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Digitalization of Acoustic Requirements in Building Design: Developing a bSDD within an Open BIM Framework

Costantino Carlo Mastino[1], Antonino Di Bella[2], Andrea Frattolillo[1]

[1]*D.I.C.A.AR., University of Cagliari, Italy*
[2]*D.I.I., University of Padua, Italy*

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Abstract

The digitalization of the construction sector is today one of the main drivers of innovation in Europe, as demonstrated by the widespread adoption and progressive regulation of Building Information Modeling (BIM). Across European countries, BIM uptake progresses at different speeds: nations such as Denmark and Finland have been implementing it for many years, while others – including Italy, Greece, and Hungary – are still consolidating their processes. In the Italian context, the regulatory pathway initiated with Ministerial Decree 560/2017 and formalized in the new Public Contracts Code (Legislative Decree 36/2023) makes BIM mandatory from January 1, 2025 for all public works exceeding 2 million euros, with specific thresholds for cultural heritage interventions. The objective is to increase transparency, control, and quality in public works, while reducing inefficiencies and risks in project management. In parallel, the private sector also recognizes BIM as a competitive factor capable of improving accuracy, coordination, and error reduction. Within this framework, the Open BIM approach, based on open standards, represents an essential prerequisite for effective interoperability. The IFC (Industry Foundation Classes) format constitutes the international reference standard for the structured exchange of information across different disciplines and software environments, ensuring data continuity throughout the entire lifecycle of a project. This article focuses specifically on the proposal and role of the bSDD (buildingSMART Data Dictionary), the tool developed by buildingSMART to standardize concepts, properties, and classifications used in information models. In the field of building acoustics, the introduction of a dedicated bSDD could represent a significant advancement: it would make it possible to harmonize national and international standards, integrate performance requirements directly into IFC models, and support automated processes for design and verification. The standardization of acoustic parameters—such as sound insulation, sound pressure levels, and flanking transmission—would improve data consistency, procedural transparency, and communication among designers, verifiers, and contractors. The integration of digitalization, BIM methodologies, and advanced classification tools such as the bSDD thus paves the way for an interoperable information ecosystem capable of responding to European regulatory demands and supporting the technical evolution of the contemporary construction sector.

Keywords: bSDD*, BIM, Digitalization*

1. Introduction

In recent years, the evolution of the openBIM paradigm [1–3] has promoted a profound transformation in the way technical and performance-related information is generated, shared, and reused throughout the entire lifecycle of a building asset [3–5]. However, despite the increasing maturity of digital tools for construction design and management, the field of building acoustics is still often characterized by data fragmentation and a lack of standardization in information exchange processes. The growing complexity of acoustic requirements, combined with the need to ensure consistency between laboratory results, predictive simulations, and in situ verification, makes it essential to establish a common interoperable language capable of connecting heterogeneous skills, phases, and stakeholders [4, 6–12]. In this context, the buildingSMART Data Dictionary (bSDD) [2] emerges as a strategic tool for defining, classifying, and structuring acoustic data in a coherent and universally interpretable manner. When integrated with the Industry Foundation Classes (IFC) format [13], the bSDD enables the extension of the interoperability concept beyond mere geometry, introducing a rigorous semantic framework for the description of the properties of building elements and their physical, functional, and performance-related relationships. The possibility of creating Property Sets (Psets) and Classification Schemes specifically tailored for building acoustics represents a unique opportunity to systematize currently heterogeneous information, which is often represented in different ways by designers, laboratories, and qualified technicians. One of the main advantages derived from the use of the bSDD lies in the possibility of univocally structuring data related to laboratory tests according to ISO 10140 [12, 14–17], such as sound insulation curves, sound reduction indices in one-third octave bands, absorption data, or complementary parameters useful for predictive models. Through the introduction of shared property sets [3, 5, 9, 18, 19], it becomes possible to associate each physical element with a complete digital representation of its acoustic performance, with coherent and verifiable fields, thereby avoiding subjective interpretations and enabling automatic model updates in subsequent phases. Similarly, the predictive design phase according to ISO 12354 benefits from the openBIM approach, as it requires a structured information base for the characterization of both direct and flanking transmission paths. The use of the bSDD enables the definition of new properties related both to the performance of separating elements and to coupling parameters, such as flanking transmission coefficients KijK_{ij}Kij [10, 20, 21], which are often a significant source of design uncertainty. Through the definition of specific relationships between IFC entities, it becomes possible to explicitly represent acoustic bridges by identifying geometries, connections, and interface categories that influence sound propagation in buildings. This level of semantic integration enables the development of predictive models directly based on BIM, reducing the need for manual data re-entry and minimizing the risk of inconsistencies. Another crucial aspect concerns the in situ verification phase according to ISO 16283 [11, 22, 23], which requires a transparent comparison between predicted and measured performance. The data structure provided by the bSDD makes it possible to create dedicated property sets for instrumental results, including not only final index values but also metadata related to measurement conditions, instruments, uncertainties, and frequency band curves. This approach ensures full traceability between design, construction, and testing processes, supporting a more objective and well-documented verification procedure. The integration of acoustic data into BIM also raises the issue of frequency band management. International standards traditionally rely on one-third octave bands in the range of 100–3150 Hz, but many applications require extensions toward lower (50 Hz) or higher (5000 Hz) frequencies. The bSDD allows the definition of customized frequency fields, making their structure explicit and ensuring that such information is correctly interpreted by interoperable software, thus preserving the consistency of analyses and results. Overall, the adoption of the bSDD for structuring acoustic data within BIM represents a decisive step toward the full integration of technical disciplines into the digital process. Semantic interoperability based on IFC enables the creation of a continuous and verifiable information flow, from laboratory testing to design, up to in situ validation. This convergence among regulatory standards, open formats, and digital dictionaries establishes a new paradigm for building acoustics, promoting quality, transparency, and repeatability in design and control processes, while paving the way for increasingly advanced analytical and predictive solutions. Although ISO 10140, ISO 12354, and ISO 16283 represent the core standards for describing the different stages of the acoustic process, the information workflow based on bSDD and IFC must also include all complementary standards required for an accurate and comprehensive representation of acoustic data. Among these, for example, EN 61260-1, which defines the characteristics of frequency bands for acoustic analyzers and measurements, plays a crucial role in the standardization of laboratory, predictive, and in situ curves. Similarly, other standards related to instrumental quantities, measurement methods, transducer requirements, and data processing procedures can be integrated into the digital dictionary, ensuring that each acoustic datum is described according to standardized specifications and fully interoperable. In this way, the openBIM model gains the capability to consistently represent the entire regulatory ecosystem of building acoustics, ensuring traceability and reliability throughout the entire lifecycle of the building asset [4, 24].bSDD for building acoustics

1.1 Domain architecture and classification scheme

Figure 1 maps the main ISO standards governing building acoustics across three operational stages: Acoustic Design (ISO 12354), Acoustic Laboratory (ISO 10140 series, ISO 354, ISO 9052), and Acoustic Measurement (ISO 16283, ISO 3382, ISO 16032). The bSDD domain proposed in this work defines Property Sets corresponding directly to each stage, ensuring that normative requirements are represented as machine-readable, IFC-linked data throughout the building lifecycle..

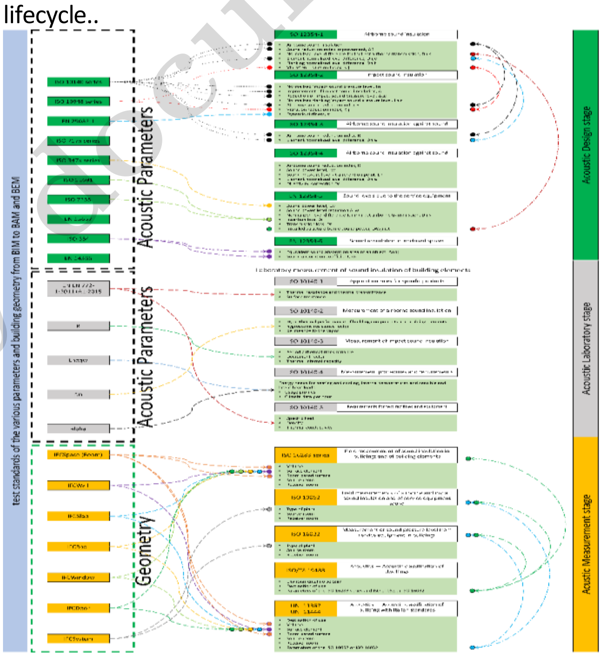

Figure 1. Figure captions should be placed below the figure.

The proposed bSDD domain, named Building Acoustics — ITA/EU, is structured according to the buildingSMART Data Dictionary specification and organized in three hierarchical levels: Domain, Classification Scheme, and Property definitions. At the top level, the domain establishes a shared namespace and URI reference that uniquely identifies each concept within the interoperable information ecosystem. The Classification Scheme organizes acoustic knowledge into six thematic categories, each corresponding to a distinct phase of the acoustic performance chain. This modular structure ensures that each category can be independently adopted, extended, or mapped to national regulatory frameworks without compromising the integrity of the other modules. Table 1 provides a summary of the six Psets, the associated standards, the IFC entity types, and the primary acoustic parameters covered by each module.

Table 1. Pset_AcousticsLabMeasurement — property definitions

Property Set	Standard di riferimento	Entità IFC	Parametri principali
Pset_AcousticsLabMeasurement	ISO 10140, ISO 717-1/-2, EN 61260-1	IfcWall, IfcSlab, IfcDoor	Misure di laboratorio — Rw, R(f), αw, Ln,w
Pset_AcousticsPrediction	ISO 12354-1/-2, DPCM 1997	IfcWall, IfcSlab, IfcSpace	Calcolo previsionale — R'w, DnTw, Kij
Pset_AcousticsFieldMeasurement	ISO 16283-1/-2, IEC 61672-1	IfcSpace, IfcBuildingElement	Verifica in opera — DnTw, R'w, L'nTw
Pset_RoomAcoustics	ISO 3382-1/-2, ISO 354, IEC 60268-16	IfcSpace, IfcZone	Acustica ambienti — RT60, C80, STI, EDT
Pset_NoiseSources	ISO 16032, ISO 717-2, ISO 9052-1	IfcElement (impianti), IfcSlab	Impianti e calpestio — LAeq, ΔLw, s'
Pset_FlankingTransmission	ISO 12354-1 Ann.B, EN 61260-1	IfcRelConnectsElements	Trasmissione laterale — Kij, Kij(f)

1.2 Domain architecture and classification scheme

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1.3 Property Set definitions

1.3.1 Pset_AcousticsLabMeasurement

This Pset covers laboratory test data according to ISO 10140-1 through ISO 10140-5, and includes both single-number indices (Rw, C, Ctr, Ln,w, αw) defined in ISO 717-1/-2 and full third-octave band spectra in the range 50–5000 Hz as defined by EN 61260-1. The inclusion of frequency-resolved data as ordered real-value lists (RealList type) enables direct compatibility with predictive models based on ISO 12354. Measurement metadata — laboratory identification, accreditation number, test date, background noise level, and extended measurement uncertainty — are stored as structured string and real properties to ensure full traceability.

Table 2. Pset_AcousticsLabMeasurement — property definitions

Property name	Type	Unit	Range	Standard ref.
Sample identification				
SpecimenID	String	—	free text	ISO 10140-1 §5
SpecimenDescription	String	—	free text	ISO 10140-1 §5
SpecimenMass	Real	kg/m²	≥ 0	ISO 10140-1 §5.3
SpecimenThickness	Real	mm	≥ 0	ISO 10140-1 §5.3
LaboratoryName	String	—	free text	ISO 10140-1 §4
TestDate	String	YYYY-MM-DD	ISO 8601	ISO 10140-1 §4
AccreditationNumber	String	—	free text	ISO 10140-1 §4
Air insulation — valori indice (ISO 717-1)				
Rw	Real	dB	0–100	ISO 717-1
C	Real	dB	-20–0	ISO 717-1
Ctr	Real	dB	-20–0	ISO 717-1
Rw_C	Real	dB	0–100	ISO 717-1
Rw_Ctr	Real	dB	0–100	ISO 717-1
Impact insulation — valori indice (ISO 717-2)				
Ln_w	Real	dB	0–120	ISO 717-2
CI_50_2500	Real	dB	-20–0	ISO 717-2
DeltaLw	Real	dB	0–50	ISO 717-2
Frequency curves 50–5000 Hz (EN 61260-1)				
R_FrequencyBands	RealList	dB	29 valori	ISO 10140-2 · EN 61260-1
FrequencyBandCenters	RealList	Hz	50–5000	EN 61260-1
Ln_FrequencyBands	RealList	dB	29 valori	ISO 10140-3 · EN 61260-1
Alpha_FrequencyBands	RealList	—	0.0–1.0	ISO 10140-5 · ISO 354
Sound absorption				
AlphaW	Real	—	0.0–1.0	ISO 11654
AbsorptionClass	String	—	A, B, C, D, E	ISO 11654
NRC	Real	—	0.0–1.0	ASTM C423
Instrumental metadata				
MeasurementMethod	String	—	enum	ISO 10140-2 §6
BackgroundNoiseLevel	Real	dB(A)	≥ 0	ISO 10140-2 §7
MeasurementUncertainty	Real	dB	≥ 0	ISO 10140-2 §8
SoundSourceType	String	—	enum	ISO 10140-1 §6

1.3.2 Pset_AcousticsPrediction

This Pset captures the outputs of both simplified and detailed calculation methods under ISO 12354-1 and ISO 12354-2, including the calculated apparent sound reduction index R'w, the standardized level difference DnT,w, and the respective third-octave spectra. Properties distinguishing the contributions of direct and flanking transmission paths support transparent decomposition of the predicted performance. A ComplianceStatus boolean property directly flags regulatory conformity with the applicable national requirements.

Table 3. Pset_AcousticsPrediction — property definitions.

Property name	Type	Unit	Range	Standard ref.
Air insulation — ISO 12354-1				
R_prime_w_calc	Real	dB	0–100	ISO 12354-1 §5
DnTw_calc	Real	dB	0–100	ISO 12354-1 §5
C_calc	Real	dB	-20–0	ISO 12354-1
Ctr_calc	Real	dB	-20–0	ISO 12354-1
R_prime_FreqBands_calc	RealList	dB	29 valori	ISO 12354-1 §5
Walking — ISO 12354-2				
LnTw_calc	Real	dB	0–120	ISO 12354-2 §5
Ln_FreqBands_calc	RealList	dB	29 valori	ISO 12354-2
Model parameters				
CalculationMethod	String	—	enum	ISO 12354-1 §4
SoftwareName	String	—	free text	—
DirectTransmissionRw	Real	dB	0–100	ISO 12354-1 §5.2
FlankingTransmissionRw	Real	dB	0–100	ISO 12354-1 §5.3
CalculationUncertainty	Real	dB	≥ 0	ISO 12354-1 §7
RegulatoryRequirement_Rw	Real	dB	0–100	DPCM 5/12/1997
ComplianceStatus	Boolean	—	true/false	—

1.3.3 Pset_AcousticsFieldMeasurement

This Pset is associated with ISO 16283-1 and ISO 16283-2 and stores in-situ measurement results alongside their full metrological context: instrument model and class, calibration date, measurement operator, background noise correction status, reverberation time used for normalization, and extended measurement uncertainty. This structure enables a transparent and documented comparison between predicted and measured performance at the building handover phase.

Table 4. Pset_AcousticsFieldMeasurement — property definitionss

Property name	Type	Unit	Range	Standard ref.
On-site airborne insulation				
DnTw_field	Real	dB	0–100	ISO 16283-1
R_prime_w_field	Real	dB	0–100	ISO 16283-1
DnT_FreqBands_field	RealList	dB	29 valori	ISO 16283-1
On-site footfall				
LnTw_field	Real	dB	0–120	ISO 16283-2
Ln_FreqBands_field	RealList	dB	29 valori	ISO 16283-2
Metadata and measurement conditions				
MeasurementDate	String	YYYY-MM-DD	ISO 8601	ISO 16283-1 §5
Operator	String	—	free text	ISO 16283-1 §5
InstrumentModel	String	—	free text	ISO 16283-1 §6
InstrumentClass	String	—	1, 2	IEC 61672-1
CalibrationDate	String	YYYY-MM-DD	ISO 8601	ISO 16283-1 §6
BackgroundNoiseCorrection	Boolean	—	true/false	ISO 16283-1 §7
ReverbTime_SourceRoom	Real	s	≥ 0	ISO 16283-1 §7
MeasurementUncertainty_field	Real	dB	≥ 0	ISO 16283-1 §9
ComplianceStatus_field	Boolean	—	true/false	DPCM 1997

1.3.4 Pset_RoomAcoustics

This Pset addresses room acoustic parameters according to ISO 3382-1 and ISO 3382-2, including reverberation time T60 at individual frequencies and across the full third-octave spectrum, early decay time (EDT), clarity indices (C80, C50, D50), and speech intelligibility (STI per IEC 60268-16). Geometric attributes of the IfcSpace entity — volume and total boundary surface area — are linked as input parameters for Sabine, Eyring, or Millington calculation methods, making the Pset self-contained for room acoustic design verification.

Table 5. Pset_RoomAcoustics — property definitions

Property name	Type	Unit	Range	Standard ref.
Geometry of space				
RoomVolume	Real	m³	≥ 0	ISO 3382-1 §5
RoomSurfaceArea	Real	m²	≥ 0	ISO 3382-1 §5
RoomOccupancy	String	—	enum	ISO 3382-2 §4
Reverberation time				
RT60_500Hz	Real	s	0–30	ISO 3382-2 §5
RT60_1000Hz	Real	s	0–30	ISO 3382-2 §5
RT60_FrequencyBands	RealList	s	29 valori	ISO 3382-2 · EN 61260-1
EDT_MidFreq	Real	s	0–30	ISO 3382-1 §A.2
T20_MidFreq	Real	s	0–30	ISO 3382-1 §A.2
RT_Target	Real	s	0–30	ISO 3382-2 §4
Clarity and intelligibility				
C80	Real	dB	-10–+15	ISO 3382-1 §A.3
C50	Real	dB	-10–+15	ISO 3382-1 §A.3
D50	Real	—	0–1	ISO 3382-1 §A.3
STI	Real	—	0–1	IEC 60268-16
Total absorption				
TotalAbsorption_500Hz	Real	m²	≥ 0	ISO 354 · Sabine
TotalAbsorption_FreqBands	RealList	m²	29 valori	ISO 354
CalculationMethod_RT	String	—	enum	ISO 3382-2 §5

1.4 Pset_NoiseSources

This Pset addresses two distinct phenomena: noise from building services (HVAC, hydraulic, lift) according to ISO 16032, characterized by LAeq and LAmax values and full spectral data; and impact noise improvement by floor coverings according to ISO 717-2 and ISO 10140-3, including the weighted improvement ΔLw and the dynamic stiffness s’ of resilient layers per ISO 9052-1.

Table 6. Pset_NoiseSources — property definitions

Property name	Type	Unit	Range	Standard ref.
Noise from technical installations				
ServiceNoiseLevelLAeq	Real	dB(A)	0–120	ISO 16032 §5
ServiceNoiseLevelLAmax	Real	dB(A)	0–120	ISO 16032 §5
ServiceNoiseFreqBands	RealList	dB	29 valori	ISO 16032 · EN 61260-1
ServiceType	String	—	enum	ISO 16032 §4
OperatingCondition	String	—	enum	ISO 16032 §6
RegulatoryLimit_Services	Real	dB(A)	0–120	DPCM 1997 tab.C
Improvement of footfall (ISO 717-2)				
DeltaLw_Covering	Real	dB	0–50	ISO 717-2 · ISO 10140-3
DeltaLw_FreqBands	RealList	dB	29 valori	ISO 10140-3
CoveringType	String	—	enum	ISO 10140-3 §5
ResilientLayerDynamicStiffness	Real	MN/m³	≥ 0	ISO 9052-1
Compliance				
LnTw_field_limit	Real	dB	0–120	DPCM 1997 tab.B
ServiceNoise_Compliant	Boolean	—	true/false	DPCM 1997

1.4.1 Pset_FlankingTransmission

This Pset captures the vibration reduction index Kij at the structural junction between adjacent elements, both as a single weighted value and as a frequency-resolved spectrum (Kij(f) for 29 third-octave bands per EN 61260-1). Properties describing junction geometry (type, angle, element masses) and the presence of structural breaks enable the explicit representation of flanking paths in the BIM model, supporting direct use of the data in ISO 12354-1 Annex B calculations.

Table 7. Pset_FlankingTransmission — property definitions

Property name	Type	Unit	Range	Standard ref.
Coefficienti di trasmissione laterale				
Kij	Real	dB	0–80	ISO 12354-1 Ann.B
Kij_FrequencyBands	RealList	dB	29 valori	ISO 12354-1 Ann.B · EN 61260-1
Kij_Type	String	—	Ff, Fd, Df, Dd	ISO 12354-1 §5.3
Kij_DataSource	String	—	enum	ISO 12354-1 Ann.B
Joint characterization				
JunctionType	String	—	enum	ISO 12354-1 §5.3
JunctionConnectionAngle	Real	°	0–180	ISO 12354-1 §5.3
Element_i_Rw	Real	dB	0–100	ISO 12354-1 §5.3
Element_j_Rw	Real	dB	0–100	ISO 12354-1 §5.3
Element_i_SurfaceMass	Real	kg/m²	≥ 0	ISO 12354-1 §5.3
Element_j_SurfaceMass	Real	kg/m²	≥ 0	ISO 12354-1 §5.3
JunctionResilienceType	String	—	enum	ISO 12354-1 §5.3
StructuralBreakPresent	Boolean	—	true/false	ISO 12354-1 Ann.B
Uncertainty and traceability				
Kij_Uncertainty	Real	dB	≥ 0	ISO 12354-1 §7
Kij_ReferenceDocument	String	—	URI / free text	—

1.5 FC entity mapping and semantic relationships

The integration of the proposed bSDD into IFC-based BIM models is achieved through three standard IFC relationship entities. IfcRelDefinesByProperties associates any Pset instance to the corresponding building element or space. IfcRelAssociatesClassification links each IFC entity to the corresponding bSDD classification URI, establishing machine-readable semantic interoperability. IfcRelConnectsElements is used to model the structural junction between two adjacent elements, making the flanking path an explicit geometric and informational object in the model.

Table 8. IFC relationship entities and acoustic functions

Relazione IFC	Entità coinvolte	Funzione acustica
IfcRelDefinesByProperties	IfcWall, IfcSlab, IfcSpace	Associa Pset a elemento IFC
IfcRelAssociatesClassification	Qualsiasi entità IFC	Collega a URI bSDD
IfcRelConnectsElements	IfcWall ↔ IfcSlab	Modella giunto (nodo Kij)
IfcPropertySetTemplate	All acoustic Psets	Define bSDD templates

The four primary IFC entity types involved are IfcWall and IfcSlab for separating elements, IfcSpace for source and receiving rooms, and IfcRelConnectsElements for junctions. This mapping ensures that acoustic information follows the same lifecycle logic as geometric and structural information, from design through construction to performance verification.

2. Conclusion

The present work has proposed and described a structured bSDD domain for building acoustics, articulating the full performance chain — from laboratory characterisation to predictive design and in-situ verification — within a coherent, machine-readable, and normatively grounded information framework. The six Property Sets defined cover the complete spectrum of acoustic parameters required by ISO 10140, ISO 12354, ISO 16283, ISO 3382, ISO 717, and ISO 16032, including frequency-resolved data across the 50–5000 Hz range in accordance with EN 61260-1. Each property is defined with explicit data type, measurement unit, value range, and normative reference, ensuring that acoustic information is no longer encoded as unstructured text or spreadsheets, but as semantically rich, queryable, and interoperable data embedded in the BIM model.

The proposed bSDD represents a significant step forward in the digitalization of building acoustics as a technical discipline. By encoding acoustic properties as structured IFC Property Sets, referenced through a shared bSDD URI, it becomes possible to establish a continuous and traceable data thread from the material characterization phase through to the final building handover. This approach aligns with the broader digitalization agenda of the European construction sector and with the mandatory adoption of BIM for public works established by Legislative Decree 36/2023 in Italy, extending its scope to include acoustic performance as a first-class information domain within the open BIM process.

A particularly significant implication of the proposed framework is its direct compatibility with the Information Delivery Specification (IDS) standard developed by buildingSMART International. IDS defines machine-readable rules that specify which information must be present in an IFC model at a given project phase, and can automatically verify compliance of a delivered model against those rules. At the design stage, an IDS file can require that every separating wall and floor element carries a populated Pset_AcousticsPrediction with a valid R'w value and a ComplianceStatus flag, enabling automated pre-construction acoustic compliance checking without manual document review. At the project completion stage, a distinct IDS file can mandate the presence of Pset_AcousticsFieldMeasurement on every tested element, verifying that measured values, instrument metadata, and measurement uncertainty are all present and within specified ranges. This two-stage IDS approach transforms acoustic verification from a post-hoc documentary exercise into an automated, model-integrated quality assurance process. The choice to base the proposed framework on IFC and bSDD — both open, vendor-neutral standards maintained by buildingSMART International — is a fundamental prerequisite for genuine interoperability. Proprietary data formats create information silos that fragment the construction supply chain. The IFC schema, combined with the semantic disambiguation provided by the bSDD, eliminates this fragmentation by providing a single, universally interpretable representation of acoustic data that any conformant software can read, write, and validate. The IfcRelDefinesByProperties and IfcRelAssociatesClassification relationships ensure that Pset instances are formally and traceably bound to the physical elements they describe, while the bSDD URI provides a globally unique, resolvable identifier for every property definition. This semantic anchoring guarantees that the concept "weighted sound reduction index Rw" means the same thing — with the same unit, the same normative basis, and the same data type — in every software environment, from acoustic simulation tools to quantity surveyors' applications to building management systems. The framework proposed in this work constitutes a foundational contribution that opens several directions for further development. Foremost among these is the formal publication of the domain on the buildingSMART bSDD platform, which would make all property definitions publicly accessible via API. The development of a reference IDS library for Italian and European acoustic regulatory requirements — structured around the DPCM 5/12/1997 thresholds and the UNI 11367 acoustic classification system — would provide practitioners with ready-to-use verification rules deployable across any IFC-compatible project workflow. In this broader perspective, the standardization of acoustic data through bSDD and IFC is not only a tool for improving design quality and verification efficiency, but a structural contribution to the digital transformation of the construction sector as a whole..

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