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HUBCAP

Fifth Version of HUBCAP Contents

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Document History

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0.1	28/07/2022	Stefano Tonetta	Initial structure
0.2	18/08/2022	Alberto Debiasi	Added contents on guidelines
0.3	14/09/2022	Alberto Debiasi	Updated section on wiki
0.4	15/09/2022	Stefano Tonetta	Polishing
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Abstract

The **HUBCAP Collaborative Platform** provides **catalogues of models and tools** for trial experiments with Model-Based Design (MBD) technology to design and develop innovative Cyber-Physical Systems (CPS) solutions with the support of MBD.

The HUBCAP platform is fully operational and contains more than 60 tools and more than 100 models. The platform is therefore rich of contents to allow SME getting started with MBD tools and techniques. However, the large amount of information may be a blocking issue for new adopters of MBD solutions.

The purpose of Task 6.5 is to lower the barrier for new adopters by proving guidelines, ensuring the quality and usability of the platform's contents, and giving direct support to the users and in particular to the winners of the Open Calls (OC). In this document, we report on the latest activity and material developed by the partners for this purpose. More specifically, we describe the process and results for checking and ensuring the quality of the assets in the platform and on the wiki pages that guide the users to find the right MBD techniques/tools.

With respect to D6.5, the document reports on the completion of the quality review, the assignment of badges to good-quality assets, the completion of the navigation tree and wiki pages to guide the user to find the right asset. Differently from D6.5, we omitted activities on training workshops and first-level support to OC winners as in the last period there was less need, while we focused on quality assurance and guidelines material.

D6.6 is a deliverable of **type "OTHER"**, given by the actual enhancement of the platform's contents. These can be browsed by accessing the platform. This document summarizes D6.6 contributions.

List of Abbreviations

API	Application Programming Interface
CCA	Common Cause Analysis
CLI	Command Line Interface
CMS	Catalogues Management System
COE	Co-simulation Orchestration Engine
CPU	Central Processing Unit
DIH	Digital Innovation Hub
DMA	Direct Memory Access
DSE	Design Space Exploration
FMEA	Failure Modes and Effects Analysis
FMI	Functional Mock-up Interface
FMU	Functional Mock-up Unit
FTA	Fault Tree Analysis
GPU	Graphics Processing Unit
GUI	Graphical User Interface
HSM	HUBCAP Sandboxing Middleware
HTTP	HyperText Transfer Protocol
IDE	Integrated Development Environment
IdM	Identity Management
JSON	JavaScript Object Notation
KMS	Knowledge Management System
MBD	Model-Based Design
MBT	Model Based Testing
MCS	Minimal Cut Sets
OSLC	Open Services for Lifecycle Collaboration
QA	Quality Assurance
RBAC	Role-Based Access Protocol
RCP	Rich Client Platform
REST	Representational State Transfer
SAT	Boolean Satisfiability Problem
SMT	SAT Modulo Theories
SME	Small and Medium-sized Enterprises
SSO	Single Sign On
SSP	System Structure and Parametrization
SysML	Systems Modeling Language
TFPG	Timed Failure Propagation Graphs
TRL	Technology Readiness Level
UML	Unified Modeling Language
UAV	Unmanned Aerial Vehicle
VDM	Vienna Development Method
VM	Virtual Machine
VNC	Virtual Network Computing

Contents

1. Introduction

Model-Based Design (MBD) is a method to address the design of complex systems with models. It prescribes the use of models throughout the development process in order to represent system structure and behaviours, providing a basis for machine-assisted analysis of system properties, and supporting design decisions through processes of refinement into implementation. The purpose is 1) to **reduce the complexity** of design **by abstraction**; 2) to **ensure the quality** of the system **by rigorous analysis** of its properties; 3) to **reduce the cost** of the development **by detecting issues** in the **early** phases of the development. MBD is quite standard in software engineering and is becoming more and more relevant in systems engineering, where it must integrate methods for control engineering and safety engineering.

MBD appears largely to be applied in domains such as aerospace where the return on investment can take decades. By contrast, SMEs require considerable flexibility to change processes to adopt MBD and may lack in-house expertise. In addition, the selection, procurement, training and deployment costs for some methods and tools can be discouragingly high. In general, it is difficult for SMEs to invest in acquiring the necessary background for example because of the high license fees from commercial vendors of MBD assets.

The **HUBCAP Collaborative Platform** lowers such barriers by providing **catalogues of models** and MBD tools for trial experiments to design and develop innovative CPS solutions with the support of MBD technology. D6.6 consists of the fifth version of the platform's contents and, in particular, the guidelines for new adopters of MBD. This document summarizes the contents of the catalogue for the reviewer's convenience, and reports on additional T6.5 activities to support the platform's users.

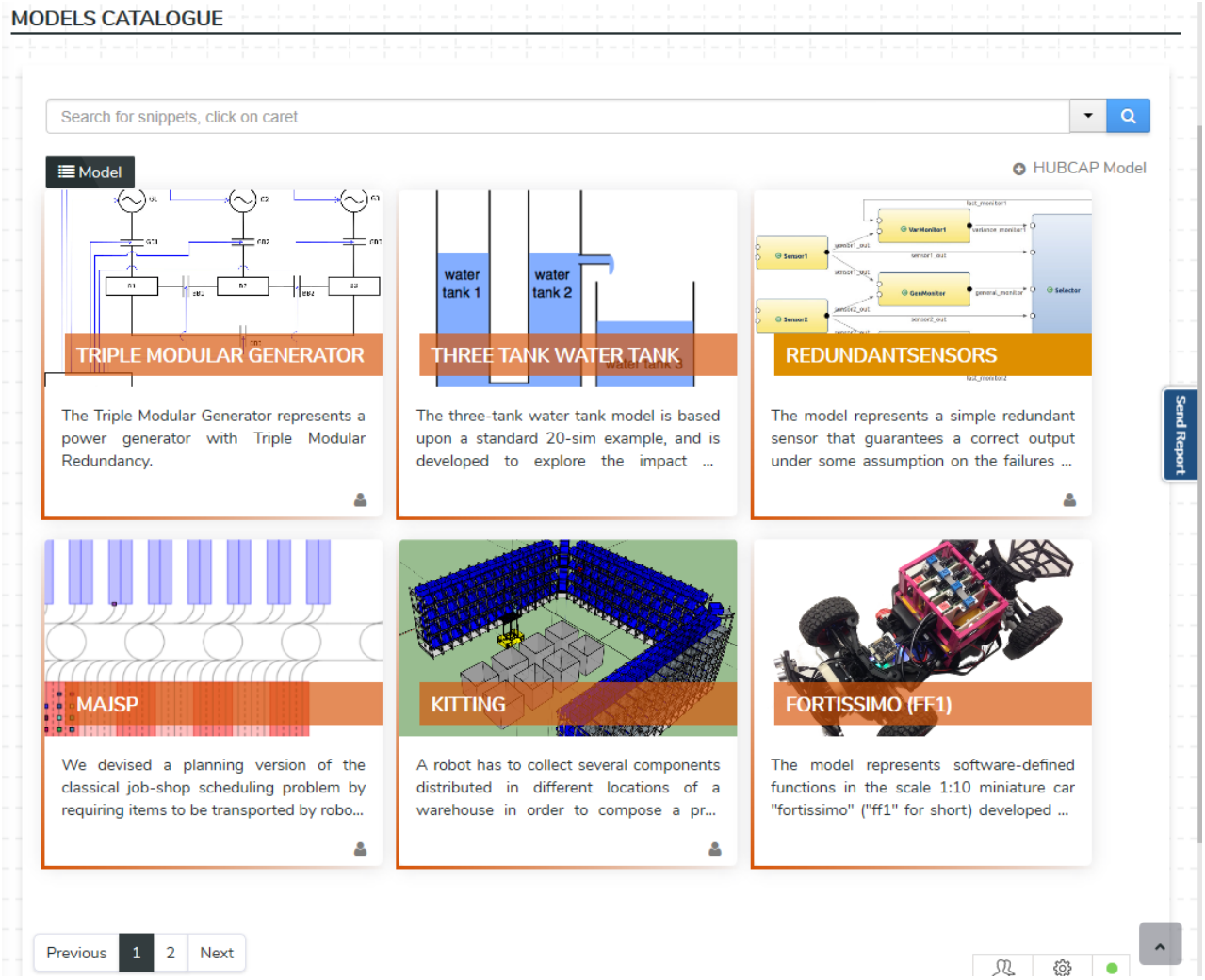


Figure 1: Screenshot of the models catalogue.

2. Summary of current HUBCAP contents

In the previous deliverables, we described the models and tools that were initially uploaded and how they are linked to the sandbox environment through the "Try It Now" features. These contents have been continuously updated, also contributed to by the SME winners of the open calls. The number of models in the platform is indeed contributing to the KPIs of the HUBCAP project. We summarize here the status of models and tools.

The models cover various application domains including control engineering, electrical engineering, automotive, and avionics. The model catalogue (Figure 1) currently has more than 100 models, almost all of which have been connected to the sandbox environment (Figure 2).

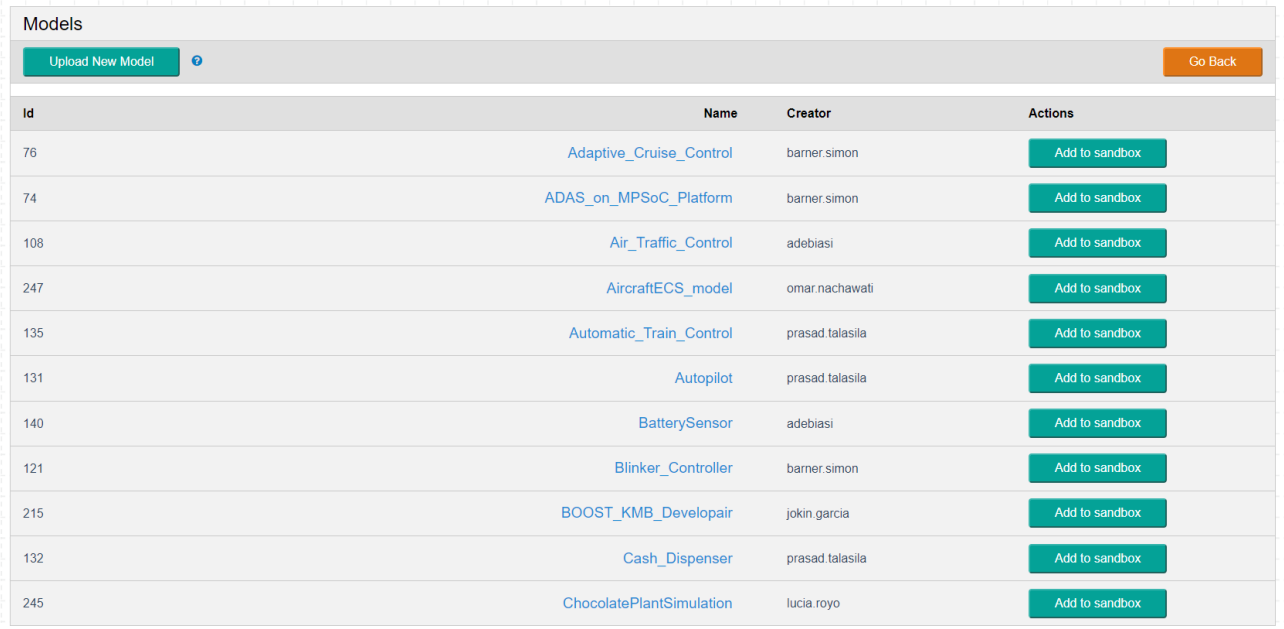


Figure 2: The sandbox environment.

At present, the tool catalogue (Figure 3) has more than 60 tools and most of them have been connected to the sandbox environment. The sandbox can be launched directly from the tools catalogue with the "Try It Now" feature. These tools are provided by the HUBCAP partners, SMEs partners, and they are uploaded, installed, and tested inside the HUBCAP Collaborative Platform sandbox to constitute the contents of the catalogue of tools.

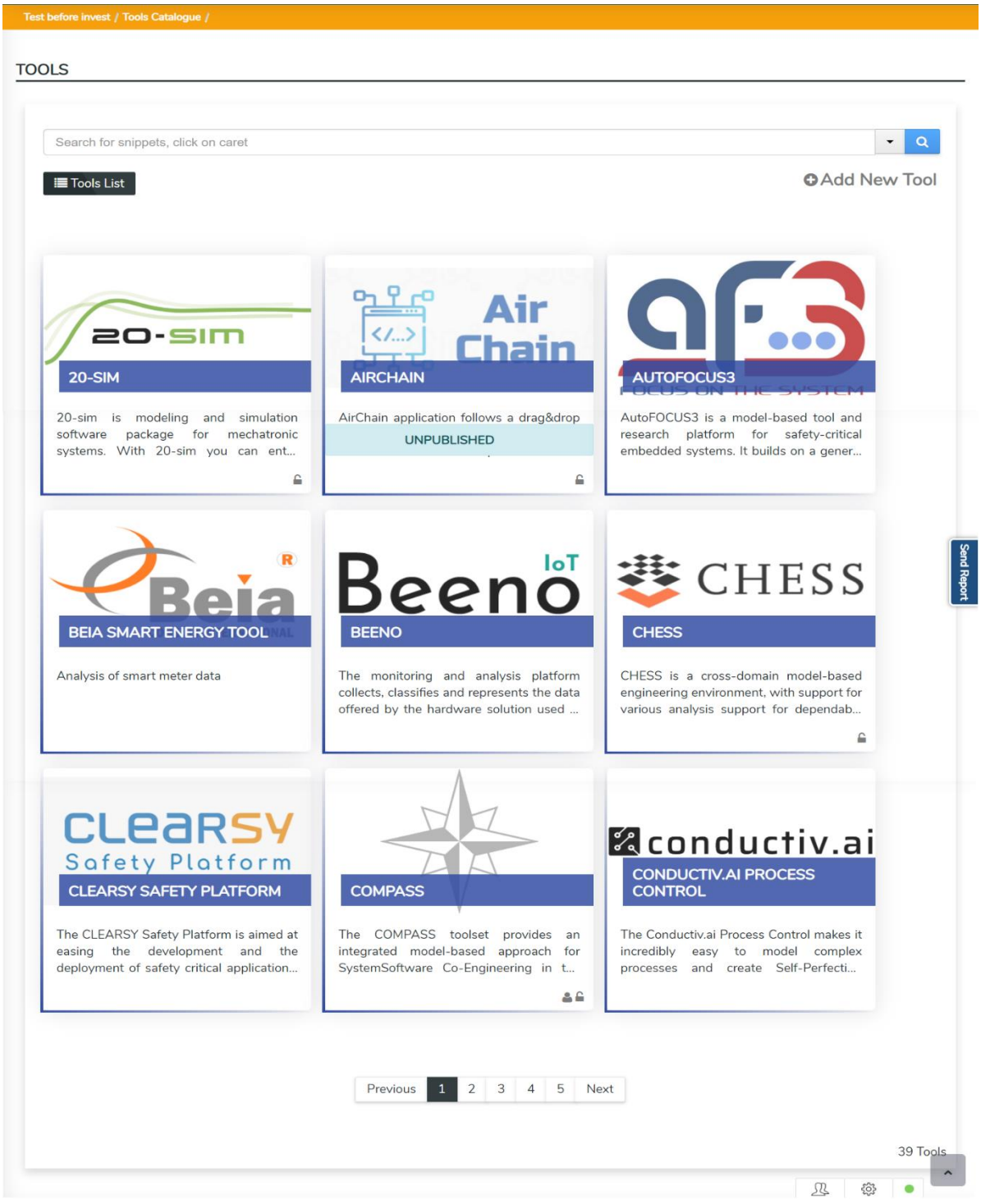


Figure 3: The Tools catalogue.

3. Guidelines

3.1. Videos

The guidelines related to the HUBCAP platform are provided in video format. The available videos cover the following topics:

- HUBCAP Sandbox Environment:
  - Login and Sandbox creation.
  - Run model-based design tool.
  - Add a tool to the repository.
  - Add a model to the repository.
  - Share the Sandbox with other users.
- Ferryman Model Evaluation in the HUBCAP Sandbox Environment.
  - Using the “Try-It-Now” feature from the HUBCAP platform.
- RT-TESTER MBT tool experiment in the HUBCAP Sandbox Environment
  - Using the “Try-It-Now” feature from the HUBCAP platform.
- HUBCAP Platform.
  - Contents of the HUBCAP platform.
- OCLS Service Provider for MBD Analysis.
- Servitization of certifying model checking.
- Beia Smart Energy Tool.
- Simulating a 20-sim model in the sandbox.
- Manufacturing Process Simulation in a Hybrid Cloud Setup.

Such material is available in the Hubcap YouTube channel[1] and in the Guidelines Section[2] of the Hubcap Portal (Figure 4).

[1] https://www.youtube.com/channel/UCgGzupq5xi6gku7J7U1_Efg

[2] https://hubcap-portal.eng.it/group/guest/guidelines

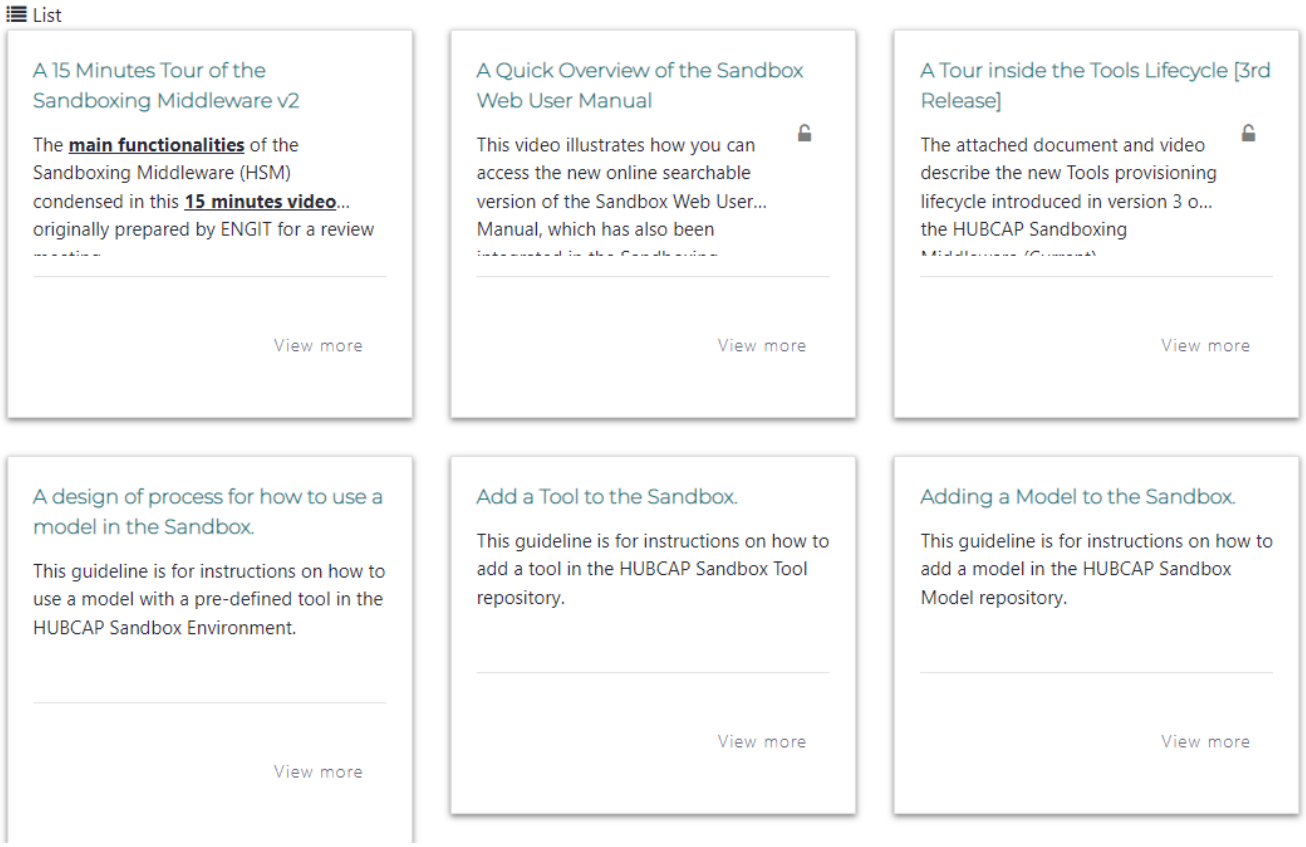


Figure 4: The Guidelines section.

3.2. Mind maps

As described in the D6.5, the mind map is a graphical visualization that describes the techniques supported by each target tool. The mind maps that are available cover the following tools:

- AutoFocus
- Chess (Figure 5)
- Compass
- HyComp
- NuXmv
- OCRA
- OpenModelica
- TASTE
- xSAP

Figure 5: Mindmap related to the CHESS tool.

Such material is accessible as “Additional Material” in the pages of the catalogue of tools.

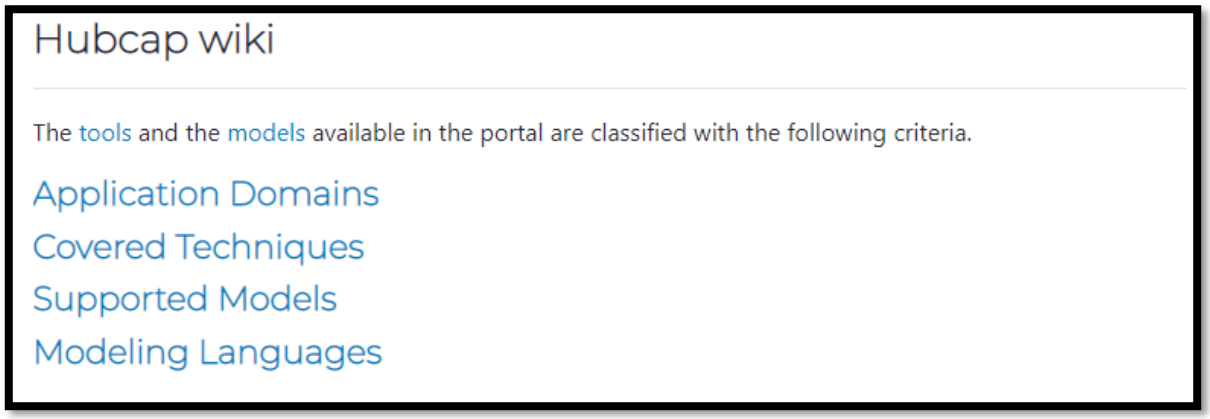
Mind maps were created using a customized Canva template available online[3]. The content providers can use such material to create new mind maps that will be used to enrich to the Hubcap portal. This is an ongoing process that will continue after the end of the project.

3.3. Wiki

The wiki section is now available in the Hubcap portal[4] (Figure 6). It is designed to ease the access of information available in the catalogues. In particular, the user can browse the tools and the models starting from the application domains, the covered techniques, the supported models, and the modelling languages. The wiki is a collaborative environment, that is getting enriched with new content by the WP6 partners. Up to now, there are:

- 12 pages in the Techniques section.
- 6 pages in the Modeling Languages section.
- 4 pages in the Supported Models section.
- 1 page in the Application Domains section.

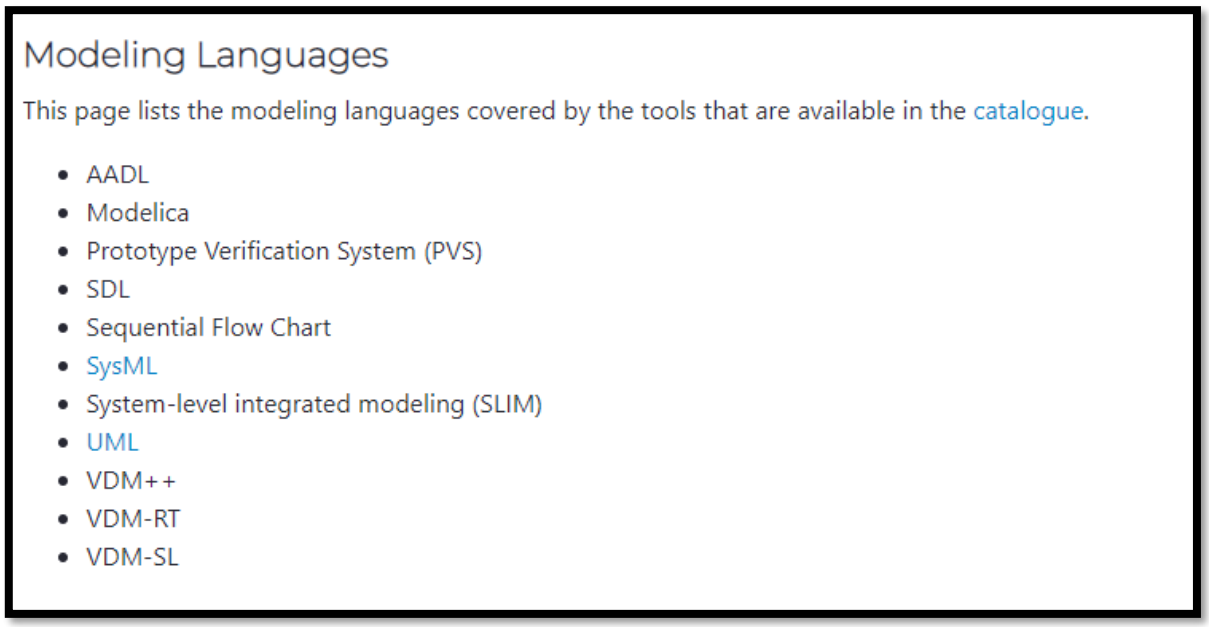
[3] https://www.canva.com/design/DAEyVzk7Bco/398Tumtyxnn5N1CqOGDGLg/edit
[4] https://hubcap-portal.eng.it/group/guest/wiki



Hubcap wiki

The tools and the models available in the portal are classified with the following criteria.

Application Domains
Covered Techniques
Supported Models
Modeling Languages



Modeling Languages

This page lists the modeling languages covered by the tools that are available in the catalogue.

- AADL
- Modelica
- Prototype Verification System (PVS)
- SDL
- Sequential Flow Chart
- SysML
- System-level integrated modeling (SLIM)
- UML
- VDM++
- VDM-RT
- VDM-SL

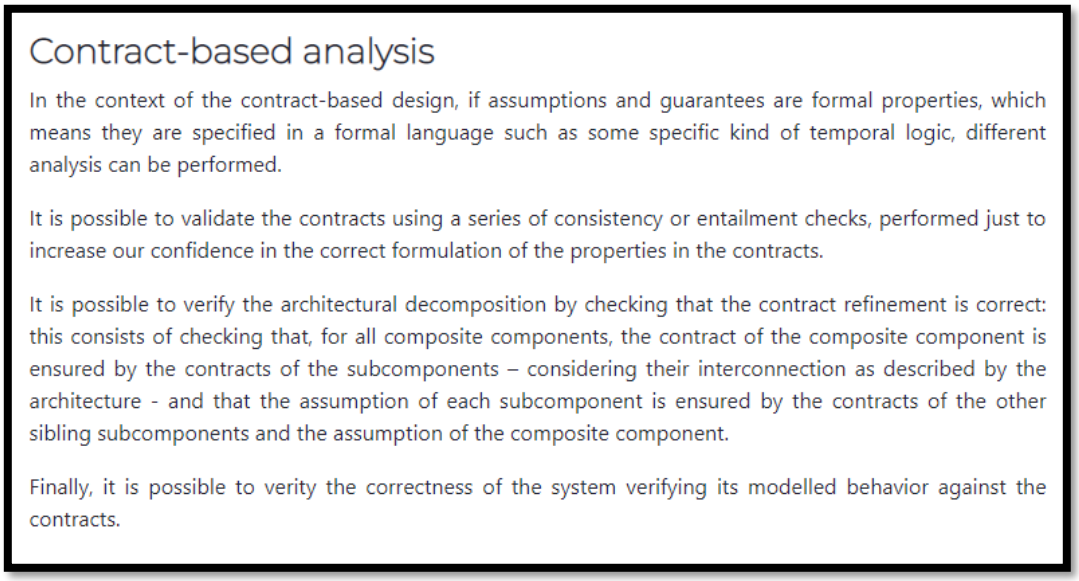


Figure 6: In top-down order. The main page of the Wiki section, the Modeling languages page, and the page of one supported technique: the contract-based analysis.

Each wiki section contains the link to a specific navigation tree described in the D6.5 [1]. This interactive visualization helps the user to find the tools and the models according to different criteria such as the application domains, the covered techniques, the supported models, and the modelling languages. *Figure 7* shows the navigation tree where the tools and models are grouped by the techniques they support.

The wiki is a collaborative tool to help the adopters of the model-based tools. The tools providers are free to contribute to the wiki to improve its structure and content. This action

is not bound to be completed by the end of the project.

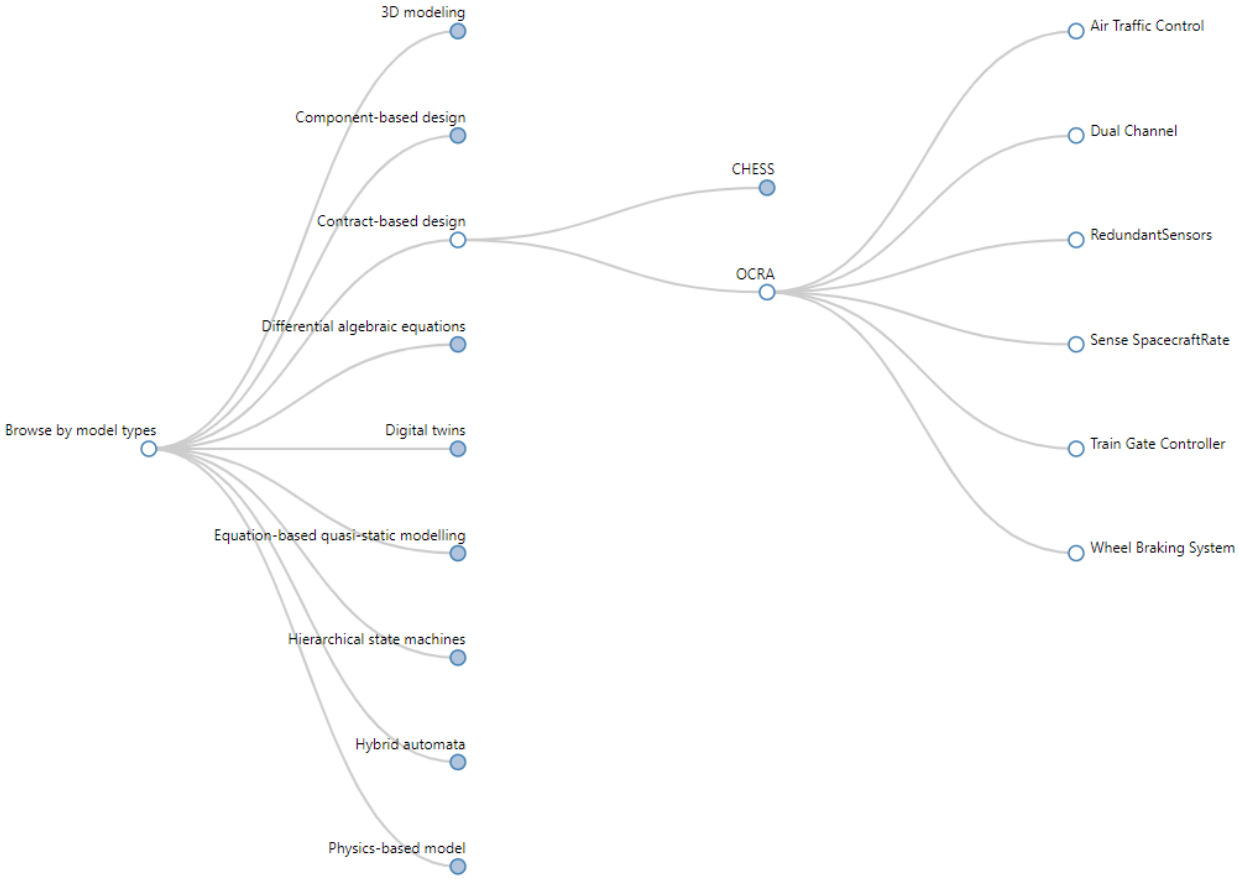


Figure 7: Navigation tree. The tools and models are grouped by the techniques they support. There are other navigation trees available in the wiki that group the tools and models by languages, model types, application domains.

4. Quality checking of assets on the platform

The quality assurance process of the catalogues has evolved through different stages and has been adjusted and perfected throughout the Task 6.5.

The QA process proposed at the beginning of the task was based on an analysis of literature and technical material related to quality assurance of assets on digital platforms, as well as the project requirements previously defined by the HUBCAP stakeholders. As a part of the literature analysis conducted, it was considered generating and setting the QA process for catalogues based on external methods, guidelines and techniques related with the reinforcement of quality. In that way, ISO/IEC 25010:2011: norms for systems and software and Quality Requirements and Evaluation (SQuaRE) were considered and studied. However, after their analysis, the external methods and standards selected were discarded, as they did not fit well with the requirements to be addressed in this particular QA process. Thus, it was decided to create a tailored solution, according to the main characteristics and peculiarities of the platform and of its catalogues. The HUBCAP platform entails many particularities, and the method utilized for uploading and hosting information required a more customized QA process.

The definitive internal process of design of the QA process for the catalogues can be summarized in the following workflow diagram.

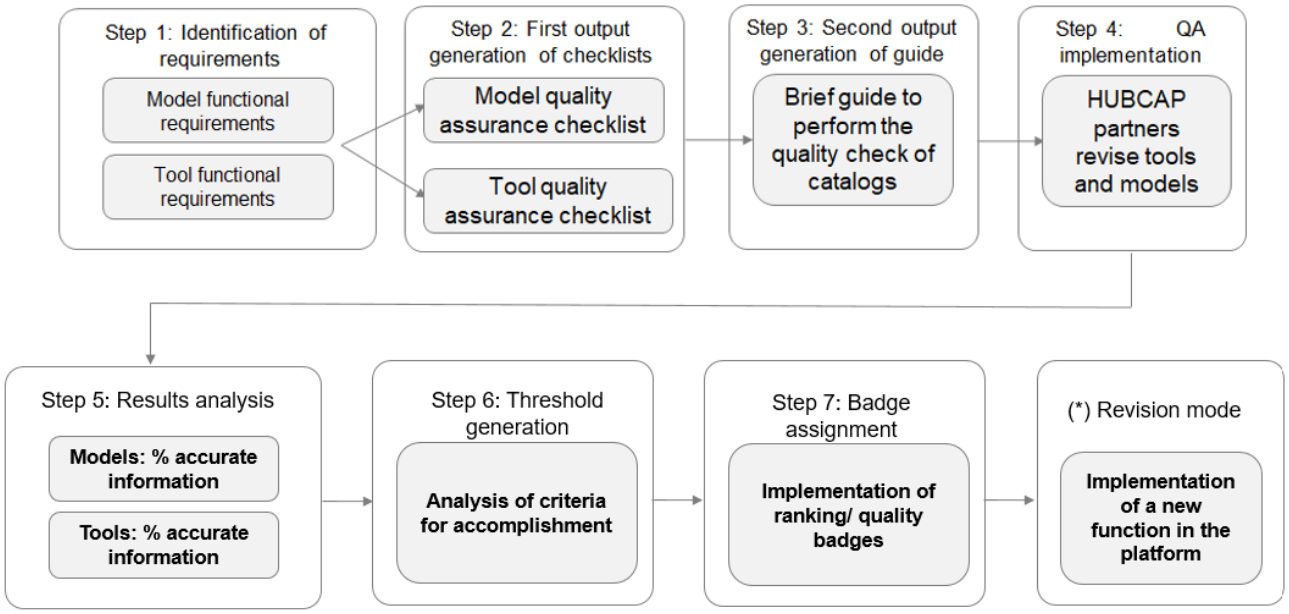


Figure 8: Workflow diagram QA process generation.

As previously mentioned, it was decided to base the quality criteria on the functional requirements previously defined by the HUBCAP stakeholders and listed in the document “Task T5.2: Models Marketplace and Modelling/Simulation Services – Functional Requirements” in the step 1 of the

workflow. From a selection of these functional requirements, the checklists were generated in step 2. The input document counted two types of functional requirements:

- Security requirements, focused on providing guidelines for the login, user management and functions for the roles present in the platform (administrator, provider, end user).
- Asset Catalogue Requirements, divided into:
  a. asset catalogue items definition
  b. list and description of possible actions available inside the catalogues (add, remove, update, search, view an asset).

The checklists were generated based on the asset catalogue items definition, which represented the basic fields needed to describe an asset in the platform. In this way, a quality check of these items represented as well checking the quality of the contents of the platform.

Model Name:	(Write model's name in this cell)			
Item	**Description**	**Instructions**	**Answer**	**Comments**
Model Name	Is the name correctly indicated?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue	Yes	
Modelling languages or model types (ODE, DAE, FEM, etc.) utilized	Is any Modelling language or type indicated?	If it is correct, indicate it in the "Answer" column. If not, and it's required, please indicate it and make a comment on the issue.	No	
Model-based analysis technique implemented (simulation, model checking, safety analysis, etc.).	Is any Model-Based Technique indicated?	If it is correct, indicate it in the "Answer" column. If not, and it's required, please indicate it and make a comment on the issue		
Model Version	Is the model version provided?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue		
Model ID	Is the model ID provided?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue		
Tool ID	Is the tool ID provided?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue		

Figure 9: Model checklist format

After the configuration of a brief set of guidelines on how to use the checklists (step 3 of the workflow), the quality checking of 90 models and 54 tools was conducted in two rounds and was developed manually in a joint effort from all the partners of the WP6 (who adopted the reviewer role). For those assets that have been added after the second round, it is expected to conduct a third one. The QA implementation (step 4 of the workflow) consisted in distributing the of assets to be reviewed evenly among the partners. The distribution of assets consisted in 9 models and 3 tools on the first round, and in 2 models and 3 tools on the second round. FBK and Polimi, WP and subtask leader respectively, were assigned with a higher number of assets than the rest of the partners. Essentially, the reviewer had the task to report in the checklist the status of each item of an asset, through the

dedicated section to indicate correct, incorrect or missing items, as it is shown in Figure 9. There was also a dedicated section to leave a comment from the reviewer.

After the first round of revision (carried out in March) a first results analysis was conducted and reported in D6.5. However, those insights were not enough to have a full picture of the quality of the content within the platform.
In order to set up a deeper procedure of evaluation and process of the obtained results, and to distinguish between different levels of quality of the assets, a set of quality criteria or a quality threshold was needed. The quality threshold was widely discussed in several monthly meetings. The outcome of those discussions was the establishment of three main criteria to set up the quality threshold (step 6 of the workflow). The assets that fulfilled the joint criteria, would receive a quality badge to be easily identified by the users in the platform.
The three simultaneous requisites were:

1. “Try It Now” feature available (asset available in the sandbox)
2. More than 50% of accurate information in the checklist
3. Step by step guideline (for models) and quickstart guideline (for tools) available

From the 90 models and 54 tools that were checked, 47 models and only 10 tools received a quality badge (step 7 of the workflow). That is, less than half of the assets accomplished the quality requisites. In Figure 10, the new display of the platform with some assets with their quality badges is shown. The aim was to give recognition to those asset providers who furnished quality information to the platform, as well as facilitate the navigation to the users to easily recognize those assets and access to them.

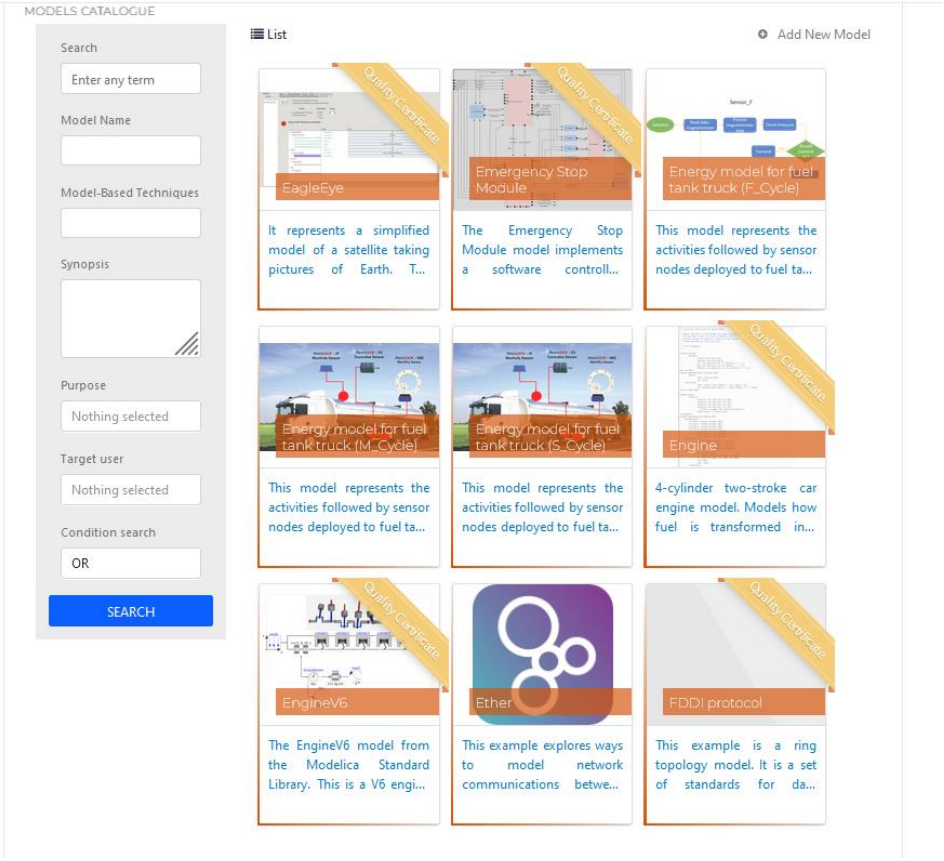


Figure 10: New display of the model catalogue with quality badges implemented.

The QA process proposed in this task is meant to unify the contents on the platform as well as generate a mechanism to detect missing or wrong information, while helping the user of the platform to better navigate and recognize those assets that are better described in the platform. The aim is not to change the nature of the information provided, since the items to define an asset in the platform have been previously defined.

The fact that only 40% of the checked assets received a quality badge is explained by the strict criteria selected to assign them. WP6 members discussed and selected the 3 above mentioned criteria, since they are the basic but most important to make use of an asset in the platform. These criteria are the common elements that are missing in the items of the catalogue, that explain the overall quality assignment figure, and that should be addressed in order to increase the number of quality badges among the platform assets.

The first criterion, to be available in the sandbox, is related with the test before invest function, one of the main objectives of the HUBCAP platform and the implementation of the testing environment in it. In this case, this doesn't represent a critical criterion, since 68% of the reviewed assets are available in the sandbox.

The second criterion was supposed to check if the main support tool to start using the asset, the step by step guideline (for the models case) or the quickstart guideline (in the case of tools) was available to support the proper utilization of an asset. In this case, 54% of the checked assets accomplished this requirement.

Lastly, in order to be assigned with the quality badge, an asset must count with more than 50% of accurate information in the checklist, to assure a minimum quality threshold in the provision of information within the catalogue by grouping all the rest of the items, of different nature between them (from technical aspects to contact information). In this case, 77% of the analysed assets accomplished this requirement.

The previous breakdown of the overall figure can better explain how only 40% of the total checked assets accomplished the 3 joint criteria. Both three of the selected requirements required an effort from the asset provider, not just exposing an asset in the catalogue but making it available in the sandbox, generating guidelines for their proper use, and taking care to provide accurate information in most of the items completed to upload it in the HUBCAP platform.

The procedure of assignment of the badges was also manual and consisted in counting the number of “yes” and “no” obtained from each asset, calculating if the “yes” (representing accurate or correct information) surpassed the 50% of the items (over 16 items for the models and over 17 items for the tools) and assigning a “1” if they did and “0” if they did not. Then, checking if the step-by-step guide and “Try It Now” feature were present or not, assigning a “1” if they were available and “0” if not. To obtain the quality badge, the sum of the last column should be “3”. This information was collected in the table that is shown in Figure 11.

Model	Yes	No	Over 5(	Try it nc	Step by st	Joint conditio
Airfoil - parametrized design	20	11	1	0	1	2
BOOST	15	16	0	1	1	2
ChocolatePlant	13	18	0	0	0	0
Dezyne Lego Wafer Inspection System	15	16	0	0	0	0
Digitizing the auscultation process	8	23	0	0	0	0
Dual Channel	15	16	0	1	0	1
Dual Channel (CHESS model)	22	9	1	1	1	3
Energy model for fuel tank truck	18	13	1	0	0	1
LIBPF™ Combined Heat and Power plant demo	24	7	1	1	1	3
Line Follower Robot	18	13	1	0	0	1
Marine AIS signal analysis and vessel detection	13	18	0	0	0	0
Pellet Plant Virtual Commissioning	15	16	0	0	0	0
Sense Spacecraft Rate (CHESS model)	23	8	1	1	1	3
SmartSpot	3	28	0	0	0	0
Train Gate Controller (CHESS model)	20	11	1	1	1	3
Unmanned Aerial Vehicle Swarm	18	13	1	0	0	1
fortissimo Rover	24	7	1	1	1	3
iTwinBuild	15	16	0	0	0	0

Figure 11: Models quality badge assignment for the models checked in the second round*, checking of joint criteria.*

Hereafter, some figures of the results obtained from both rounds of QA are provided. There were 90 models (2790 items) and 54 tools (1899 items) checked, i.e., 147 assets and around 4700 items checked in total. Currently, 47 models and 10 tools hold a quality badge in the platform. The quality levels of the assets (in absolute and relative numbers) are shown in the following Figures 12 and 13.

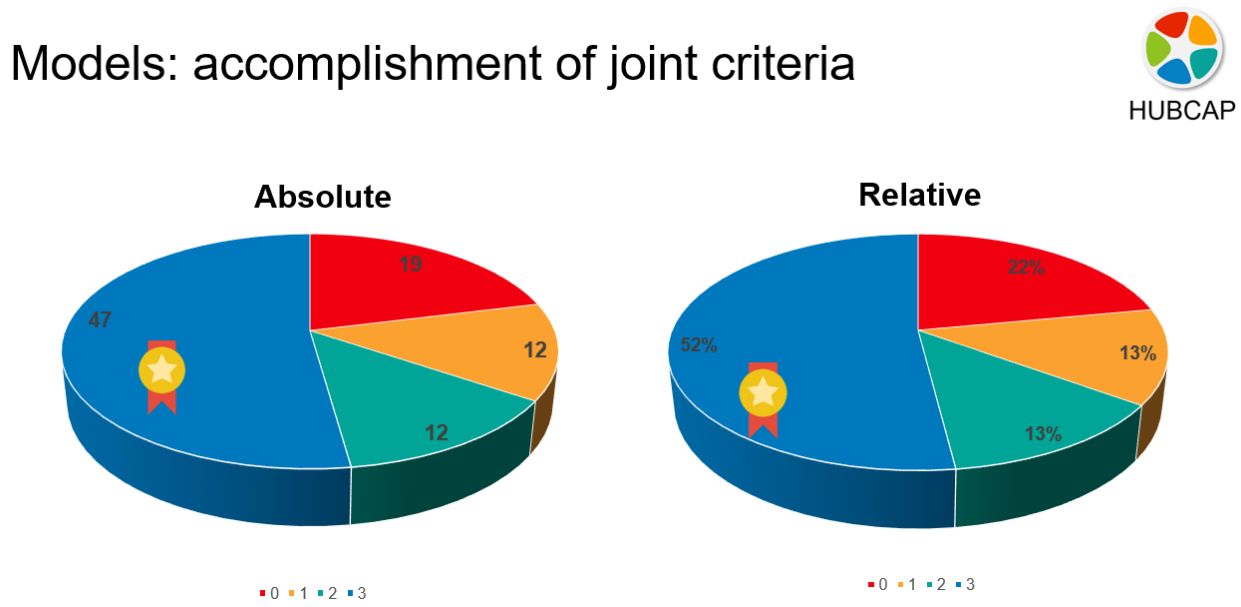


Figure 12: Number and percentage of models with an assigned badge out of the total.
Red (0): corresponds to the models that did not accomplish any of the 3 criteria established to get the quality badge. 19 models (22%) of the total checked models (in the first and second round) did not fulfill any of the 3 criteria.
Yellow (1): corresponds to the models that accomplished just 1 out of the 3 criteria established to get the quality badge. 12 models (13%) of the total checked models (in the first and second round) fulfilled only 1 out of the 3 criteria.
Green (2): corresponds to the models that accomplished 2 out of the 3 criteria established to get the quality badge. 12 models (13%) of the total checked models (in the first and second round) fulfilled 2 out of the 3 criteria.
Blue (3): corresponds to the models that accomplished all of the 3 criteria established to get the quality badge. 47 models (52%) of the total checked models (in the first and second round) fulfilled all the 3 criteria.

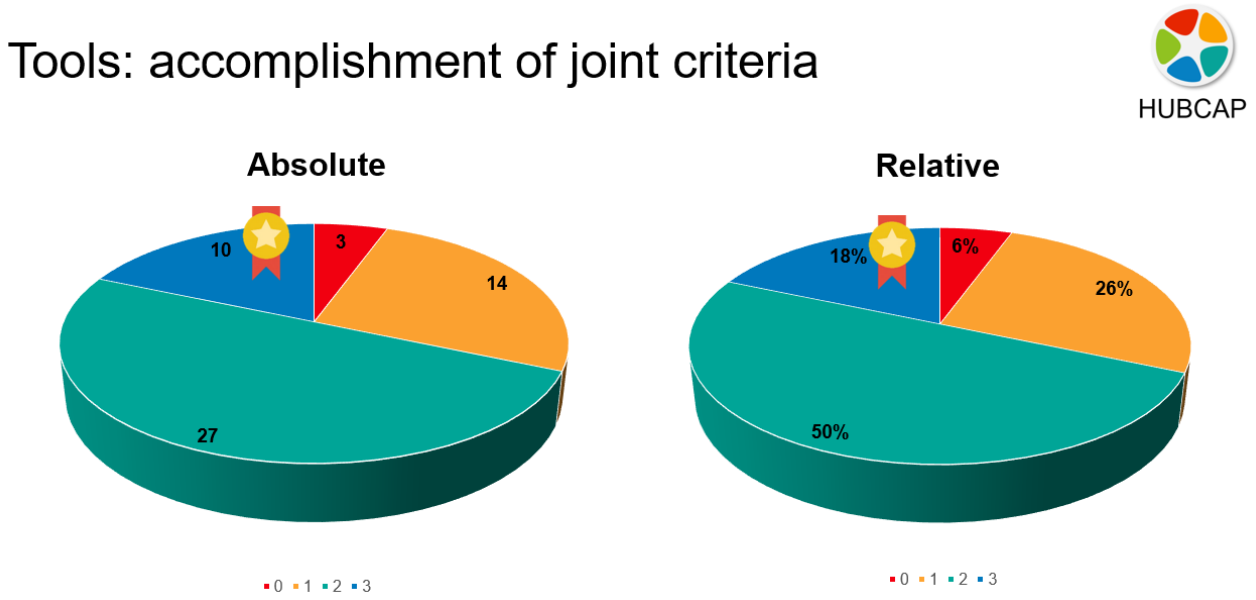


Figure 13: Number and percentage of tools with an assigned badge out of the total.
Red (0): corresponds to the tools that did not accomplish any of the 3 criteria established to get the quality badge. 3 tools (6%) of the total checked tools (in the first and second round) did not fulfill any of the 3 criteria.
Yellow (1): corresponds to the tools that accomplished just 1 out of the 3 criteria established to get the quality badge. 14 tools (26%) of the total checked tools (in the first and second round) fulfilled only 1 out of the 3 criteria.
Green (2): corresponds to the tools that accomplished 2 out of the 3 criteria established to get the quality badge. 27 models (50%) of the total checked tools (in the first and second round) fulfilled 2 out of the 3 criteria.
Blue (3): corresponds to the tools that accomplished all of the 3 criteria established to get the quality badge. 10 tools (18%) of the total checked tools (in the first and second round) fulfilled all the 3 criteria.

5. Summary

This document reports on the deliverable D6.6, which consists of the fifth version of contents that populate the models and tools catalogue on the HUBCAP platform. These contents count now more than 160 assets among models and tools. In this document we focused on the enhancement of the platform with guidelines to lower the barrier for new adopters of MBD, on the activities to improve the contents' quality, and on the support given to the users of the platform. This is an update of deliverable D6.5 [1], reporting on the final status of this task.

References

[1] D6.5 Fourth Version of HUBCAP Contents.