



**BE S²ECURE**

(make) Built Environment Safer in Slow and Emergency Conditions through behavioral assessed/designed Resilient solutions

Grant number: 2017LR75XK

## How to read the Representation matrix for BET

According to the goals of T3.2, the matrix supports the de-fragmentation of the BE and, then, BETs “Elements” involved in the risk analysis, towards their representation in GIS, BIM and VT models.

Due to the differences in GIS/BIM and VT tools and potentialities in representing virtual models, as well as in creating models, BET elements are also codified as **Representation elements**. In detail, for VT models derived from the panoramas of virtual environment represented in BIM/GIS environment, all the elements are already represented in the models. The lower queriable level of VT models require to discuss representation conditions of features. On the other hand, for BIM and GIS models, elements are codified and then discussed in table 1 according to the main tools to represent them (e.g., mass wall for BIM, or polyline in GIS).

Table 1. Representation elements in GIS/BIM models

Representation criteria of descriptors in GIS/BIM models	CODE OF ELEMENT	BIM - GRAPHICAL INFORMATION	GIS - GRAPHICAL INFORMATION	
	(E code)	(E <sub>BIM</sub> )	(E <sub>GIS</sub> )	
			N1	N5
<b>OS</b>	OS	Pavement (OS)	Add PolOAS (derived from PolBF)	Add PolOS (derived from PolBF)
<b>AS</b>	AS	Pavement (AS)	Add PolAS (Derivable from PolBF)	Add PolAS (Derivable from PolBF)
<b>Building fronts / special buildings</b>	BF	Wall (BF)	PolBF	PolBF
<b>Sidewalk</b>	SW	Pavement (SW)	PolSW	PolSW
<b>Street</b>	ST	Pavement (ST)	PolST (Derivable PolBF - PolSW)	PolST (Derivable PolBF - PolSW)
<b>Mitigation / control system</b>	MC	Add object (MC)	Add Line (LineMC)	Add Line (LineMC)
<b>Accesses</b>	AC	Add object (MC)	LinAC (Derivable from PolBF)	LinAC (Derivable from PolBF)
<b>Porches</b>	PR	Add object (PR)	PolPR	PolPR
<b>Green area</b>	GR	Add object (GR)	PolGR	PolGR
<b>Monuments</b>	MN	Add object (MN)	PolMN	PolMN
<b>Vehicles (parking)</b>	PK	Pavement (PK)	PolPK	PolPK
<b>Crowding</b>		Human-agent	n.a.	n.a.
<b>Sights</b>	SG	Wall/Add object (SG)	PolSG	PolSG



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These “elements” are included and classified as descriptors that determine the part and relative properties or performances, according to main classes identified in 5 sections. Some descriptors are referred to specific “P” parameters used for the identification of BET. Table 2 summarizes them and associates to them specific colours re-preposed into the representation Matrix.

Table 2. Parameters involved in the identification of BET and associated colours.

	<b>P1</b>	Morphological configuration		<b>P2</b>	Dimensions		<b>P3</b>	Structural type
	<b>P4</b>	Permeability (accesses)		<b>P5</b>	Special buildings		<b>P6</b>	Homogeneity of constructive technique
	<b>P7</b>	Porches		<b>P8</b>	Slope		<b>P9</b>	Green

Each descriptor introduced in the representation matrix is qualified as Qualitative or quantitative according to the Table 3. If descriptor is quantitative, the equivalent unit of measure [u.m.] is introduced in the successive column.

Table 3. Qualification of the descriptor

Qualification of the descriptor	
quantitative features	
<b>q1</b>	Geometric features of characters that could be directly measured or derived – as combination of two or more geometric data - in geometric-base BET models (e.g. BIM, GIS)
<b>q2</b>	Boolean data as derived quantitative information details; in this case, the presence/absence of urban elements or specific features of single element could be express as Boolean
<b>q3</b>	Enumerated data type, derived by the counting the presence of BE elements involved in risk models
<b>q4</b>	Quantitative properties/attributes of elements characterized by specific units of measurement
Qualitative features	
<b>Q1</b>	Ranges of values – so by conditions
<b>Q2</b>	Descriptive – so textual.

Similarly, all the features/properties can be referred to specific elements or to the wide territory as well as they can characterize parts or single elements of the OS/LS. Thus, characters require to be referred according the most coherent “scale of reference”, supporting the level of knowledge implementation at the correct scale. In fact, according to the inherent classification of BE characters, each properties/characterization is associated to a proper level, as in Table 4.

Table 4. Reference levels for descriptors

Scale/Level of reference for descriptor	
<b>L1</b>	Site level referring to the features that are independent of OS/LS. The scale is overarched than the OS level, thus features characterize the city or territorial areas.
<b>L2</b>	OS/LS level includes all the properties widely referred to the OS/LS without spatial exception. Dimension, perimeter of Open Areas and properties of single element compared with the Open area (e.g. incidence, position of each element) are part of this scale of spatial reference.
<b>L3</b>	Frontier or content level comprises all the features referred to single elements or their group specifically located in the frontier or in content. Here, all the properties that characterize the frontier or content are included such as the extension of elements along the frontier.
<b>L4</b>	Single elements or component; here, all the properties are independent of the frontier/content or OS/LS but they are referred to the single elements being part into the OS/LS.

Then, all the descriptors are then classified according to their “Representability” in GIS, VT and BIM tools. These features derived from the inherent nature of the descriptors as well as to the inherent representation criteria of features in GIS/BIM and VT virtual models. Due to that, Tables 5 and 6 summarize the Representation criteria to be associated to each descriptor.

Table 5. Representation criteria of descriptors in BIM/GIS models

Representation criteria (GIS/BIM)	
<b>R1</b>	The descriptor is measurable in the model
<b>R2</b>	The descriptor is a property in the model (ad es. area, volume)
<b>R3</b>	The descriptor is obtained with a conditional/analytical formula from other descriptors
<b>R4</b>	The descriptor is represented as digital content (image, pdf)

Table 6. Representation criteria of descriptors in VT models

Representation criteria (VT)	
<b>LoR A</b>	Graphical information in spherical photos (scenes)
<b>LoR B</b>	Graphical information in hotspot plans
<b>LoR C</b>	Graphical information in detailed hotspots

Finally, all the descriptors are discussed for their inherent capacity to contain the information. This level of knowledge is associated to the “data type” classification that constitutes the lower level of detail of descriptor information. Data type are discussed for two main BIM tools, Revit® and Archicad®, and generally for GIS architecture, In table 7 and 8, respectively.



Table 7. Data type information for Autodesk REVIT and Graphisoft ARCHICAD Tools (BIM models)

Data Type	Description
<b>REVIT ®</b>	
<b>Text</b>	A value that is entered as text. This value is completely customizable.
<b>Integer</b>	A value that is expressed as an integer.
<b>Number</b>	A value that is numeric. Can have real numbers.
<b>Length</b>	A value that is the length of an element or sub-component.
<b>Area</b>	A value that is the area of an element or sub-component.
<b>Volume</b>	A value that is the volume of an element or sub-component.
<b>Angle</b>	A value that is the angle of an element or sub-component.
<b>Slope</b>	Can be used to create parameters that define slope.
<b>Currency</b>	Can be used to create currency parameters in Addition to the default Cost parameter.
<b>Mass Density</b>	A value that represents the mass per unit volume of a material.
<b>URL</b>	Provides a web link to a userAddefined URL.
<b>Material</b>	A value that is the material for the element.
<b>Yes/No</b>	Used most often for instance properties when the parameter is defined with either a Yes or No.
<b>ARCHICAD ®</b>	
<b>String</b>	Any text or number
<b>Number</b>	Any number expressed in decimals
<b>Integer</b>	A whole number
<b>True/False</b>	A logical true or false value
<b>Tags List</b>	A tag or series of tags.
<b>Option Set</b>	Provides a fixed set of options. The user can choose a value from this set.
<b>Area</b>	A value that is the area of an element or sub-component.
<b>Length</b>	A value that is the length of an element or sub-component.
<b>Angle</b>	A value that is the angle of an element or sub-component
<b>Volume</b>	A value that is the volume of an element or sub-component.



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Table 8. Data type information for GIS Tools

GIS Data type	Name	Description
<b>Boolean</b>	Boolean data	True/False
<b>Date</b>	Date	dd/mm/yy
<b>Enum</b>	Enumerated	List of values
<b>Integer</b>	Integer numeric value	Integer number
<b>Real</b>	numeric value	Number with decimals
<b>String</b>	Alphanumeric data	Line with ASCII data
<b>Numeric String</b>	Numeric line	Line with only numbers