new concepts, structural improvements, or terminological corrections, recorded through an accessible history that ensures the traceability and evolution of the system.

5. Conclusions

The proposed classification system, EsBIMclass (for use in Spanish) and AllBIMclass (international English version), is presented as a unified and functional solution for the semantic organization of elements in BIM projects. It integrates more than 1,300 concepts into a single hierarchical table, applicable to both building and civil works projects. Its structure, consisting of four main nodes with a maximum of five hierarchical levels, and its compatibility with software such as Revit and Archicad, enable immediate implementation in real-world environments.

Among its main contributions, the simultaneous inclusion of specific nodes for architecture and civil works & infrastructure stands out, as well as an additional node for preliminary works (such as topographic surveys or site preparation) and another specific node for IoT sensors and devices focused on environmental control, an area not yet addressed by national classification systems.

EsBIMclass and AllBIMclass have been designed in accordance with ISO 12006-2:2015 and structurally aligned with established international systems such as Uniclass, OmniClass, and CoClass, ensuring their interoperability, scalability, and regulatory coherence. Additionally, it evolves towards greater technological integration through the development of a RESTful API that will enable its dynamic connection with BIM platforms and external services.

As a product of an individual initiative with public and academic goals, this system represents a realistic and viable contribution to improving traceability and standardization of information in BIM models, particularly in the context of current challenges related to sustainability, environmental health, and digitalization. Its use in educational environments has validated its understanding and applicability with diverse professional profiles, consolidating its potential as an open, practical, and evolving system.

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Use of Generative Artificial Intelligence

No generative artificial intelligence was used in preparing this communication.

Communication aligned with the Sustainable Development Goals