SWIMing Methodology

This document provides a description of the application of the SWIMing methodology. The process of defining these use cases is based upon an established methodology called the IDM/MVD methodology [1] and also guidelines[1] set down in the Ready4SmartCities project. We have taken and extended this methodology for the purpose of identifying data requirements (and models) within the EeB projects. Figure 1 gives the BPMN [2] process model we have developed for defining use cases (task 1- 3 in swim lane 1) and which have been employed in the SWIMing project [3],[4],[5],[6]. This document describes the different steps as defined in Figure 1.

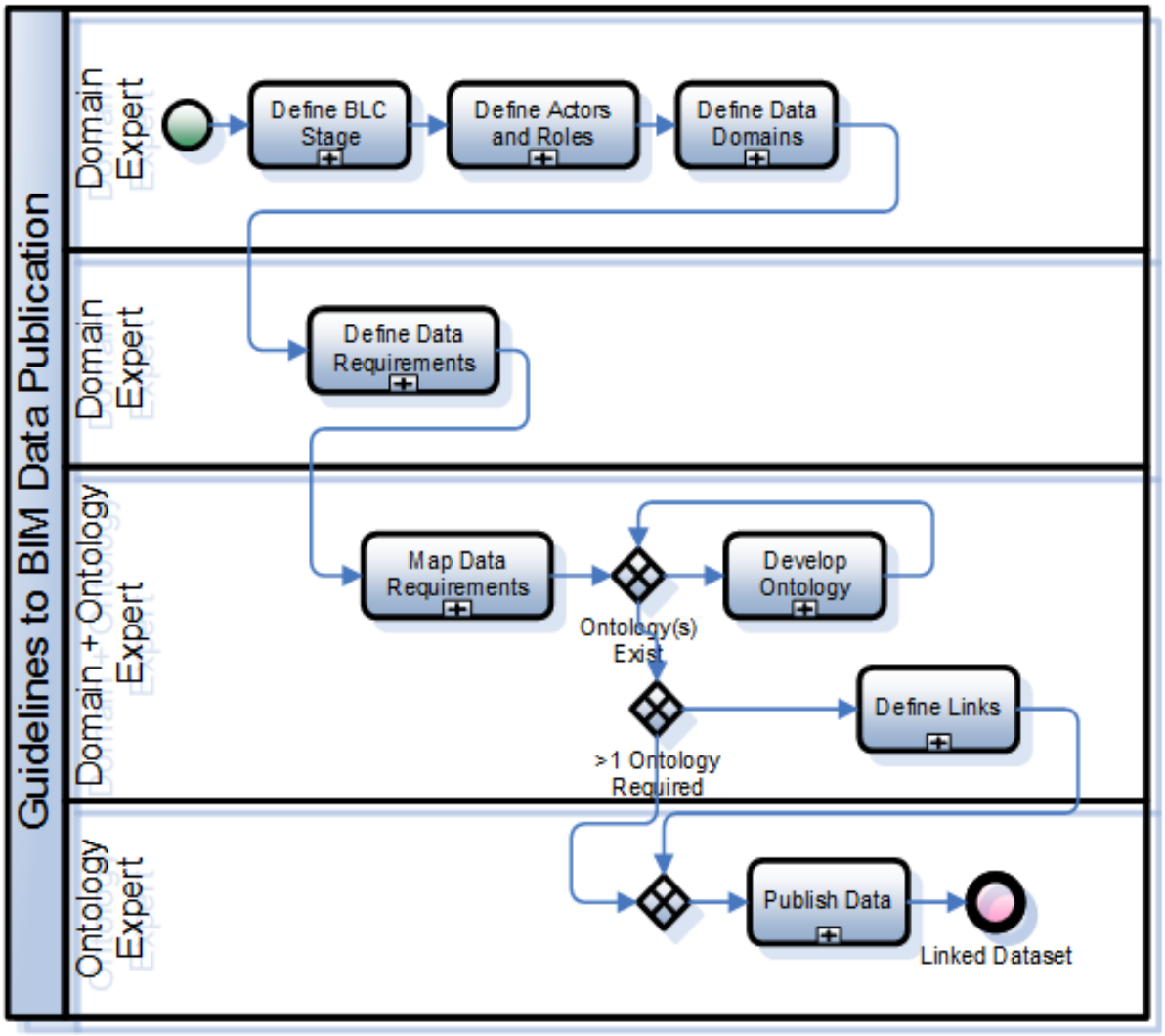


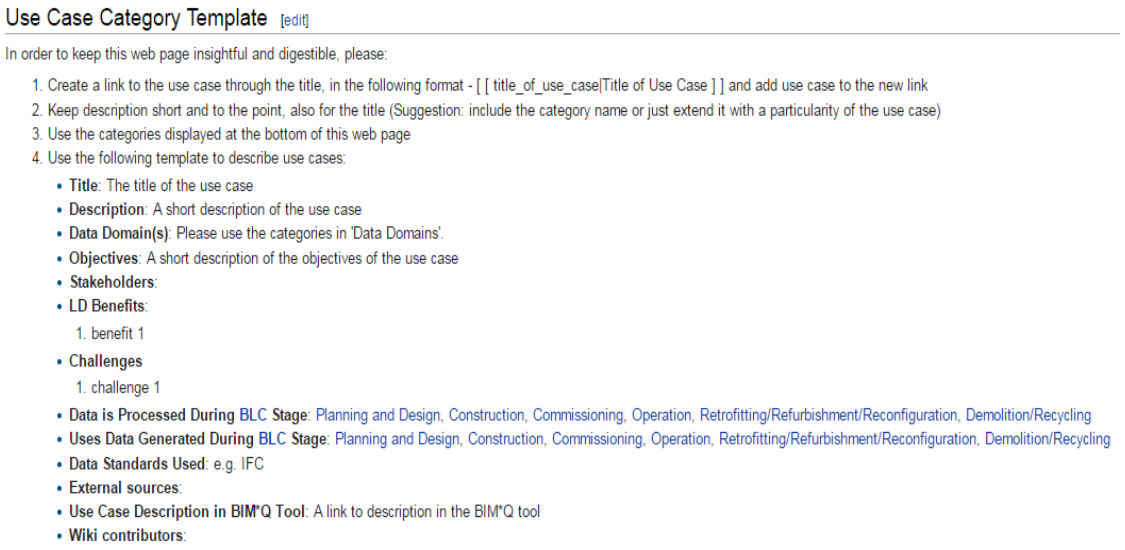
Figure 1: BPMN Model of Guidelines for BIM Data Publication

Step one (1) is to identify the BLC stages which have been defined within the context of the Linked Building Data community and consist of:

- Design,
- Construction,

[1] http://www.ready4smartcities.eu/guidelines

- Commissioning,
- Operation,
- Retrofitting/ Refurbishment/ Reconfiguration,
- Demolition/Recycling. [2]



Use Case Category Template [edit]

In order to keep this web page insightful and digestible, please:

1. Create a link to the use case through the title, in the following format - [[title_of_use_case|Title of Use Case]] and add use case to the new link
2. Keep description short and to the point, also for the title (Suggestion: include the category name or just extend it with a particularity of the use case)
3. Use the categories displayed at the bottom of this web page
4. Use the following template to describe use cases:
   - **Title**: The title of the use case
   - **Description**: A short description of the use case
   - **Data Domain(s)**: Please use the categories in 'Data Domains'.
   - **Objectives**: A short description of the objectives of the use case
   - **Stakeholders**:
   - **LD Benefits**:
     1. benefit 1
   - **Challenges**
     1. challenge 1
   - **Data is Processed During BLC Stage**: Planning and Design, Construction, Commissioning, Operation, Retrofitting/Refurbishment/Reconfiguration, Demolition/Recycling
   - **Uses Data Generated During BLC Stage**: Planning and Design, Construction, Commissioning, Operation, Retrofitting/Refurbishment/Reconfiguration, Demolition/Recycling
   - **Data Standards Used**: e.g. IFC
   - **External sources**:
   - **Use Case Description in BIM*Q Tool**: A link to description in the BIM*Q tool
   - **Wiki contributors**:

Figure 2: High Level Use Case Template

Step two (2) is to identify the different actors involved in the different processes required to complete the use case.

The purpose of this process is to enable the quick identification of responsible stakeholders for generating and processing data exchanges. For each process identified in the use case at least one actor must be defined who is responsible for generating that data.

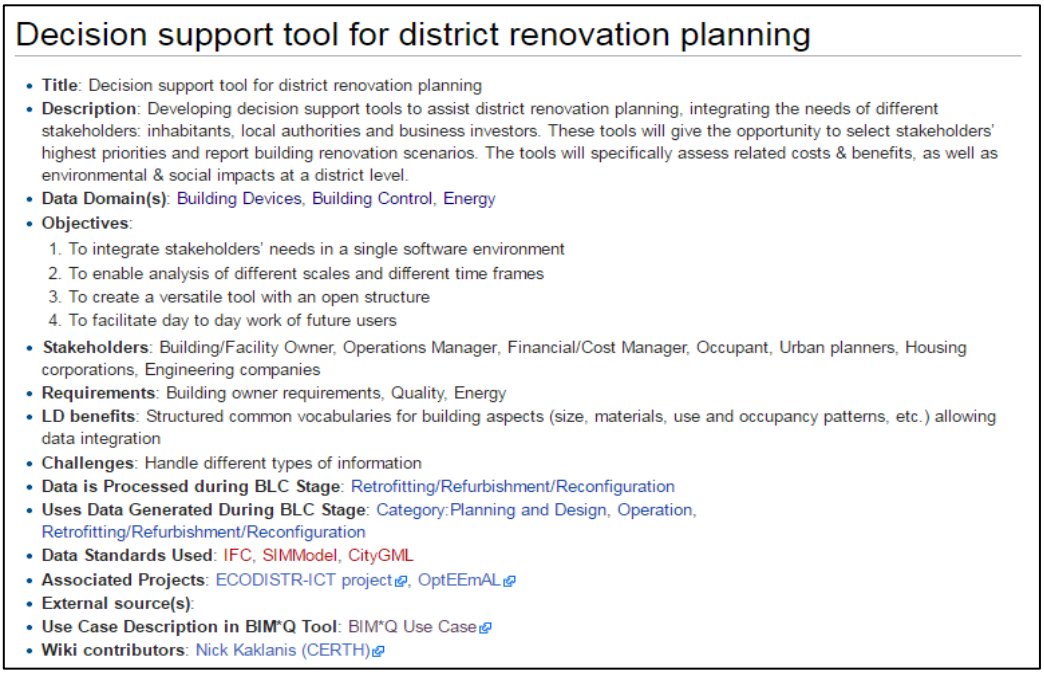
Step three (3) is to identify at a high level the data domains that the use case requires and consist of [11], [3]:

- Product
- Device
- Control
- Behaviour
- Communications
- Data Measures
- Energy
- Weather
- Geolocation

The purpose of this process is to provide a quick reference to data structures best suited for a particular domain. Again this data is added to the wiki, resulting in a description of the use

[2] This data is first recorded using an open shared wiki [11], described in D1.1 [3]. The shared wiki provides a template (Figure 2) which allows BLC stages to be added to a description of the use case.

case, for example the use case 'Decision support tool for district renovation planning'[3] is shown in Figure 3. The high level use cases are used to automatically generate the use case overview [12]



Decision support tool for district renovation planning

- **Title**: Decision support tool for district renovation planning
- **Description**: Developing decision support tools to assist district renovation planning, integrating the needs of different stakeholders: inhabitants, local authorities and business investors. These tools will give the opportunity to select stakeholders' highest priorities and report building renovation scenarios. The tools will specifically assess related costs & benefits, as well as environmental & social impacts at a district level.
- **Data Domain(s)**: Building Devices, Building Control, Energy
- **Objectives**:
  1. To integrate stakeholders' needs in a single software environment
  2. To enable analysis of different scales and different time frames
  3. To create a versatile tool with an open structure
  4. To facilitate day to day work of future users
- **Stakeholders**: Building/Facility Owner, Operations Manager, Financial/Cost Manager, Occupant, Urban planners, Housing corporations, Engineering companies
- **Requirements**: Building owner requirements, Quality, Energy
- **LD benefits**: Structured common vocabularies for building aspects (size, materials, use and occupancy patterns, etc.) allowing data integration
- **Challenges**: Handle different types of information
- **Data is Processed during BLC Stage**: Retrofitting/Refurbishment/Reconfiguration
- **Uses Data Generated During BLC Stage**: Category:Planning and Design, Operation, Retrofitting/Refurbishment/Reconfiguration
- **Data Standards Used**: IFC, SIMModel, CityGML
- **Associated Projects**: ECODISTR-ICT project, OptEEmAL
- **External source(s)**:
- **Use Case Description in BIM*Q Tool**: BIM*Q Use Case
- **Wiki contributors**: Nick Kaklanis (CERTH)

Figure 3 High Level Use Case Wiki Example

*After the high level use cases is described, the steps 4-5 require more functionality, and so we recommend the use of the BIM*Q tool.*

The first steps are to align the data from the wiki with the BIM*Q tool. To achieve this one must currently take the wiki use case title and description and add these to a new use case templates created in the BIM*Q tool (Figure 4). Once this has been completed, the user must continue to copy and paste data across to the BIM*Q tool. Step 1 and 2 are shown in the BIM*Q in Figure 5 and Figure 6 respectively. In Step 3, particular ontologies are added for each domain as can be seen in Figure 7. Once these steps have been completed, it is possible to begin Steps 4-5.

[3] https://www.w3.org/community/lbd/wiki/Decision_support_tool_for_district_renovation_planning

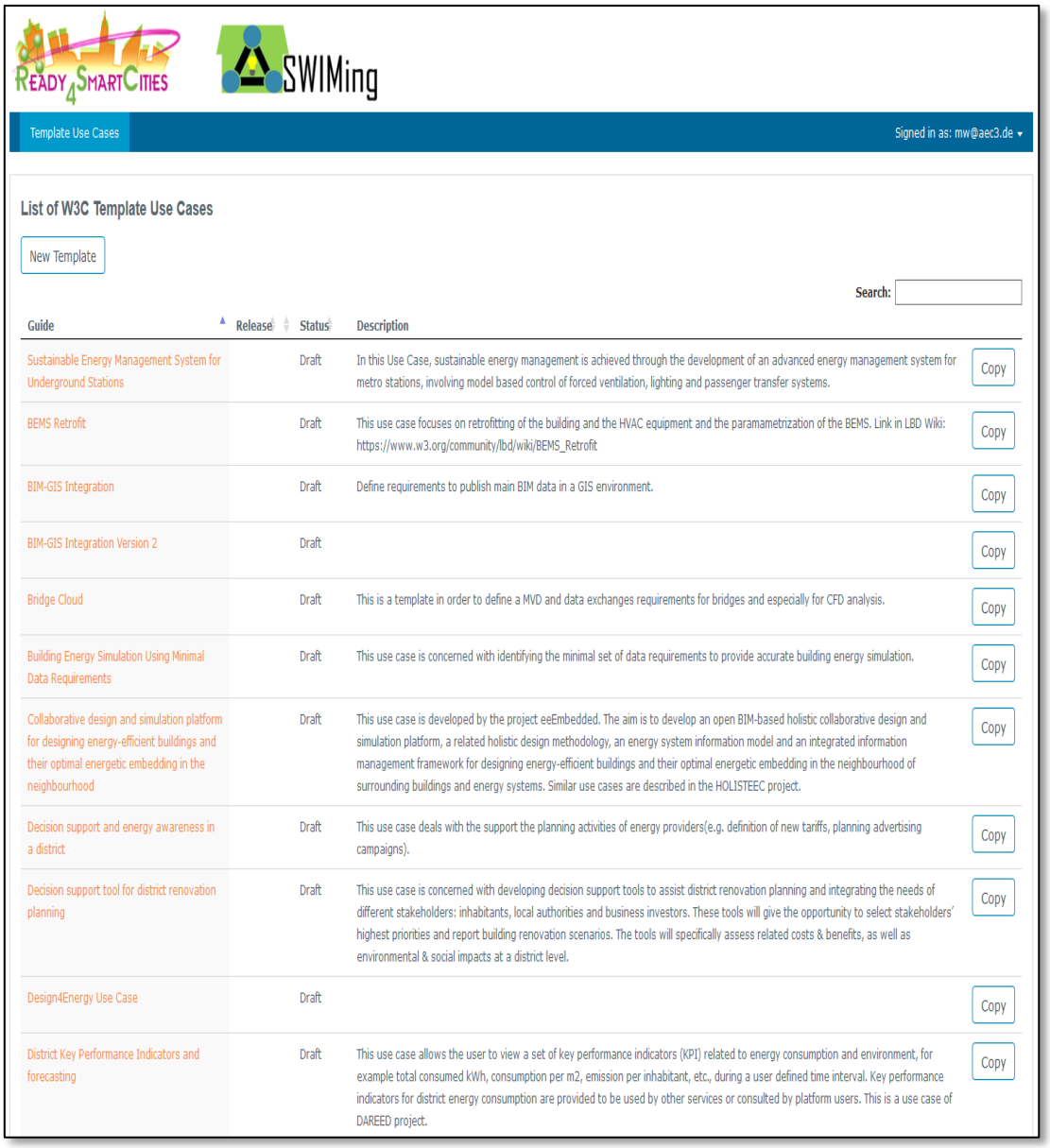


*Figure 4 Overview of Use Cases in BIM*Q*

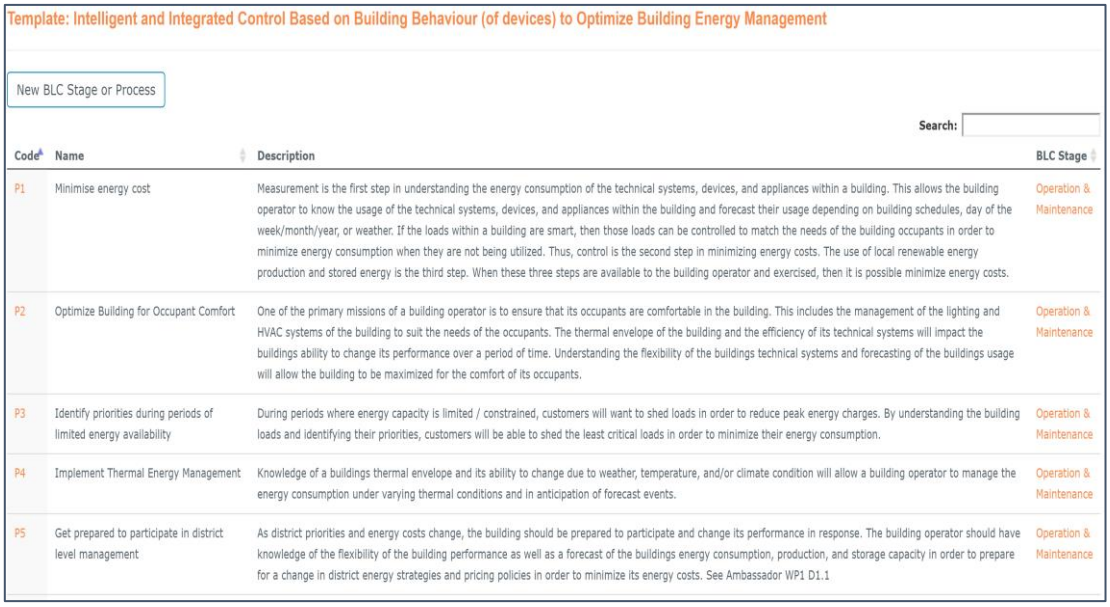


*Figure 5 Defining Processes in BIM*Q*

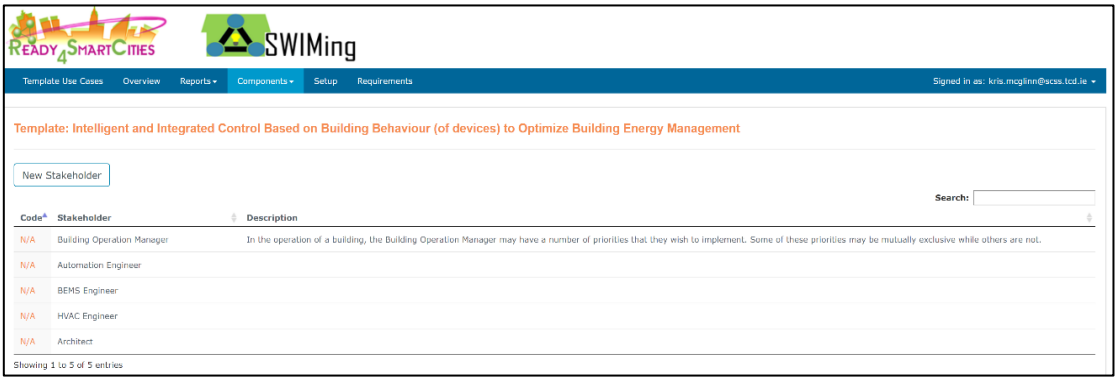


*Figure 6 Defining Stakeholders/Actors in BIM*Q*

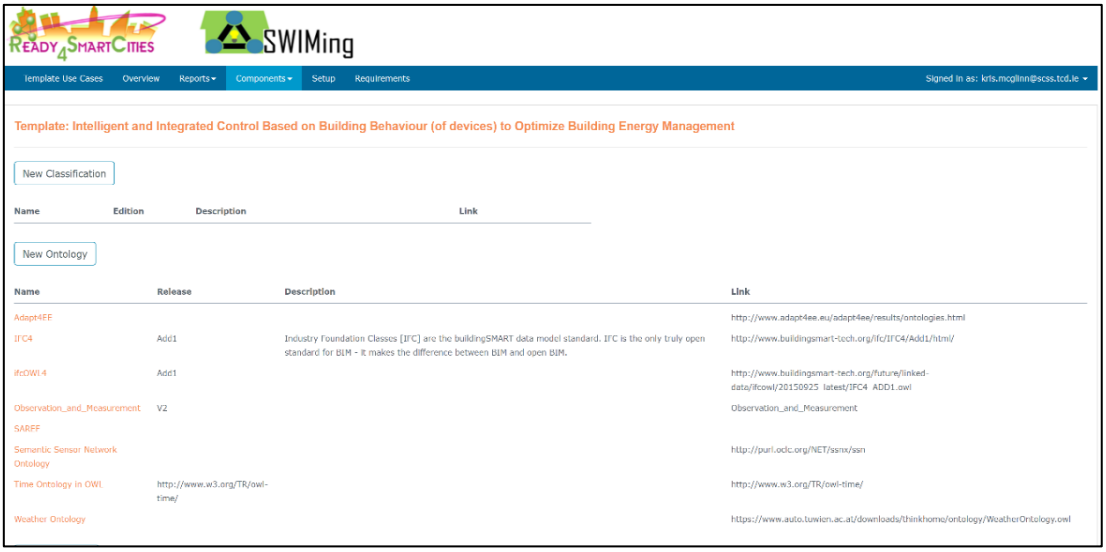


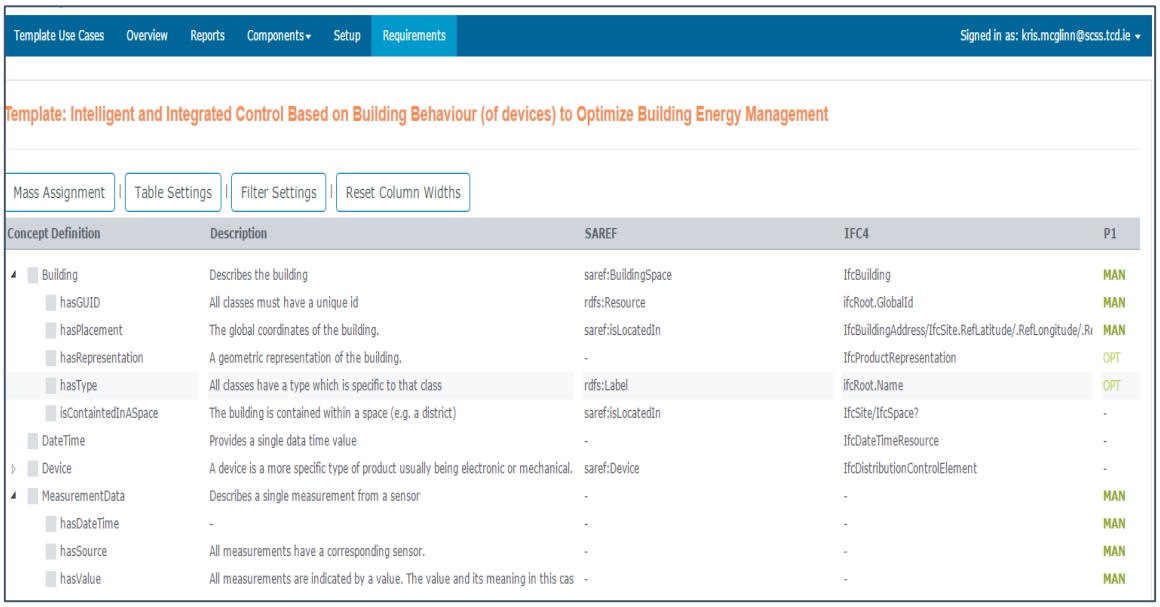
*Figure 7 Defining Available Ontologies in BIM*Q*

Step four (4) is to identify in greater detail the specific data requirements for each process in the use case.

The purpose of this step is to understand the exact structure of the data required to meet the use case. Each data value that is required must be captured and described. This involves structuring the data as concepts and properties. These classes are then aligned with the processes and actors.

Step five (5) is where the conceptual model is aligned with existing ontologies and standards (Figure 8).

The purpose of this step is to provide a quick reference point for the identification of alignments within existing domain models, thus supporting those who wish to enable similar use cases. The alignment process is based upon expert knowledge of the existing domain models and therefore may need to undergo several review steps to ensure that the data alignments are correct (see Step/Task 8 in D2.2).



Concept Definition	Description	SAREF	IFC4	P1
Building	Describes the building	saref:BuildingSpace	IfcBuilding	MAN
hasGUID	All classes must have a unique id	rdfs:Resource	ifcRoot.GlobalId	MAN
hasPlacement	The global coordinates of the building.	saref:isLocatedIn	IfcBuildingAddress/IfcSite.RefLatitude/.RefLongitude/.R	MAN
hasRepresentation	A geometric representation of the building.	-	IfcProductRepresentation	OPT
hasType	All classes have a type which is specific to that class	rdfs:Label	ifcRoot.Name	OPT
isContaintedInASpace	The building is contained within a space (e.g. a district)	saref:isLocatedIn	IfcSite/IfcSpace?	-
DateTime	Provides a single data time value	-	IfcDateTimeResource	-
Device	A device is a more specific type of product usually being electronic or mechanical.	saref:Device	IfcDistributionControlElement	-
MeasurementData	Describes a single measurement from a sensor	-	-	MAN
hasDateTime	-	-	-	MAN
hasSource	All measurements have a corresponding sensor.	-	-	MAN
hasValue	All measurements are indicated by a value. The value and its meaning in this cas	-	-	MAN

*Figure 8 Concept Definition and Alignment with Processes and Ontologies in BIM*Q*

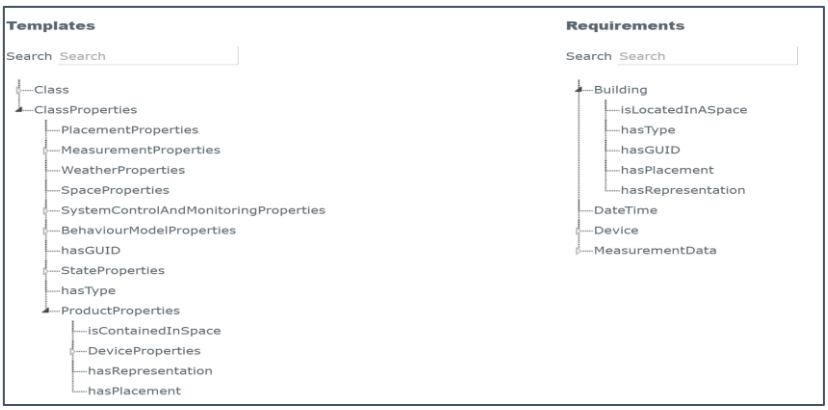


*Figure 9 A Specific Data Exchange Defined in BIM*Q Tool*

Step six (6) is to develop models that will meet the data requirements of use cases which are not currently supported by any existing ontology or standard.

The purpose of this step is to develop new or extend existing ontologies were no existing ontology meets the requirements of the use case. The BIM*Q tool provides a basis for capturing concepts and therefore provides a good bridge toward ontology development, but

currently does not provide the kind of complex relations that are required for new ontological definitions. Therefore, it is recommended that OWL based ontology development be conducted with existing tools, such as Protégé [13], or to support more collaborative work the web based WebProtege [14].

There is already plenty of information readily available on ontology development [15] and methodologies for developing ontologies [16], and these can be applied in different scenarios. For example, there are approaches which make use of UML to derive ontologies (e.g. UPON [17]), fact oriented approaches like those GOSPL referred to in [16] and DOGMA [18], structured English approaches (e.g. ACE [19]), and OWL based approaches, which the aforementioned Protégé tool supports, and more collaboratively with WebProtege. NeOn, developed within the context of an EU project of the same name [20], also provides a methodology and workbench which supports choosing between these different approaches based on scenarios [21].

Step seven (7) is to define links between ontologies and data models, where multiple are required to meet the use case Define Links.

The links between ontologies can be created in the T-Box part (classes) and A-Box part (individuals). The linking of T-Box elements results in linked vocabularies. The methods to link the T-Box elements are for example as follows [22]:

1. Creating sub-classes of classes defined in other ontologies using rdfs:subClassOf
2. Creating sub-properties of properties defined in other ontologies using rdfs:subPropertyOf
3. Defining domain and/or range of properties from imported resources using rdfs:domain and rdfs:range
4. Linking equivalent classes and properties coming from different ontologies using owl:equivalentClass and owl:equivalentProperties

The linking of A-Box elements can be done through the use of owl:sameAs to define two individuals, that are already declared in different ontologies, refer to the same thing. An individual can be linked to a defined in another ontology by defining class membership using rdf:type.

Step eight (8) is the publication of data so as to make it accessible both within the scope of a particular use case, but also to make it available to external use cases.

The linked data can be published by using tools like LOD-Viewer[4] where the data user can navigate over both classes and individuals. Furthermore, linked open data platform, such as Linked Open Data cloud[5] initiated by Linking Open Data community, allows the linked data publication on the web and linking to other open data. The data have to be registered in datahub[6] and follow the linked data principles, i.e. having resolvable http URIs, having RDFa, RDF/XML, Turtle, or N-Triple format, containing at least 1000 triples, having at list 50 links to the registered data sets, and allowing access via RDF crawling, via an RDF dump, or via a SPARQL endpoint. We suggest all data publication follow existing W3C Best Practices[7], which is also referenced in D2.1 [23].

[4] http://lodview.it/
[5] http://lod-cloud.net/
[6] https://datahub.io/
[7] https://www.w3.org/TR/dwbp/

References

[1] W. Jeffrey and J. Karlshoej, “Information delivery manual: Guide to components and development methods,” *BuildingSMART International*, 2010. [Online]. Available: http://iug.buildingsmart.org/idms.
[2] Object Management Group, “Business Process Model and Notation (BPMN), V1.2,” 2012.
[3] H. Wicaksono and K. McGlinn, “SWIMING : D1.1 Business Use Cases for the Use of BIM-LOD in BLCEM Phase I,” 2015.
[4] H. Wicaksono and K. McGlinn, “SWIMIng: D1.2 Business Use Cases for the use of BIM-LOD in BLCEM – Phase II.”
[5] M. Weise and K. McGlinn, “SWIMing: D2.2 Guidelines and best practices for BLCEM process and data management - Phase I,” 2015.
[6] M. Weise and K. McGlinn, “Guidelines and best practices for BLCEM process and data management - Phase II.”
[7] J.-R. Noemi, “EEEMBEDDED Papers,” *eeEmbedded Project*, 2013. [Online]. Available: http://eeembedded.eu/.
[8] D. S.p.A., “HOLISTEEC,” 2013. [Online]. Available: http://www.holisteecproject.eu.
[9] Solintel, “DESIGN4ENERGY,” 2013. [Online]. Available: http://www.design4energy.eu/.
[10] “ISES.” [Online]. Available: http://ises.eu-project.info/.
[11] “SWIMing Wiki- Seed Use Cases.” [Online]. Available: https://www.w3.org/community/lbd/wiki/Seed_Use_Cases.
[12] Kris McGlinn and Hendro Wicaksono, “Use Case Classification Table.” [Online]. Available: http://phaedrus.scss.tcd.ie/buildviz/SWIMing/u_c_overview/. [Accessed: 18-Dec-2016].
[13] “The Protégé Ontology Editor and Knowledge Acquisition System.” [Online]. Available: http://protege.stanford.edu/. [Accessed: 01-Mar-2013].
[14] “WebProtege.” [Online]. Available: https://webprotege.stanford.edu/#List:coll=Home; [Accessed: 20-Dec-2016].
[15] S. Staab and R. Studer, *Handbook on ontologies*. 2013.
[16] C. Debruyne, T.-K. Tran, and R. Meersman, “Grounding Ontologies with Social Processes and Natural Language,” *J. Data Semant.*, vol. 2, no. 2–3, pp. 89–118, Jun. 2013.
[17] A. De Nicola, M. Missikoff, and R. Navigli, “A proposal for a unified process for ontology building: UPON,” *Int. Conf.*, 2005.
[18] M. Jarrar and R. Meersman, “Ontology Engineering – The DOGMA Approach,” in *Advances in Web Semantics I*, Berlin, Heidelberg: Springer Berlin Heidelberg, 2008, pp. 7–34.
[19] K. Kaljurand, “ACE View---an Ontology and Rule Editor based on Attempto Controlled English.,” *OWLED*, 2008.
[20] “NeOn Project.” [Online]. Available: http://www.neon-project.org/nw/Welcome_to_the_NeOn_Project. [Accessed: 21-Dec-2016].
[21] M. Suárez-Figueroa and A. Gomez-Perez, “The NeOn methodology for ontology engineering,” *Ontol. Eng.*, 2012.
[22] H. Wicaksono, K. Tonev, and P. Dobreva, “Linked Data for Data Integration based on SWIMing Guideline: Use Cases in DAREED Project,” in *4th International Workshop on Linked Data in Architecture and Construction (LDAC)*, 2016.
[23] M. Weise and K. Mcglinn, “SWIMING : D2.1 Data Management Plan,” 2015.