WP2 – ICT Platform Requirements and KPIs Definitions

D2.3 SPHERE user scenarios and specific requirements for renovation

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DISCLAIMER

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Project	
Project Acronym	SPHERE
Project Title	Service Platform to Host and SharE REsidential data
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Call identifier	H2020-NMBP-EEB-2018
Topic identifier	LC-EEB-06-2018-20 ICT enabled, sustainable and affordable residential building construction, design to end of life (IA 50%)
Funding Scheme	Research and Innovation Action
Project duration	48 months (From November 1st, 2018)
Coordinator	IDP – Eduard Loscos / Mikel Borràs
Website	http://sphere-project.eu/
Deliverable	
Deliverable No.	2.3
Deliverable title	SPHERE user scenarios and specific requirements for renovation
Description	This task will identify the specification of the use cases and relevant digital twin service requirements based on the previous tasks' findings. The task will carry out the role of bridging the renovation market needs, drivers and the digital twin functionality definition as an enabler to serve the demand. ***Subtask 2.3.1 Development of the SPHERE Use Cases (EKO)****:* The detailed use cases will be identified based on Integrated Design and Delivery Services (IDDS) framework findings. Unified Modelling Language (UML) methodologies will be used in the task for a normalised specification of needs. Additional technical definitions with sequence diagrams will be identified. Relevant workflows of the user types and the identification of best interaction and communication methods with them will be identified. Needs for monitoring and reporting services including the virtual tools and mobile communication needs via mobile apps, augmented reality presentations and novel visualisation functionalities will be identified.

	Subtask 2.3.2 Detailed SPHERE Platform Requirements Definition (EKO)**:* Identification of the complete platform needs for the platform will be made (ICT tools, Digital Twin, IoT, IDDs, building methods, value chain performance procurement, data retrieving, social acceptance). The detailed functionalities of the identified user scenarios and the use cases will be made. The task will also focus on the interoperability of the various services of the platform, with a core focus on the user experience (UX) design. The enhancing user satisfaction with the SPHERE platform will provide the usability, accessibility, and efficiency in the user interaction among the various components of the SPHERE platform, acting as a united single service environment. UX mock ups for the user scenarios will be generated and tested among relevant stakeholders to deliver a satisfactory environment. ***Subtask 2.3.3 Delivery of the Agile Software Requirement Management Tool (EKO): This sub task will deliver the agile development methodology and the quality assurance framework for the substantially software service oriented SPHERE project. The methodology for the component development, integration and quality assurance (QA) will be identified. A cloud based project requirement management and result delivery tool (e.g. Atlassian Jira etc.) will be delivered. The requirements will be uploaded and managed throughout the project lifecycle via the platform. The Quality Assurance methodology and relevant actors of the project with their respective responsibilities will be identified. Identification of the development progress monitoring and agile performance KPIs will be made. The software QA will serve throughout the project as the validation tool for ensuring a close to market and efficient digital twin solution service. The deliverables of this task include the Report on the SPHERE Use cases definitions and software requirement specifications and the requirement and development management tool, hosting the whole set of the requirements and the tools for quality assurance.
WP No.	WP 2
Related tasks	Inputs from T2.1, T2.2 Outputs to T3.1, T3.2, T3.4, T3.5, WP3, WP4, T6.1
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Table of Contents

List of Figures

List of Tables

1. Executive Summary

The SPHERE's projects overarching goal is to advance digital tools to build new and improve existing buildings' across their entire life-cycle. Better energy design improved and reduced construction cost, better operational performance, and ease of management, and better overall energy performance fit with a low carbon future. The novelty of SPHERE project is the demonstration and validation of one of the world's first Building Digital Twin platform's with cross-cutting tools for architects, engineers, construction managers, and building facility managers, naming a few, working with both real new building and retrofitting construction cases.

SPHERE as a special innovation project assembles and integrates different information streams needed to make these improvements happen, and bring together close to 20 existing software technologies, advancing them from laboratory or small pilots to large scale demonstrations, on the way for real use by companies. Another socio-technical innovation that SPHERE tries to accomplish is to bring as many actors in the life cycle of a building together through the Digital Twin approach, so they increase collaboration and create co-benefits. For example, for building facility managers to bring relevant operational energy use insights to building designers for making buildings use less energy. Done by advancing the idea of a fully systematic, collaborative and integrated framework for setting up and managing a building construction or renovation projects called Integrated Design and Delivery Services (IDDS).

The purpose of this report is to help SPHERE software tool and platform developers in the project to better understand the needs of potential users of the platform, by defining how the work can be improved of people working in the Architecture Engineering Construction Owner & Operation sector (AECOO). The report also creates a coherent overview of the different software components to be delivered within SPHERE, what these components are supposed to do for different professions in AECOO in terms of outputs, information flows, and features, and how all the software's to be brought together within the SPHERE Digital Twin platform fit together. The work also helps the demonstration works on real buildings to be carried out in Austria, Italy, Finland and the Netherlands in the project, by creating the start of a roadmap for what benefits the demonstration companies in the project can expect in their active design, construction and facility management from the SPHERE platform.

The works in this report will be carried forward to establish the technical architecture of the SPHERE platform. It will help to make key decisions, including what needs to be improved within the existing software tools to be advanced to fit with the AECOO user requirements, what additional functionalities will need to be developed in the architecture for the SPHERE platform to fit with the demonstration companies needs. It also helps by providing the groundwork for defining the data architecture of the platform, by having compiled a large number of needed information flows, and by starting to define specific features that components in the platform will need to have. And finally, it provides the basis for implementing an IDDS guideline sub-module, that will guide the implementation of IDDS as a collaborative practice across the building life cycle. As such, the report provides a compass for future development, in the form of a critical overview of the integrated capabilities of the platform for further development

The deliverable is targeted primarily to the SPHERE consortium of 19 partners in moving forward with delivering the SPHERE platform and its functionalities and features. It is also helpful for companies and other projects consortium who are on their way to deliver similar or complementary platforms for the Architecture Engineering Construction Owner & Operation sector (AECOO), so as to learn and compare new ideas about delivery integrated Digital Twin platforms for buildings.

2. Introduction

2.1 Purpose and Target Group

The works carried out in this report serve to define at an intermediate level what the services are that the SPHERE platform and related tools should provide, and what features these services should have for particular user types in the life cycle of a renovation or new-build project. Resulting in an Identification of the complete platform needs for the platform. The works serves 9 different purposes based on the project Description of the Action (DoA) related to sections in this report (also see Figure 1 below):

1. Description of specific modules and sub-modules in the SPHERE platform that are to be grouped in **Chapter 4** that provide for specific functionalities, including their linkage to particular tools (briefly described in section 3.2 and with details in Appendix A).
2. Description for specific sub-modules that provide for monitoring and reporting services in **Chapter 4** under the platform, including identification of the format provided (such as the virtual tools, mobile apps, augmented reality presentations and novel visualisation).
3. Specification of user stories and related use cases based on the pilot workflows in relation to AECO sector roles as users, provided in **Chapter 5** at user story level.
4. Delivery of a summary of the SPHERE modules and sub-modules in relation to the descriptions and inputs and outputs described in **Chapter 6.**
5. Detailed functionalities are provided for the use case as features for each sub-module of the platform, identified in **Appendix B**.
6. Delivery of Digital Twin service requirements by development of what activities would be carried out by new DT specific roles (Digital Twin Manager, Digital Twin Configuration Manager, and Digital Twin Simulation Manager), **Chapter 7 section 7.4**
7. Identification of the information flows for the user stories for each pilot, as a set of sequenced identification that provides for communication methods for users to provide interaction. These are listed as a series of inputs and outputs in the swim-lane diagrams in **Chapter 7** for each pilot and the DT service delivery.
8. A small set of initial user interface mock-ups is generated and shown in **Chapter 8** that provides for first ideas of how a user would traverse through the platform in a scenario driven manner taking into account interoperability and relationships between tools.
9. The agile development methodology connected to the cloud based XWIKI platform is described in the methodology **chapter 9**, that is further detailed in Deliverable 2.4 including the quality assurance framework for software development under SPHERE.

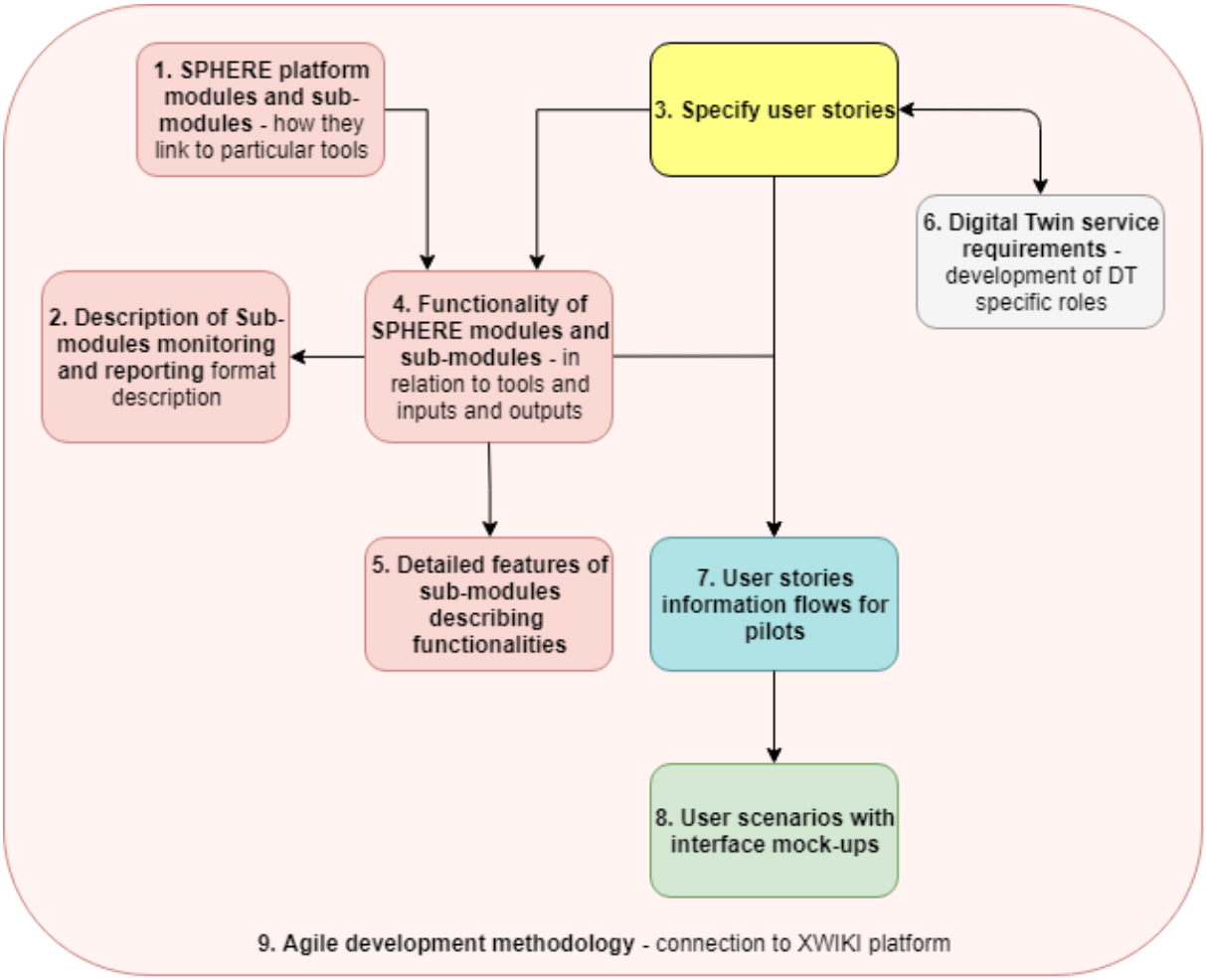


Figure 1. Overview of purposes of the Report as defined in DoA

2.2 Target Group of The Deliverable

The target group of the report is primarily the Sphere consortium of 19 partners, to inform the requirements and development of the SPHERE platform. The deliverable provides a critical overview of the integrated capabilities of the platform for further development. Other target groups that are relevant are those that can provide further feedback on the requirements of the SPHERE platform to enrich the delivery of works in this deliverable. Such target groups as identified in the communication and dissemination strategy include primarily AECOO practitioners that would form potential users of the SPHERE platform across the different life cycle phases, including architects, civil engineers, MEP engineers, construction managers, construction sub-contractors, facility managers, and building owners, among others.

2.3 Contributions of Partners

Table 1. Partner responsibilities in Task 2.3

Tasks carried out	Chapter	Involved Partner(s)
Writing of Introduction	2	EKO
Development of methodologies	3	EKO
Writing of Methodologies	3	EKO

Delivery of SPHERE Modules and Sub-Modules	4	EKO, review by all (EUT, BASF, R2M, NUIG, TNO, ASC, COMSA, VRM, EAI, VTT, CAV, DE5, CREE, NEX, OPY, IDP)
Mapping of SPHERE Pilots and Tool User Stories	5	EKO, EUT, BASF, R2M, NUIG, TNO, ASC, COMSA, VRM, EAI, VTT, CAV, DE5, CREE, NEX, OPY, IDP, VRM
Delivery of SPHERE Functionalities in activity BPMN diagrams	6	NEX, EKO, TNO, CAV, CREE, DE5
Writing of SPHERE Agile Platform and QA Requirements	6	EKO
Setup of User Interface and User Experience Scenario Method	7	EKO
Delivery of Agile Development Methodology	8	EKO
Writing of Conclusions	9	EKO
Writing of Acronyms		COMSA
Delivery of Appendix A information	App. A	EKO. NEX, DE5, CREE, CAV/VTT, TNO
Delivery of Appendix B information	App. B	EKO, EUT, BASF, R2M, NUIG, TNO, ASC, COMSA, VRM, EAI, VTT, CAV, DE5, CREE, NEX, OPY, IDP, VRM
Delivery of Appendix C information	App. C	EKO, EUT, BASF, R2M, NUIG, TNO, ASC, COMSA, VRM, EAI,VTT

2.4 Baseline

The deliverable is mainly based on the inputs from the project to present, primarily the project proposal and the related DoA to evaluate the required outputs of the platform in the initial scoping, and the works carried out under Deliverable 2.1 that provides for a high-level overview of the required challenges and barriers in the construction sector to be solved by the platform. Both were utilised to integrate what functionalities would be needed to address these initial descriptions and needs as elicited.

2.5 Relations to Other Activities

Figure 2. Relation to other Tasks in SPHERE DoA

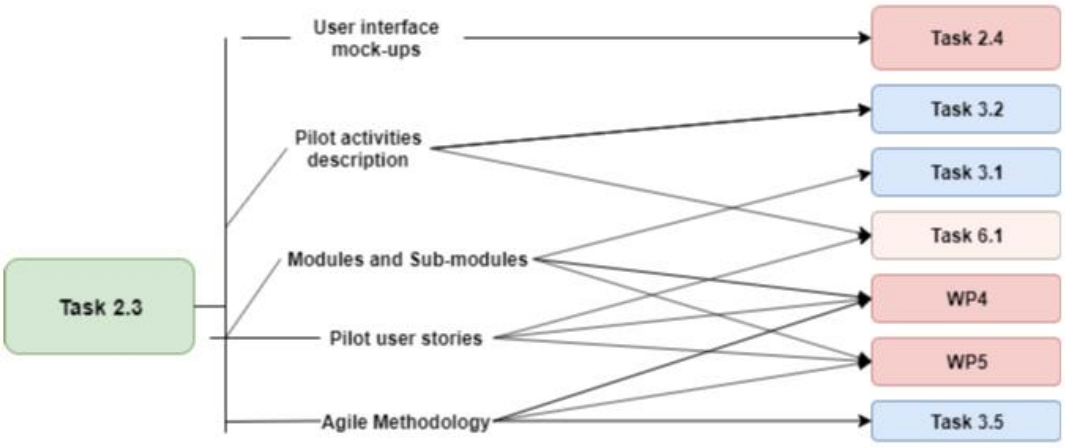


Table 2. Relationship between results sections in D2.3 and follow-up tasks in the SPHERE project

Deliverable 2.3 Result	Sections	Follow-up task
Identification of SPHERE Platform Software Modules and Sub-modules and related technology tools from partners	Chapter 4	WP3.1 to provide inputs in the technical requirements for the SPHERE PaaS following the sub-module breakdown, and sets of functionalities. WP4 and WP5 to help with placement of technologies within SPHERE context
Assessment of user stories that identify the needs for different stakeholders in the building life cycle within each SPHERE pilot for forming a pilot scenario	Chapter 5	T6.1 start for setting up scenario of activities for demo site piloting from a 'library' of activities WP4, WP5, technology tool providers knowledge for integrating services within SPHERE piloting activities
Description of series of activities for each pilot and the Digital Twin integration that form functionality requirements that the SPHERE platform should deliver with information flow inputs and outputs	Chapter 6	T6.1 start for setting up scenario of activities for demo site piloting in a sequenced manner from a managerial perspective. WP3.2 Start of setting up the data management architecture for the SPHERE DT based on defined information flows.
Approach for the user interface delivery of the SPHERE platform with a user scenario based wrapper interface that integrates different tool interfaces within the platform.	Chapter 7	T2.4. for advancement of interface works based on integration with user centred design
Description of the Agile methodology for the delivery of the SPHERE platform during the project	Chapter 8	T3.5, WP4, WP5 Setup of methodology for the implementation and sprint works to be carried out within the SPHERE project
Conclusions and recommendations for future works in the project and learnings to take on board	Chapter 9	WP3, WP4, WP5 conclusions for specific activities and strengthening of the work-packages
Module and sub-module sheets that provide quick referencing for initial feature sets for software development setup	Appendix A	T3.1, T3.2, T3.4, WP4, WP5, identification of features for establishing technical requirements and implementation works for the SPHERE platform
Additional features for each sub-modules that were defined from the pilot aspect, with cross-checking for SPHERE software tool features, for cross-checking and evaluaton in the technical platform definitions	Appendix B	
Sheets that outline for each SPHERE technology tool the background capabilities to set a baseline common understanding of capabilities	Appendix C	WP3, WP4, WP5, reference information for partners to come to a consistent set of additional foreground developments of tools with their integration in the SPHERE platform

3. Methodological Process

The works carried out in the deliverable served to provide a structural overview of the SPHERE platform in terms of potential sets of components (Modules and Sub-Modules) (section 3.1) and their relationship to the partner software tools (section 3.2) that are linked in terms of functionalities as describer (section 3.3). For each tool in relation to the SPHERE piloting activity a series of user stories were developed in the task (sections 3.4, 3.5, 3.6, 3.7). Together these inform the setup of different feature needs for the SPHERE platform (3.6) and related piloting functional requirements (3.8). Based on the roles relates to the user stories user scenarios can be defined (section 3.10), and a final set of Digital Twin Functional Requirements emerges (section 3.9) also defined per pilot.

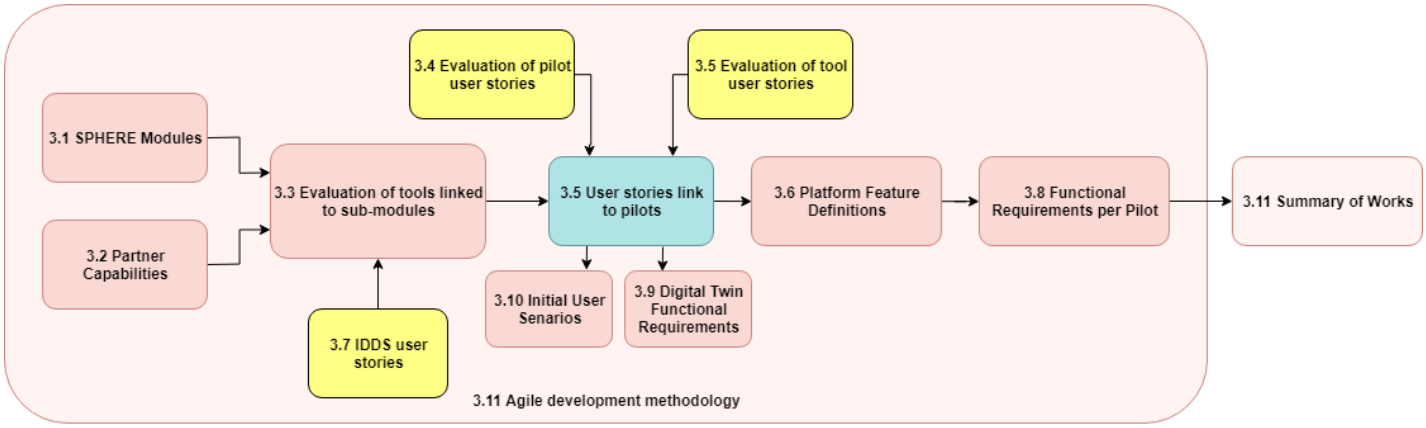


Figure 3. Overview of Methodological process to deliver the functionalities description for the SPHERE platform

3.1 Description of the SPHERE Platform Modules

The first step to provide for the requirements description of the platform was to create a listing from the project proposal of potential software components using a software engineering approach. These describe different potential functionalities that the software should perform as determined in WP2 and carried on to WP3 for refinement. To this end five main initiatives that are an umbrella of collections of functionalities for the platform were defined for the architecture:

- **Initiative 1: Horizontal Platform functions**, those functionalities needed regardless of the usage of the platform, such as user management, process workflow management, data management authorisation, and libraries.
- **Initiative 2: Brief and Target Setting,** functionalities used in the brief and target setting for the renovation or newbuild project.
- **Initiative 3: Design and Assessment Support,** functionalities used in the conceptual design and technical design phases for the renovation or newbuild project, including energy modelling and simulation and sustainability assessment
- **Initiative 4: Construction/Renovation Process management,** functionalities used in construction or renovation phase of the renovation or newbuild project, including Digital Twin blockchain services, construction operation management and document management, and the handover and commissioning.

- **Initiative 5: Use and operation support,** functionalities used in operational phase of the building including facility management, energy management and performance monitoring, and financial monitoring and accounting.

Each Initiative was subsequently split into modules and sub-modules for specific functions. The process was carried out by screening the project proposal and all listed aspects therein that would be integrated under the SPHERE project, refined in discussions in the work-package teleconferences. The evaluation resulted in a total of 18 modules and 55 sub-modules defined that are proposed for the SPHERE platform development, as listed in Appendix A and utilized in Chapters 4 and 5.

3.2 Definition of Existing Background Capabilities of Partners

The SPHERE platform will be composed of a combination of both new capabilities that will be developed, and existing software tools of partners in the consortium that will be integrated. The requirements analysis of the platform includes an understanding of what these tools can provide for, based on the existing state of these tools and an early overview of foreseen enhancement. To this end all tool providers were asked to provide a description of their tool in a standardised evaluation sheet, that was developed in agreement with WP4 and WP5 work-package leaders. The filled-in sheet can be found in Appendix C, and a summary of each tool and their acronym, as used in the report chapter 4 and 5 can be found in Table 3 below.

Table 3. A summary of the tools that will be integrated in the SPHERE platform

Acronym	Tool name	Brief description	Tool provider
iESD_E	Intelligent Energy Designer	Intelligent Energy System Design - tool to evaluate retrofitting energy use impacts for both passive and active building parts.	Eurecat
iESD_W	Intelligent Water Designer	The tool will provide a recommendation of the most suitable grey water treatment technology to be used, both from an economical and environmental point of view, as well as the water availability and requirements for a given building	Eurecat
iPREDICT	Predictive Maintenance Tool	A predictive maintenance module based on AI and machine learning which enables to minimize downtimes due to unexpected breakdowns and reduce energy waste due to malfunctioning or misuse of equipment. Initially designed for heating and air conditioning and in water heating systems; it can be extended easily to other equipment or building elements subject to data availability, domain knowledge and users interest.	Eurecat
IMAN	IMAN	An issues and maintenance system for existing buildings to flag problems and help with assignment of works. The Computerized Maintenance management System (CMMS) will integrate maintenance orders triggered by predictive algorithms.	COMSA
HTM	Human Thermal Model	Demand-based and individual controlled methodology of thermal environments.	VTT
EPESUS	EPESUS	A life Cycle Assessment (LCA) software with a map-based interface that is used for material footprint and environmental assessments.	EKO

CMT	Concrete Management Tool	Tool for retrofit and strength existing buildings, using composites (Externally Bonded CFRP Systems). Easy friendly used charts as a guide selector.	BASF
OPT	On-line Planning Tool	Linked as an external online tool OPT helps to overcome information overload issues by offering an efficient way to manage the project specifications. Additionally, incorporated BIM objects libraries and pricing information (upon request) enable construction professionals to complete project task in a shorter time.	BASF
FRCT	Fiber Reinforced Concrete Tool	Tool for designing Fiber Reinforced Concrete (FRC) precast panels and assess geometric and physical elements with BIM Object information output.	BASF
LCCCA	Life Cycle Cost Concrete Assessment	Spreadsheet Life Cycle Costing Tool for concrete that allows to compare repair and coating solutions for concrete on the basis of Life Cycle Costs (LCC), to provide a solid economic foundation to select the best repair/coating solution for an specific situation in a building	BASF
En-MS	Energy Management System	Tool including energy audit workflows, providing a energy planning process, objectives & targets that can be tracked, and supporting the Energy Review identifying the energy sources and related significant energy uses together with estimation of possible improvement opportunities.	R2M
ECOSIMPRO	ECOSIMPRO	Modelling and simulation tool for modeling 0D or 1D multidisciplinary continuous-discrete systems and any kind of system based on differential-algebraic equations (DAE) and discrete events.	EAI
Refurbify	Refurbify	A cloud-based platform enabling owners and suppliers to manage refurbishments, repairs and maintenance. Refurbify brings together documents, permissions, and tasks to improve quality of work, timelines, and compliance using a digital audit process. It streamlines interactions between large housing stockowners, their residents and suppliers enabling seamless collaboration in the cloud.	VRM
Clarity	Clarity	Using innovative 3D management dashboards, CLARITY integrates data from existing in-house sources as well as BMS, AMR, and IoT sensors to provide real-time data to monitor and improve the efficiency of networks.	VRM
VCMP	VCMP	A cloud-based platform enabling owners and suppliers to manage construction works. VCMP brings together specific documents, permissions, and tasks to improve quality of work, timelines, and compliance using a digital audit process. It streamlines interactions between large contractors, subcontractors and, their all off-site and on-site construction workers enabling seamless collaboration in the cloud.	VRM
ModSCO	ModSCO	ModSCO is the acronym for Model-Supported Control. This is a web application currently in development within the IRUSE group at NUIG. ModSCO uses Reduced Order Grey Box Models (ROM) developed with the MODELICA ® language. It offers standardized Performance Assessment Methods in order to analyse and optimize building	NUIG

		performances by: applying control settings, testing envelope retrofit packages and evaluating the savings by using a novel IPMVP method.	
RobMOS	RobMOS	Micro-services that can carry out dedicated energy temperature and indoor env. Quality evaluation based on a reduced order model of the building spaces, and compares it with historic data for reducing uncertainty due to variability (such as due to occupancy).	TNO
FLINK2GO	FLINK2GO	B2B product bringing paperless solutions to the construction site for process management focusing on detecting and correcting construction defects.	ASC

3.3 Evaluation of Tools Linkage to Sub-modules

The 11 tool providers and their 18 software tools in the project will need to be able to provide for substantial additional services for the piloting of works in the project. A large amount of capabilities already exists that will be integrated in the SPHERE Digital Twin Building Platform, and some capabilities will need to be further developed. To evaluate how these will be linked into the SPHERE platform a mapping took place, where each of the sub-modules was mapped to the existing background software tools in the project where applicable, of which the results are provided in Table 5 in Chapter 4. This allows for a cleaner development and understanding of what existing functionalities exist in existing software's that are furthered in WP4 and WP5, and what new sub-modules will need to be developed under WP3. The sub-modules are subsequently used to relate them to the user stories and use cases for the SPHERE platform to identify what different users would potentially get out of the platform, and in what steps in their interaction with the platform.

3.4 Evaluation of Pilot User Stories From Workflows

In the works for deliverable 2.1 a series of workflows were developed for the two building renovation cases (Finland CAV and Italy DE5), and the two new build pilot cases (the Netherlands TNO and Austria CREE). These contained the stage-by-stage processes during the pilot from initial brief to design to renovate/construction to handover and in use of the buildings. Typically containing between 30 to 50 process steps across these stages, specified by sequence of occurrence and by the main role who instigates or carries out the process (including building owners' designers, construction managers, handover team, facility manager among others).

The workflows were further advanced with the pilot companies/organisations in the project (DE5, CAV, CREE, TNO) in workshops under guidance of EKO (for DE5, CREE and TNO) and VTT (for CAV), so as to improve the workflows themselves, and integrate how the SPHERE platform would potentially be used. To this end two approaches were utilised from software development practices. For each process step a user story was developed that highlighted how in each step the main user would carry out an action under a particular sub-module of the SPHERE platform (as described in section 3.1). The following format was used to this end:

"As a (user) I want to carry out (actions X, Y, Z) so as to accomplish (result A, B, C.)"

The user story sentence provides for a high-level understanding of the required functionality of the platform. The total combined listing of user stories from the pilots provides for the first step towards a blueprint of expected services to be provided for the piloting activities in the project.

3.5 Delivery of Tool User Stories and Linkage to Pilot User Stories

In parallel to the user stories defined from the four pilots in the SPHERE project, each of the tool providers was asked to evaluate the user stories for their tool. The analysis was requested so as to map tool specific functionalities that could be provided to particular users in a systematic manner. The process was carried out based on a standardised template as shown in Figure 4 that was generated in PowerPoint. The approach was to ask each tool provider in which particular life cycle phase of a newbuild project and/or a renovation project the tool would be used, by what type of stakeholder/user in the project, and so as to accomplish what type of result. As such a uniform set of user stories was established that can be taken forward to identify the technical requirements to implement these expected functions.

Figure 4. Template used to ask tool providers for user stories inputs

[TOOL] - User Stories #1

User type No.	As a [Role] I want to:	As a [Role] I want to:	As a [Role] I want to:	As a [Role] I want to:	As a [Role] I want to:
Strategic definition					
Preparation and brief					
Concept design					
Developed & technical design					

After the tool user stories were created a cross-mapping took place, where based on the pilot user stories it was checked which tool could provide for the pilot user story functionality. As such the expected tool functionalities are directly linked to the pilot functionalities, and also pilot functionalities not provided by the software tools of the partners become apparent. The cross-check mapping is delivered in Chapter 5 in a series of pilot specific tables.

3.6 SPHERE Platform Features Definitions

To develop specific feature requirements for the platform the pilot companies (DE5, CAV, CREE) together with EKO and VTT held discussion in several teleconference workshops. The purpose was under each user story to identify the specific features the pilots would like to have, so as to enable the desired capabilities under the user story. As such a mapping emerges from the sub-modules that are required for each user story and the specific needs from that sub-module in terms of functionalities.

In parallel tool providers were asked to define the features for each sub-module, also based on their existing knowledge from existing background, and expertise in particular new-build and renovation processes across the life cycle. The listing of about 5 to 10 features for each sub-module provides for

a basis of starting the technical research and innovation implementation roadmap to deliver these capabilities that can be undertaken in WP3, WP4 and WP5.

Both sets of features are listed in Appendix B in a structured way for each of the sub-modules where the features are listed in a parallel manner, as shown in Figure 5 below. The parallel listing allows for crosschecking the interpretation of the sub-module, and to create a holistic overview of what should be accomplishable with the sub-module by the user. After the table was made all tool users were asked to crosscheck the features and refine them. The lists of features will require further discussion during the implementation stages to further align and provide for the technical implementation and delivery pathway under WP3.

Figure 5. Example of Features listing for a sub-module in the SPHERE platform.

I1.M3: Common Data Environment/Management Module

Coding	Name	Feature from pilots	Features from software tool providers
I1.M3.SM1 NEX	Data/Document Management		F1. Add files
			F2. Download files
		P12. Management to the data/documents used for the selection of candidates,access to previous documentation during tendering (Ita US20, US21,	F3. Manage document versions
		P13. Management the previous BIM data and reports (design reports, LCA,LCC),access to previous documentation (Ita US22)	
		P14. Construction companies participating in the tender able to manage the previous documentation during tendering (Ita US23)	
			F4. Organize relation between documents and assets
			F5. Create relations between documents and assets
			F6. Manage sharing of documents or specific version of a document
		P1. Data/document utilised by brief and target setting (Aus US1, US2, US3; Ita US1, US2)	
		P2 access to strategic definition and survey needs data (Aus US3; Ita US2)	
		P3 Access previous findings (Aus US4, US5, US23, US27, US28, US29; Ita US3, US5, US9, US26, US27, US28)	

After both sets of features were defined a crosschecking e second step was to define the required features and interlinked

3.7 Analysis of the IDDS Methodology and Practices

In deliverable 2.1 of the SPHERE project a definition of the Integrated Design and Delivery Service was provided, including an synthesis of collaborative practices that define an IDDS project. The eight definitions were captured as follows:

1. Align values in a kick-off meeting that are carried out throughout the project
2. Setup performance-based goals with all parties involved with a shared responsibility
3. Select a joint business model and contract structure with shared risk
4. Establish a shared project roadmap with collaborative group updating meetings
5. Establish open communication channels and practices across involved partners
6. Methodological discovery and implementation to reach the team goals
7. Sustaining the collaboration through an experienced facilitator
8. Construction and operation considerations to optimize results and ensure objectives

To continue the integration of IDDS into the SPHERE platform a series of specific IDDS user stories were developed. These were linked to sub-modules in the SPHERE platform, and specific features to enable IDDS were elaborated upon for these sub-modules. The integration allows for setting up a

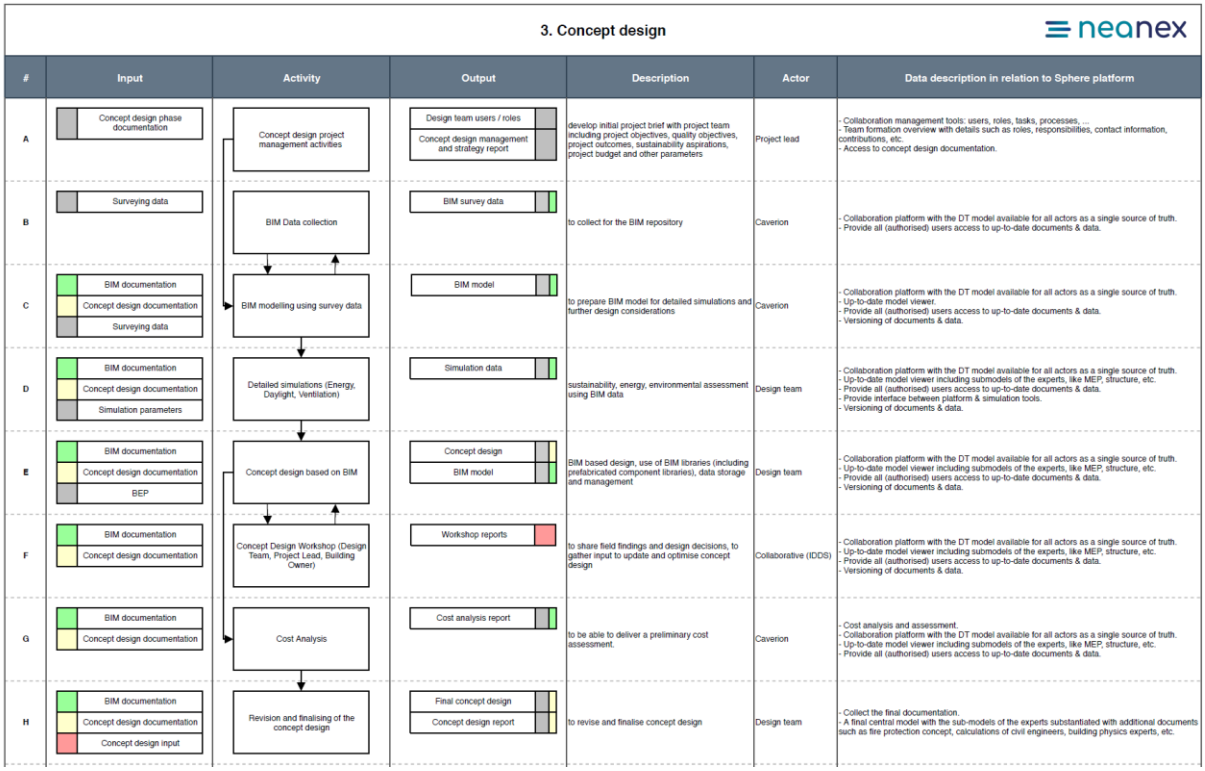
The second step was to define the required features and interlinked

3.8 Development of Functional Requirements Per Pilot

The delivered user stories and features described by three pilot partners (DE5, CAV, CREE) for Austria, Italy and Finland, were utilised to create a concise overview of the sequence of activities in these pilots based on the platforms. Insufficient information was made available by the Dutch pilot (TNO) at this stage of the project due to pilot consolidation challenges to create such swim-lanes, and these will be delivered at later stages.

The swim-lane diagrams developed by Neanex give an overview of each phase of the life-cycle of the activities to be carried out, the main responsible in terms of role for the activities, the input to output flow in terms of documents, data or delivered results, the related tools for the activity, and the related sub-modules for each activity. An example is provided in Figure X below. The visual diagram gives a clear overview for both the pilot partners of the steps that will be followed in their piloting, and for the tool providers in terms of the linked functionalities that will be expected and need to be developed at a high-level. The swim-lane diagrams are summarised in Chapter 7 of the report for each of the three pilots.

Figure 6. Example of a Pilot Swim-lane Diagram.



3.9 Development of Specific Digital Twin Functional Requirements

In addition to the pilot driven works a series of user stories was developed that identified specific needs for implementing Digital Twins of buildings. The collective knowledge of Digital Twins developed to present was integrated centring around three new anticipated roles for the implementation of Digital Twins as summarised in Table 4 below.

Table 4. Initial definition of new Digital Twin related roles and responsibilities under SPHERE

Role	Responsibilities
Digital Twin Manager	Digital Twin Requisites settings and ICT framework design; Develop a Monitoring Strategy; Develop a Recording Strategy; Develop a Digital Twin Integrity Strategy; Setup a data analysis strategy; Supervision of Information Security management (ISO/IEC 27000); Supervision of Digital Twin Configuration Management (ISO/IEC 12207); Supervision of Digital Twin Simulation Management.
Digital Twin Configuration Manager	Identification and Management of roles and permits through Configuration Items (CIs); Establishment of Configuration Baselines and Configuration status availability; Set Configuration Audits and their uptake; Templating System that can be used to facilitate setting up configuration files and services; Extensibility to share custom extensions from the different agents involved; Identify potential deviations in Updating Costs beyond automations that include time, experience and training; DT system or information releases and deliveries are controlled and approved
Digital Twin Simulation Manager	Identify simulation strategy according to the received project and the actors involved across the lifespan of the asset, from design and construction to operation phases; Participate with the BDTManager and representative Stakeholders (Employer, BIM Manager, etc.); Identify / enhance synergies derived from collaboration between different applications and promote collaboration between them; Set simulation objectives based on the Exchange Information Requirements.

The activities are delivered in a similar swim-lane manner in Chapter 7 section 7.4 so as to provide for a comprehensive overview of what new activities would need to be deployed under these roles to form a Digital Twin. The aim in the project is to test these new roles and their responsibilities in all the pilots, so as to provide for a first real-life testing of the procedures needed to setup, deliver and maintain a Digital Twin of a building.

3.10 Delivery of Initial User Scenarios and Interface Mock-ups

The SPHERE platform will be based on its diverse number of potential users and diverse set of tools and functionalities brought together, require structured setup in terms of scenario driven user interfaces and related user experiences. For each user type a different entry point and usage to the platform could exist. The different user stories provide for the baseline of such scenarios in terms of the different aspects a user would carry out, based on which an initial structure of required user interfaces can be provided. The scenario driven work was developed and is summarised in chapter 8 based on summarising the linked user stories to a particular user and developing initial archetype user interfaces that link to a particular set of sub-modules in the platform. The set of scenarios and user interface and user experience requirements with first feedbacks will be further developed in Task 2.4

3.11 Agile Software Development and Management

The identified platform sub-modules and provided user stories, use cases and swim-lanes provide for a working basis to further the platform development under WP3, WP4, and WP5. To support the works to be carried out in these work-packages an agile software development approach is proposed that is summarised in Chapter 9. The approach includes a suggested further break-down of sub-modules and related features into further detail, in relation to the requires user functionalities based on the user stories and use cases. It also suggests a break-down based on a sprint and agile scrum based methodology that is becoming common practice in software development, as highlighted in Chapter 9.

In parallel to the methodological description and works in this report, an open accessible collaborative platform was launched (XWIKI) for the SPHERE project that contains the contents of this report. The XWIKI tool will be used to consolidate the knowledge generate to present SPHERE project that can be updated in an agile manner and enhanced as the project progresses. It can also be used to identify and map specific sprints, as needed using the agile methodology. Its specific use and updating procedures are described in Deliverable 2.4 that also provides an overview of the information captured to present in the platform. The SPHERE XWIKI is available only to members of the consortium given the development nature of the knowledge therein.

3.12 Summary of Works to Deliver Functional Requirements

The combination of the developed content in terms of sub-modules, user stories, feature based use cases, and summary swim-lanes is synthesized in Chapter 10 of the report. The chapter summaries the achievements made in this report and how they can be utilised in the development of the SPHERE platform. How these should be taken up in continued developments of further tasks in the SPHERE platform, as also identified in section 2.5, and what lessons were learnt from the process of the works under this deliverable. Of particular relevance is the Agile software development methodology as highlighted earlier in Chapter 9.

4 SPHERE Functionality Requirements

The project consortium carried out a mapping of the functionalities to be provided by the platform divided into different platform building blocks. To this end a software engineering structure was adopted that divides the platform into initiatives, modules and sub-modules to create a hierarchical structure that clusters different functionalities. A summary Table 5 is provided that summarises the expected sub-modules of the platform for horizontal needs like user management, data and document storage, and specific needs such as energy assessments or operational contractual requirements checking for energy performance contracts. The table also includes identification of the software tools by different partners in the project that will be linked into a sub-modules. Finally, a summary is provided of the number of user stories that were identified by the pilot were use is made of a particular sub-module. This shows that the Austrian and Italian pilot by CREE and DE5 will integrate detailed pilots in terms of usage of the full spectrum of the SPHERE platform, whilst the Finnish and Netherlands pilots will utilise a small sub-set of capabilities of the platform.

Table 5. Summary of platform modules, sub-modules and generated SPHERE user stories from pilots and software tools

Coding	Name	Description of functionalities	Respective partners	Associated Tools	WP	No pilot user stories linked to sub-module (A – Austria, I – Italy, F- Finland, N - Netherlands)
Horizontal Platform Functions						
I1.M1	**1. User and Network Management Module**					
I1.M1.SM1	1. Identify Users	Registration and access rights assignment of platform users by a platform administrator	VTT, NEX, VRM, ECO, IDP, ASC	Refurbify, FLINK2GO	WP3	6(A)+12(I)+1(F)+ 0(N)
I1.M1.SM2	2. Create Project & Identify Roles	Identify and assignment of user roles in newly created/existing project by a project manager	VTT, NEX, VRM, ECO, IDP, ASC	Refurbify, FLINK2GO	WP3	6(A)+12(I)+0(F)+ 0(N)
I1.M2	**2. Processes and Workflows Management Module**					
I1.M2.SM1	1. Setup and Management of Project Phases and Processes	Outline and set up the activities in a new build/renovation project by selecting project phases and the activities/processes in each phase in a configurable manner	VTT, NEX, VRM, ECO, IDP	OPT, LCCCA, CMT, Refurbify	WP3	2(A)+7(I)+ 0(F)+ 0(N)
I1.M2.SM2	2. Roles and Processes Matching	Identify roles to related processes. Enable skills-based access to job/process types based on roles.	VTT, NEX, VRM, ECO, IDP, ASC	Refurbify, FLINK2GO	WP3	5(A)+13(I)+ 0(F)+ 0(N)

I1.M2.SM3	3. Authorisation	Roles-based notifications related to job progress. Off-site issue management and job approval.	VTT, NEX, VRM, ECO, IDP, ASC	Refurbify, FLINK2GO	WP3	6(A)+14(I)+ 0(F)+ 0(N)
I1.M2.SM4	4. IDDS Guidelines, Roles and Information flows sharing module	Setup and management of Integrated Design and Delivery Services (IDDS) workflows by a series of guidelines and user roles and processes if a project is carried out with an IDDS structure (integrated AECOO teams, information sharing across life cycle, joint-contracting, joint-risk sharing) and bringing together the Digital Twin information flows for supporting IDDS practices.	EKO, OPY, IDP	NEW TOOL	WP3	TBD
I1.M3	**3. Common Data Environment/Management Module**					
I1.M3.SM1	1. Data/Document Management	Secure and organised document input, output and storage. Addition of metadata describing document contents. Management of document access in the CDE.	VTT, NEX, VRM, ECO, IDP	Refurbify	WP3	31(A)+33(I)+3(F)+1(N)
I1.M3.SM2	2. Connectivity to IoT and External Live Sources	The IoT platform will allow the use of a range of sensors that will provide the metrics required by the DT platform to perform a variety of functions. The captured data is used for allowing trends over time analysis and provide the required amount of data for predictive maintenance.	VTT, NEX, VRM, ECO, IDP	Clarity	WP3	1(A)+1(I)+ 0(F)+ 0(N)
I1.M3.SM3	3. Exporting/Allow Access/Deletion of Data and Documents	View data within and outside to third parties to the platform. Select data and document and export via excel, csv, pdf etc. Allow deletion of data and document in compliance with GDPR.	VTT, NEX, VRM, ECO, IDP	Clarity	WP3	14(A)+10(I)+2(F)+ 0(N)
I1.M3.SM4	4. Dynamic Data Visualisation	Utilise live or near-live data and represent the data visually in diagrams and tables for the platform user in a manner, which enhances their understanding, enables actions.	VRM, ASC	Clarity, FLINK2GO	WP3	14(A)+7(I)+2(F)+ 0(N)
I1.M3.SM5	5. Reporting	Parameter and metric based reports generation, configurable for each life cycle phase with related processes and reportable benchmarked, performance and other outputs.	VRM	Clarity	WP3	29(A)+32(I)+1(F)+ 0(N)
I1.M4	**4. BIM and Objects Libraries Module**					
I1.M4.SM1	1.BIM Execution Plan	Enhancement of project process workflow with BIM exchange information requirements and metadata needs in relation to roles and responsibilities as specified in BIM execution plan. Provides a high-level guidance for the setup of a BEP.	IDP	NEW TOOL	WP3	7(A)+11(I)+ 0(F)+1(N)
I1.M4.SM2	2. BIM and Objects Libraries	Digital Twin libraries. Open Software In the Loop BIM object libraries connections with a manual selection option to enrich IFC instances (for example used for indoor environment simulation and analysis.)	IDP, NEX	OPT	WP3	19(A)+14(I)+ 0(F)+ 0(N)
I1.M4.SM3	3.Material Library	Material libraries are collections of materials, from different manufacturers. SPHERE material library allows user to assign materials to BIM objects without browsing for other databases. In addition to physical (density, specific heat, thermal conductivity etc.) and chemical properties (toxicity, chemical stability etc.), cost information will be available in SPHERE material libraries. The availability and the integration of the material library facilitate the creation of Bill of Quantities (BoQ) and simulations.	EKO	OPT	WP3	12(A)+13(I)+ 0(F)+ 0(N)
I1.M4.SM4	4. HVAC Library	Library for the simulation of HVAC systems in EcosimPro simulation platform. It will allow the user to model the HVAC system connecting components from the library with the objective of analysing the system performance.	EAI	EcosimPro, RobMOS	WP3	13(A)+14(I)+ 0(F)+ 0(N)

I1.M4.SM5	5.Thermal and Fluid Component Libraries	Libraries for the simulation of the building in EcosimPro simulation platform. They will allow the user to model the passive elements (walls, windows, etc) of the building and the heat transfer phenomena The module includes also the fluid properties calculation for HVAC library.	EAI	EcosimPro, RobMOS	WP3	11(A)+12(I)+ 0(F)+ 0(N)
I1.M5	**5. Procurement and Contracting Module**					
I1.M5.SM1	1. Tendering Functionalities	Based on the previous reports (brief and strategic definition, early concept design draft, basic cost estimation reports) provide for a search among listed performance ranked service and or component suppliers as a first selection to invite to tender.	VRM, EKO	Refurbify (Potentially)	WP3	6(A)+10(I)+4(F)+3(N)
	Brief and Target Setting					
I2.M1	**Brief and Target Setting Module**					
I2.M1.SM1	1. Brief Definition	Setup of a structured form for defining a brief that results in a brief report. Selection options based on standardised typologies for renovation and newbuild informed by BIM IFC standards. Ability to link documents and other projects information as examples.	EKO	NEW TOOL	WP3	2(A)+1(I)+ 0(F)+ 0(N)
I2.M1.SM2	2. Target Setting & Collaborative Management	Selection of KPIs for the project performance targets in relation to the workflow process, including whole-life costing, durability, lifespan and maintenance environmental sustainability and standards, and energy usage targets. Setting of the KPI goals to be achieved. Ability to track targets collectively by adding information to track targets development.	EKO	NEW TOOL	WP3	13(A)+11(I)+3(F)+2(N)
I2.M1.SM3	3. ESCO Operational & Contractual Responsibilities	Tracking module in which the apartment owners and ESCO detail rights and obligations and can track the responsibilities during the contract term (operational guarantee from client side, guaranteed savings and guaranteed performance from ESCO side, ESCO technical support etc.).	R2M	En-Ms	WP3	0(A)+0(I)+ 0(F)+2(N)
	Design and Assessment Support					
I3.M1	**1.Energy Modelling and Simulation Module**					
I3.M1.SM1	1. Settings and Parameters: Temperature, Indoor Environment Quality Control (Comfort)	Serves to set the occupant operational parameters requirements for different spaces and durations in the building including temperature set points, indoor environment quality needs, and occupancy. Informed by type of building and usage, and when available for existing buildings by historic data.	TNO, EKO	RobMOS HTM	WP4	4(A)+4(I)+ 0(F)+4(N)
I3.M1.SM2	2. Targets and Metrics	Allows for selection of specific energy KPIs/metrics and targets to be achieved in relation to regulatory requirements (U-values, nZEB buildings) differentiated between countries.	TNO, EKO	All energy tools	WP4	4(A)+4(I)+2(F)+4(N)
I3.M1.SM3	3. Heat Load Modelling	Utilisation of building BIM data combined with weather information, semantic heat load information and occupancy values to model the expected heat usage in a new or existing building over time at aggregate level and for each space	TNO, EAI, NUIG	ModSCO, RobMOS, EcosimPro	WP4	4(A)+4(I)+ 0(F)+4(N)
I3.M1.SM4	4. Renovation Energy Assessment	Evaluate the impact of different building envelope renovation (ModSCO) and building envelope and HVAC renovation (EcosimPRo) scenarios on the energy use and indoor environment quality using predictive algorithms, taking into account weather data and	EAI, NUIG	ModSCO, EcosimPro	WP4	4(A)+2(I)+ 0(F)+4(N)

		historic data for calibrations or using physics based models of the building and HVAC (EcosimPro). In the former, the simulation model may include building, HVAC and control, allowing the user to carry out a functional assessment of the system.				
I3.M1.SM5	5. Energy Efficiency and Supply	Calculates and evaluates the energy requirements of the building (heating, cooling, hot water, and lighting) and determine the most efficient energy supply equipment to be installed in the building, based on its demand profiles.	EUT	iESD_E	WP4	4(A)+2(I)+ 0(F)+4(N)
I3.M1.SM6	6. Micro-services for Energy Modelling Calibration and Validation	Provides a calibration service to evaluate from building BIM data and historic energy and/or environmental quality data the forecasted temperature and thermal values.	TNO	RobMOS	WP4	4(A)+4(I)+ 0(F)+4(N)
I3.M1.SM7	7. Human Thermal Model	Provides for a fine-grained estimation of temperature needs in a building for each space based on space data (temperature, air velocity, relative humidity) and occupant specific scenarios (metabolism, clothing insulation) to estimate reasonable operational temperature needs.	VTT	HTM	WP4	4(A)+ 4(I)+ 0(F)+ 0(N)
I3.M2	**2. Sustainability Assessment**					
I3.M2.SM1	1.Material Flow Management	Provides for an evaluation of the material footprint of the building by generation of a Bill of Quantities from a BIM file with additional semantic data, either manually added or based on standardised building typologies.	EKO	EPESUS	WP4	4(A)+3(I)+ 0(F)+ 0(N)
I3.M2.SM2	2.Life Cycle Impact Assessment	Evaluates the environmental impacts of the building for a range of relevant KPIs, by drawing upon the bill of quantities data, with linkages to LEED and BREEAM assessment needs.	EKO	CMT, EPESUS	WP4	4(A)+2(I)+ 0(F)+ 0(N)
I3.M2.SM3	3.Life Cycle Costing Analyses	Evaluates the life cycle costing of the building based on the associated costing data in the BIM file (where available) and/or manually added data for specific building components and processes costing. Includes estimations of the operational costs of building operations and maintenance, to come to full life cycle costs.	EKO	LCCCA, EPESUS	WP4	4(A)+2(I)+ 0(F)+ 0(N)
I3.M2.SM4	4.Circularity Assessment	Evaluates deconstruction scenarios for the building based on the material footprint by evaluating the recyclability and re-usability of different simple components, based on linkage to a deconstruction technology and practice database.	EKO	EPESUS	WP4	4(A)+3(I)+ 0(F)+ 0(N)
I3.M2.SM5	5. Water treatment assessment	Calculate and evaluate the water availability (greywater and rainwater) and water requirements of the building (related to irrigation and toilet discharge) and evaluate which water treatment technology is the most suitable to install in the building according to its climatic condition, use, architectonic characteristics and its requirements (irrigation, toilet discharge). Determine the optimal sizing of the technologies based on the building's conditions.	EUT	iESD_W	WP4	0(A)+0(I)+ 0(F)+ 0(N)
	Construction/Renovation Process Management					
I4.M1	**1.Blockchain Services for the Construction Processes Module**					
I4.M1.SM1	1.Time stamping/ Versioning for Digital Twin Certification	Provides for a set of automated rules to provide for versioning of the Digital Twin (potentially as a blockchain checked unique entry logbook), required for legal purposes	IDP	NEW TOOL	WP3	6(A)+9(I)+ 0(F)+ 0(N)

		of identifying the incoming, storage, and outgoing data at set points based on sets of IoT data (completeness) and enrichment (BIM data additions)				
I4.M1.SM2	3.Subcontracting Management	Allow managed access to the platform by approved sub-contractors. Restricted view of project in line with main contractor's wishes	EUT, VRM	Refurbify	WP3	1(A)+9(I)+ 0(F)+ 0(N)
I4.M2	**2.Construction Operation Management Module**					
I4.M2.SM1	1.Site Role/Task Management	Ensure role and skills are combined to restrict or correctly allocate site based tasks to different involved construction workers and companies.	CREE, ASC, VRM	Refurbify, FLINK2GO	WP5	6(A)+7(I)+1(F)+ 0(N)
I4.M2.SM2	2.Site Surveys and Inspection	Site-based operatives receive and undertake works via application. Desk based operatives approve/reject site issues as appropriate	CREE, ASC	Refurbify, FLINK2GO	WP5	3(A)+7(I)+ 0(F)+2(N)
I4.M2.SM3	3.Clash Detection Solving and Documenting	Links to a clash detection software to evaluate different versions of the BIM files and data entries for delivered supplier components on-site, related to the versioning benchmark and their consistency or differences.	CREE, ASC	External tool integration (TBD)	WP3	2(A)+0(I)+ 0(F)+ 0(N)
I4.M2.SM4	4.Progress Monitoring	Delivers a timeline of the construction process based on the workflow and set of related activities, with a monitoring progress status based on site manual and IoT information inputs	CREE, ASC	Flink2GO	WP3	6(A)+8(I)+2(F)+ 0(N)
I4.M3	**3.Construction Document Management**					
I4.M3.SM1	1.Design-As Built Data Compliance	Provides for a checker that evaluates that the final "As-built" documentation is adequately completed based on a minimum set of data requirements for different BIM versions (3DBIM, 4DBIM etc.) with the semantic data needs, manual data entries, and IoT datasets of the construction process for the Digital Twin.	EKO	TBD – external tool	WP3	4(A)+3(I)+1(F)+2(N)
I4.M3.SM2	2.Improving the Process of Change Management	Define a structured approach to setup collaborative documentation sharing, covering folder structures, secure upload of documents, file meta-data entry, author tracing, and easy retrieval.	NEX, VRM, FLINK2GO	Refurbify	WP3	4(A)+7(I)+ 0(F)+ 0(N)
I4.M4	**4.Regulatory Compliance Module**					
I4.M4.SM1	1. Regulation and Compliance Checks	Coordination of all of the onsite activities required whilst also enforcing the regulatory and compliance requirements that are programmed on the VCMP's regulations datastore	VRM	VCMP	WP3	7(A)+11(I)+ 0(F)+ 0(N)
I4.M5	**5.Comissioning**					
I4.M5.SM1	1. Comparison of Energy Simulation and Real Values	Evaluation of the energy use and temperatures in the building for different spaces during commission under controlled conditions with IoT measurements, with comparison of simulated values during the design and construction phases, including feedback for parameter improvements for future simulations.	EKO, TNO, EAI, VRM	RobMOS, EcosimPro	WP4	1(A)+1(I)+1(F)+1(N)
I4.M6	**6.Handover Management Module**					
I4.M6.SM1	1.Handover Data Management	Coordinate handover through approval or re-works processes. Enable online collaborative handover documentation review.	NEX, VRM	Refurbify	WP5	3(A)+3(I)+1(F)+ 0(N)
	Use and Operation Support					

I5.M1	**1. Facility Management Module**					
I5.M1.SM1	1. Organizing Maintenance Schedules	Time-based or expiry date maintenance documentation needs and works function, that provides based on a scheduling and micro-service event-based updates for maintenance needs.	IDP, EUT, VRM	LCCCA, Refurbify	WP5	2(A)+2(I)+ 0(F)+ 0(N)
I5.M1.SM2	2. Decision Making for Refurbishment	Tool for developing a decision support system for the selection of the construction elements for renovations of the building, from the point of view of passive solutions (e.g. focused on façade, cover, solar protection, etc.), as well as active solutions (e.g.: selection of energy supplies, energy production and conversion equipment, heat radiators, etc.) necessary for the supply and satisfaction of the energy requirements of the building.	NUIG,BASF	LCCCA, OPT, FRCT, ModSCO (only Passive)	WP5	2(A)+2(I)+ 0(F)+ 0(N)
I5.M1.SM3	3. Building Issue Management	Issue facility enabled to allow site-based operatives to undertake issue resolution works, and/or raise new jobs based on issues discovered on site during the course of their task execution	VRM, ASC	Refurbify, FLINK2GO	WP5	2(A)+2(I)+1(F)+ 0(N)
I5.M1.SM 4	4. Big Data Analytics for Predictive Maintenance	Tool to trigger early warnings to enable the shift from preventive maintenance to predictive maintenance. The main target are the most energy-demanding appliances in the domestic sector, namely heating and cooling systems and water heaters, but potentially extended to other maintenance topics related to safety (structural stability), leaks (electricity, gas, water).	COMS, EUT	IMAN,iPredict	WP5	2(A)+2(I)+ 0(F)+ 0(N)
I5.M2	**2. Energy Management and Performance Monitoring**					
I5.M2.SM1	1. Data Acquisition and Status Reporting	Integration of IoT sensor systems in building energy management systems for operational data capture and acquisition into the platform, within a standardised status reporting of aggregated data over time and per dwelling/space.	DE5, VRM	Clarity	WP5	1(A)+1(I)+ 0(F)+2(N)
I5.M2.SM2	2. Dynamic Env. Assessment and Communications	Provides for an evaluation of the renovation performance in a dynamic manner, by enabling the rapid generation of an environmental and circularity renovation profile including waste generation and management needs	EKO	EPESUS	WP4	1(A)+1(I)+2(F)+
I5.M2.SM3	3. Energy Use Optimisation	Calculates and evaluates the energy requirements of the building (heating, cooling, DHW and lighting). Then, it studies potential passive and active solutions to be installed in the building and analyse their impact in terms of energy, costs and sustainability. Determine the most efficient equipment to be installed in the building, based on its demand profiles and building's conditions.	EUT, TNO,EKO, EAI	ModSCO, iESD_E, RobMOS, EcosimPro	WP4 WP5	1(A)+ 1(I)+ 0(F)+2(N)
I5.M2.SM4	4. Energy Generation Evaluation and Decision Support	Evaluates which renewable energy technology is the most suitable to install in the building according to its climatic condition, use and architectonic characteristics (e.g. available surface for panels).	EUT	iESD_E,	WP4	1(A)+ 1(I)+2(F)+3(N)
I5.M2.SM5	5. Human Thermal Model Building Automation Control	Improves thermal satisfaction of occupants and energy efficiency of building, by a new demand based thermal comfort concept which monitors relevant space and occupant data estimates, incl. thermal sensation index values for each occupant and space, and defines optimal temperature set-point values for space control units on-line. Energy efficiency is improved by avoiding unnecessary heating/cooling when spaces are unoccupied. Provides occupant app-based feedback options	VTT	HTM	WP5	1(A)+ 1(I)+ 0(F)+0(N)

I5.M2.SM6	6. Energy Management ICT tool – ISO 50001 Decision	Energy Management tool including support for ISO 50001 and Energy audit workflows, which brings together energy decision support data from other tools. Provides for a standardised energy planning process, which is a key step in establishing an EnMS, supports the Energy Review process though assessment of the energy Sources and Energy uses building on data from other tools, to be analysed for easy identification of any related *Improvement Opportunities*. Finally providing for defining action Plans and objectives & targets that can be tracked.	R2M, VRM	En-MS	WP5	1(A)+ 1(I)+ 0(F)+ 0(N)
I5.M2.SM7	7.Reporting	Provides for a reporting standard that integrates different tool outputs for the environmental and energy management and decision support.	IDP, DE5, EKO	Overlay of different tools	WP5	1(A)+ 1(I)+ 0(F)+ 0(N)
I5.M3	**3. Financial Monitoring and Account Keeping Module**					
I5.M3.SM1	1. Smart Contract Based Open Ledger Bookkeeping Module for **Renovation**	Translation of renovation contractor and sub-contractor contracts once awarded into smart contracts using blockchain to identify milestones to specific events that can be automatically monitored using the digital twin to notify the contractor of accomplishment for intermediary awarding of funds. Identification of parties that would share the blockchain for immutability and legal requirements.	EUT, EKO	NEW TOOL	WP5	1(A)+ 1(I)+ 0(F)+ 0(N)
I5.M3.SM2	2. Smart Contract Based Open Ledger Bookkeeping Module for **Construction**	Translation of construction contractor and sub contractor contracts once awarded into smart contracts using blockchain to identify milestones to specific events that can be automatically monitored using the digital twin to notify the contractor of accomplishment for intermediary awarding of funds. Identification of parties that would share the blockchain for immutability and legal requirements.	EUT, ASC	NEW TOOL	WP3	3(A)+6(I)+ 0(F)+ 0(N)
I5.M3.SM3	3. Evidence Recording and Tracing	Provides for comparison of the Digital Twin versions and related performance evidence differences for financial contract verification purposes. Integrates time-stamping (recording) and tracing between versions.	IDP, EUT	NEW TOOL	WP5	

5 SPHERE Pilot and Tools Use Cases and User Requirements

The chapter provides an overview of the user stories developed by the SPHERE pilot partners (CAV, DE5, CREE, TNO) and the software tool providers EUT, COMSA, VTT, EKO, BASF, R2M, EAI, VRM, NUIG, TNO AND ASC. User stories are provided for each pilot per required phase in separate tables, with overlays related to tools and tool providers mapped in Green colour, additional non-matching user stories suggested by tool providers in grey colour, and additional non-matching user stories suggested by pilots in light orange colour. The pilots are presented under each section split by the Strategic Definition (5.2), Preparation and brief (5.3), Concept and Technical design (5.4), Construction/Renovation (5.5), Handover and commissioning (5.6) and in use phase (5.7). Note that in each table the user stories identified by both pilots and tool providers are displayed in **GREEN**, additional user stories suggested by tool providers are displayed in **GREY** that are not suggested/use by the specific pilot at present, and finally in **YELLOW** are user stories suggested by the pilot but not by tool providers.

5.1 User Stories for IDDS instead of Design-Bid-Build Contracting

As a premise, BIM should be used, as the main tool to link actors, disseminate information and present the transparency of the team's progress and the Integrated Design and Delivery Services (IDDS) Manager should organise and facilitate these activities. The IDDS Manager should be chosen among the technical stakeholders (design team, DT manager, BIM Manager etc.).

Table 6. User Stories for the Implementation of Integrated Design and Delivery Services

US	As a	During	I want to	And I need to involve
IDDS. 1	IDDS Manager	Strategic Definition	• Organize a **Value Workshop** to promote the Owner/Core Team Alignment and foster creativity and inter-disciplinary thinking. • Present to the collaborative team the client's business case and strategic brief to work on the project programme from this new point of view. • Establish a foundation by setting fees to provide appropriate incentives to the involved team.	Building Owner, Project Manager, Construction Manager, Architect/Designer, BIM/DT Manager, Engineer, MEP Engineer, Build Automation Team, Tenant.
IDDS. 2	IDDS Manager	Preparation & Brief	Organize a **Negotiation Workshop** to align the team, agree on values and common goals and **Evaluate:** • Identification of client's needs and objectives, business case, sustainability, life cycle and facilities management aspirations and possible constraints on development. • Preparation of feasibility studies and assessment of options to enable the client to decide whether to proceed. **Design Brief considering:** • Develop client's initial statement of key requirements and constraints. Define procurement method, project sustainability and BIM procedures, building design lifetime and project organizational structure and range of consultants and others to be engaged for the project, including their definition of responsibilities.	Building Owner, Project Manager, Construction Manager, Architect, Design Lead, BIM/DT Manager, Engineer, MEP Engineer, Build Automation Team, Tenant, Surveyor, Const. Sub-contractor.

			• Work on IPD Pre-Contracting selection to agree a base fee with contingent-on-success profits. • Determine the project budget.	
IDDS. 3	IDDS Manager	Concept Design	• Organize the **Collaborative Design Team Workshop**. • Design Product & Process simultaneously. • Organize BIM pre-start meeting. • Enable design team access to BIM data. • Share initial model with Design Team for strategic analysis and options appraisal. • Use BIM data for environmental performance and area analysis, simulations, etc. • From the beginning try to identify possible waste. • Organize smaller, focused meetings for specific issues.	Construction Manager, Architect/Designer, Engineer, MEP Engineer, BIM/DT Manager, Contractor, Build Facility Manager, Build Automation Team, Design Lead, Design Team, Design Expert, Site Manager, Project Manager, BIM Manager.
IDDS. 4	IDDS Manager	Dev. & Tech Design	Promote the **Lean Design Team Workshop**: • Organize in cross-functional teams. • Minimize negative iteration. • Use technologies that facilitate Lean Design. • Use the Last Planner system of production control. • Define contracting methodology through advances and definitions in design and management.	Precast Producer, Building Owner, Maintenance Service Company, Digital Twin Conf. Man., Architect/Designer, Engineer, MEP Engineer, BIM/DT Manager, Contractor, Build. Facility Manager, Build Automation Team, Design Lead, Design Team, Site Manager, Project Manager Project Lead.
IDDS. 5	IDDS Manager	Construction /Renovation	Organize regular W**orkshops for Collaborative Construction/Redesign Teams.** • Apply Lean Construction methodology. • Reinforce communications to keep the synergy of the collaborative team. • Assign a facilitator/Last Planner to assume coordination tasks during the length of the project. • Clarification and resolution of design queries as they arise. • Assist with preparation for commissioning, training, handover, future monitoring and maintenance.	Concrete Producer, Construction Manager, Contractor, Certification Consultant, Surveyor, Project manager, Construction Lead, Subcontractors, Build Automation Team, Suppliers, General Contractor, Commissioning Team,
IDDS. 6	IDDS Manager	Handover & Close Out	• Reduce handover time through IDDS principles and BIM technologies. • Discover possible problems in future management till completing the lifecycle of the building. • Administrate the building contract after practical completion and making final inspections. • Assist building uses during initial occupation period. • Review of project performance "in use" and comparison with BIM data.	Build. Automation Team, Maintenance Service Company, Build. Facility Manager, Surveyor, Project Manager, Constr. Sub-contractor, Building Owner, Design Team, Construction Manager
IDDS. 7	IDDS Manager	In Use Phase	**Sustain the Collaboration:** • Review with the Construction team their roles and responsibilities after construction. • Continue tracking performance and monitoring key performance indicators for the life of the building. • Coordinate commissioning: the installation of all systems by the Constructor is subject to performance goals, and commissioning is incorporated into the construction schedule. • Verify the training of the building operations team at the end of the construction. • Roll a percentage of performance savings into operations optimization. • Establish standard operating procedures that provide continuous feedback. • Communicate the building's green features & performance goals to occupants to gain their support and buy-in.	Build Facility Manager, Maintenance Service Company, BIM Manager, Digital Twin Simulation Manager, Building Owner, Build Automation Team, Tenant, Contractor, Const. Sub-contractor, Architect/Designer, Certification Consultant, Surveyor, Project Manager, Facility Manager, BIM Manager, Building Automation.

5.2 Pilot and tool user stories for the Strategic Definition

Table 7. User Stories for Strategic Definition for Austrian pilot by CREE

US	As a	During	I want to	M	SM	Tool
BO.1	Building Owner	Strategic definition	Evaluate which renewable energy technology is the most suitable to install in the building	I3.M1	SM4	iESD_E
BO.2	Building Owner	Strategic definition	Evaluate which water treatment technology is most suitable to install in the building	I3.M2	SM5	iESD_W
BO.3	Building Owner	Strategic definition	Obtain additional value from improved occupant satisfaction and energy efficiency	I3.M1	SM7	HTM
BO.4	Building Owner	Strategic definition	Compliance with current regulations on building maintenance, demand a maintenance plan in the project	I4.M4	SM.1	IMAN
BO.5	Building Owner	Strategy definition	Identify the overarching objective and performance criteria	I2.M1	SM1/SM2	
PM.1	Project Manager	Strategic definition	Set in the brief the environmental and/or circularity targets for a renovation or new build project	I2.M1	SM2	EPESUS
PM.2	Project Manager	Strategic definition	To comply with the provisions of the building owner for the project design team (architects and engineers)			IMAN
CM.1	Construction Manager	Strategic definition	Help to implement economic and environmental improvements to enhance competitiveness	I2.M1	SM1/SM2	CMT
DT/BIM.1	BIM / DT Manager	Strategic definition	Ensure that the BIM LOD level and DT software are compatible with the CMMS	I1.M3	SM2	CMT
C.1	Contractor	Strategic definition	Deliver read-to-use input data for green building rating schemes to clients (DGNB, BREEAM, HQE and LEED)	I1.M3	SM5	CMT
A/D.1	Architect /Designer	Strategic definition	Add value to buildings thanks to the quantification of environmental performance			CMT
A/D.1	Architect /Designer	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I5.M2	SM4	En-MS
Eng.1	Engineer	Strategic definition	Add value to buildings thanks to the quantification of environmental performance			CMT
MEP.1	MEP Engineer	Strategic definition	Evaluate which renewable energy technology is the most suitable to install in the building	I3.M1	SM4	iESD_E
MEP.2	MEP Engineer	Strategic definition	Determine the optimal sizing of renewable energy technologies based on the building conditions	I3.M1	SM4	iESD_E
MEP.3	MEP Engineer	Strategic definition	Evaluate which water treatment technology is most suitable to install in the building	I3.M2	SM5	iESD_W
MEP.4	MEP Engineer	Strategic definition	Determine the optimal sizing of water treatment technology based on the building conditions	I3.M2	SM5	iESD_W
MEP.5	MEP Engineer	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I5.M2	SM4	En-MS
BA.1	Build. Automation Team	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I5.M2	ESM4	En-MS
T.1	Tenant	Strategic definition	Have additional value from improved occupant satisfaction	I3.M1	SM7	HTM

Table 8. User Stories for Strategic Definition for the Italian Pilot by DE5

US	As a	During	I want to	M	SM	Tool
BO.1	Building Owner	Strategic definition	Evaluate which renewable energy technology is the most suitable to install in the building	I3.M1	SM4	iESD_E
BO.2	Building Owner	Strategic definition	Evaluate which water treatment technology is most suitable to install in the building	I3.M2	SM5	iESD_W
BO.3	Building Owner	Strategic definition	Obtain additional value from improved occupant satisfaction and energy efficiency	I3.M1	SM7	HTM
BO.4	Building Owner	Strategic definition	Compliance with current building maintenance regulations, demanding a maintenance plan in the project	I4.M4	SM1	IMAN
BO.5	Building Owners	Strategic definition	Identify the overarching objective and performance criteria	I2.M1	SM1/SM2	
BO.6	Building Owners	Strategic definition	Strategy and target setting	I2.M1	SM1/SM2	Refurbify
PM.1	Project Manager	Strategic definition	Set in the brief the environmental and/or circularity targets for a renovation or newbuild project	I2.M1	SM2	EPESUS
PM.2	Project Manager	Strategic definition	To comply with the provisions of the building owner for the project design team (architects and engineers)			IMAN
CM.1	Construction Manager	Strategic definition	Help to implement economic and environmental improvements to enhance competitiveness	I2.M1	SM1/SM2	CMT

DT/BIM.1	BIM / DT Manager	Strategic definition	Ensure that the BIM LOD level and DT software are compatible with the CMMS	I1.M4	SM2	CMT
C.1	Contractor	Strategic definition	Deliver read-to-use input data for green building rating schemes to clients (DGNB, BREEAM, HQE and LEED)	I1.M3	SM5	CMT
A/D.1	Architect /Designer	Strategic definition	Add value to buildings thanks to the quantification of environmental performance			CMT
A/D.1	Architect /Designer	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I5.M2	SM6	En-MS
Eng.1	Engineer	Strategic definition	Add value to buildings thanks to the quantification of environmental performance			CMT
MEP.1	MEP Engineer	Strategic definition	Evaluate which renewable energy technology is the most suitable to install in the building	I3.M1	SM5	iESD_E
MEP.2	MEP Engineer	Strategic definition	Determine the optimal sizing of renewable energy technologies based on the building conditions	I3.M1	SM5	iESD_E
MEP.3	MEP Engineer	Strategic definition	Evaluate which water treatment technology is most suitable to install in the building	I3.M2	SM5	iESD_W
MEP.4	MEP Engineer	Strategic definition	Determine the optimal sizing of water treatment technology based on the building conditions	I3.M2	SM5	iESD_W
MEP.5	MEP Engineer	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I3.M2	SM3/SM4	En-MS
BA.1	Build. Automation Team	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I3.M2	SM3/SM4	En-MS
T.1	Tenant	Strategic definition	Have additional value from improved occupant satisfaction	I3.M2	SM7	HTM

Table 9. User Stories for Strategic Definition for the Finnish pilot by VTT-Caverion

US	As a	During	I want to	M	SM	Tool
BO.1	Building Owner	Strategic definition	Evaluate which renewable energy technology is the most suitable to install in the building	I3.M1	SM4	iESD_E
BO.2	Building Owner	Strategic definition	Evaluate which water treatment technology is most suitable to install in the building	I3.M2	SM5	iESD_W
BO.3	Building Owner	Strategic definition	Obtain additional value from improved occupant satisfaction and energy efficiency	I3.M1	SM7	HTM
BO.4	Building Owner	Strategic definition	Compliance with current regulations on building maintenance, demand a maintenance plan in the project	I4.M4	SM1	IMAN
BO.5	Building Owner	Strategy definition	Identify the overarching objective and performance criteria	I2.M1	SM1/SM2	TBD
PM.1	Project Manager	Strategic definition	Set in the brief the environmental and/or circularity targets for a renovation or newbuild project	I2.M1	SM2	EPESUS
PM.2	Project Manager	Strategic definition	To comply with the provisions of the building owner for the project design team (architects and engineers)			IMAN
CM.1	Construction Manager	Strategic definition	Help to implement economic and environmental improvements to enhance competitiveness	I2.M1	SM1/SM2	CMT
DT/BIM.1	BIM / DT Manager	Strategic definition	Ensure that the BIM LOD level and DT software are compatible with the CMMS	I1.M4	SM2	CMT
C.1	Contractor	Strategic definition	Deliver read-to-use input data for green building rating schemes to clients (DGNB, BREEAM, HQE and LEED)	I1.M3	SM5	CMT
A/D.1	Architect /Designer	Strategic definition	Add value to buildings thanks to the quantification of environmental performance			CMT
A/D.1	Architect /Designer	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I5.M2	SM4	En-MS
Eng.1	Engineer	Strategic definition	Add value to buildings thanks to the quantification of environmental performance			CMT
MEP.1	MEP Engineer	Strategic definition	Evaluate which renewable energy technology is the most suitable to install in the building	I3.M1	SM4	iESD_E
MEP.2	MEP Engineer	Strategic definition	Determine the optimal sizing of renewable energy technologies based on the building conditions	I3.M1	SM4	iESD_E
MEP.3	MEP Engineer	Strategic definition	Evaluate which water treatment technology is most suitable to install in the building	I3.M2	SM5	iESD_W
MEP.4	MEP Engineer	Strategic definition	Determine the optimal sizing of water treatment technology based on the building conditions	I3.M2	SM5	iESD_W
MEP.5	MEP Engineer	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I5.M2	SM4	En-MS
BA.1	Build. Automation Team	Strategic definition	Obtain information for energy improvement goals and targets in an energy renovation perspective	I5.M2	SM4	En-MS
T.1	Tenant	Strategic definition	Have additional value from improved occupant satisfaction	I3.M1	SM7	HTM
	Caverion	Strategic definition	Strategy and target setting	I2.M1	SM1	

Table 10. User Stories for Strategic Definition for the Netherlands pilot by TNO

US	As a	During	I want to	M	SM	Tool
PD.1	Project Developer	Strategic definition	Strategy and target setting	I2.M2	SM3	No tools required, however, all project tools should use the same KPIs.
BO.2	Building Owner	Strategic definition	Assess data needs for early understanding of outcome	I1.M3	SM1	No tools required, however, all project tools should use the same KPIs.
BO.3	Building Owner	Strategic definition	Assess data needs for early understanding of outcome	I1.M3	SM1	No tools required, however, all project tools should use the same KPIs.

5.2 Pilot and tool user stories for the Preparation & Brief

Table 11. User Stories for Preparation & Brief for the Austrian pilot by CREE

US	As a	During	I want to	M	SM	Tool
A.2	Architect	Preparation & Brief	Receive an Environmental Product Declaration (EPD) for a building component	I3.M2	SM1	CMT
Eng.2	Engineer	Preparation & Brief	Receive an Environmental Product Declaration (EPD) for a building component	I3.M2	SM1	CMT
MEP.6	MEP Engineer	Preparation & Brief	Develop a quick model of a building and have a quick evaluation of the energy performance	I3.M1	SM5	ModSCO
S.1	Surveyor	Preparation & Brief	Input previous relevant survey info into the correct document/asset location	I4.M2	SM1	Refurbify
S.2	Surveyor	Preparation & Brief	Upload pre-condition surveys pertaining to the proposed retrofit/renovation	I1.M3	SM1	Refurbify
S.3	Surveyor	Preparation & Brief	Upload relevant observed/collected information to the platform (walkover survey outcome)	I1.M3	SM1	FLINK2GO
Sc.1	Const. sub-contractor	Preparation & Brief	Register my company via organisation framework, submit work-plans & costings prior to project start			Refurbify
PM.1	Project Manager	Preparation & Brief	Use the SPHERE platform to calculate the project timescale, to set a critical path and track progress	I1.M2	SM1/SM2	Refurbify
PM.2	Project Manager	Strategic definition	Add the project team and define their roles and responsibilities	I1.M1	SM1/SM2	FLINK2GO
PM.3	Project Manager	Preparation & Brief	Start technical assessment and team formation	I2.M1	SM2	
PM.4	Project Manager	Preparation & Brief	Assess need and listing of potential subcontractors and suppliers	I2.M1.SM1/I4.M2.SM1		
PM.5	Project Manager	Preparation & Brief	Site Surveying - meeting	I2.M1.SM1/I4.M2.SM1		
PM.6	Project Manager	Preparation & Brief	Basic cost estimation and report			
PM.7	Project Manager	Preparation & Brief	Assessment of site survey, cost and targets (CREE, building owner)			
BO.1	Building Owner	Preparation & Brief	Basic cost estimation and report			
DL.1	Design Lead	Preparation & Brief	Early Concept Design Draft	I1.M1	SM2	

Table 12. User Stories for Preparation & Brief for the Italian pilot by DE5

US	As a	During	I want to	M	SM	Tool
	Architect	Preparation & Brief	Receive an Environmental Product Declaration (EPD) for a building component	I3.M2	SM1	CMT
	Engineer	Preparation & Brief	Receive an Environmental Product Declaration (EPD) for a building component	I3.M2	SM1	CMT
	MEP Engineer	Preparation & Brief	Develop a quick model of a building and have a quick evaluation of the energy performance	I3.M1	SM5	ModSCO
	Surveyor	Preparation & Brief	Input previous relevant survey info into the correct document/asset location	I4.M2	SM1	Refurbify
	Surveyor	Preparation & Brief	Upload pre-condition surveys pertaining to the proposed retrofit/renovation	I1.M3	SM1	Refurbify
S.3	Surveyor	Preparation & Brief	Upload relevant observed/collected information to the platform (walkover survey outcome)	I1.M3	SM1	FLINK2GO
PM.1	Project Manager	Preparation & Brief	Use the SPHERE platform to calculate the project timescale, to set a critical path and track progress	I1.M2	SM1/SM2	Refurbify
PM.2	Project Manager	Strategic definition	Add the project team and define their roles and responsibilities	I1.M1	SM1/SM2	FLINK2GO
	Const. sub-contractor	Preparation & Brief	Register my company via organisation framework, submit work-plans & costings prior to project start			Refurbify
PM.2	Project Manager	Preparation & Brief	Start technical assessment and team formation	I2.M1	SM2	Refurbify, VCMP
PM.3	Project Manager	Preparation & Brief	Assessment of site survey, cost and targets			
	Surveyor	Preparation & Brief	Site surveying and data collection for BIM	I2.M1.SM2/I4.M2.SM2		Refurbify, VCMP, Flink2go

	Surveyor	Preparation & Brief	Basic cost estimation and report	I4.M2		

Table 13. User Stories for Preparation & Brief for the Finnish pilot by VTT-Caverion

US	As a	During	I want to	M	SM	Tool
A.2	Architect	Preparation & Brief	Receive an Environmental Product Declaration (EPD) for a building component	I3.M2	SM1	CMT
Eng.2	Engineer	Preparation & Brief	Receive an Environmental Product Declaration (EPD) for a building component	I3.M2	SM1	CMT
MEP.6	MEP Engineer	Preparation & Brief	Develop a quick model of a building and have a quick evaluation of the energy performance	I3.M1	SM5	ModSCO
S.1	Surveyor	Preparation & Brief	Input previous relevant survey info into the correct document/asset location	I4.M2	SM1	Refurbify
S.2	Surveyor	Preparation & Brief	Upload pre-condition surveys pertaining to the proposed retrofit/renovation	I1.M3	SM1	Refurbify
S.3	Surveyor	Preparation & Brief	Upload relevant observed/collected information to the platform (walkover survey outcome)	I1.M3	SM1	FLINK2GO
Sc.1	Const. sub-contractor	Preparation & Brief	Register my company via organisation framework, submit work-plans & costing prior to project start			Refurbify
PM.1	Project Manager	Preparation & Brief	Use the SPHERE platform to calculate the project timescale, to set a critical path and track progress	I1.M2	SM1/SM 2	Refurbify
PM.2	Project Manager	Strategic definition	Add the project team and define their roles and responsibilities	I1.M1	SM1/SM 2	FLINK2GO
PM.2	Project Manager	Preparation & Brief	Define participant roles and survey types	I2.M1	SM2	
PM.3	Project Manager	Preparation & Brief	Surveying & Data Collection for BIM (existing building - partial BIM model)			
PM.4	Project Manager	Preparation & Brief	Preliminary BIM use for thermal energy analysis (heating/cooling) for option selection)	I3.M1	SM2	
PM.5	Project Manager	Preparation & Brief	Quantity take-off of materials / Bill of materials preparation			
PM.6	Project Manager	Preparation & Brief	Cost Estimation Report building			
BO.1	Building Owner	Preparation & Brief	Assessment of site survey, cost and targets			

Table 14. User Stories for Preparation & Brief for the Netherlands pilot by TNO

US	As a	During	I want to	M	SM	Tool
PD.01	Project developer	Strategic definition	Assess need and listing of potential subcontractors and suppliers	I2.M2	SM2	No tool required

5.3 Pilot and tool user stories for the Concept and Technical Design

Table 15. User Stories for Concept Design for the Austrian Pilot by CREE

US	As a	During	I want to	M	SM	Tools
	Building Owner	Concept Design	Preview the drawings, send feedback via the SPHERE platform			FLINK2GO
	Con. Manager	Concept Design	Cost-effective rating improvements for sustainability certification by achieving mix-design optimizations			CMT
	Con.Manager	Concept Design	Request product and application pricing information	I3.M2	SM1	OPT
	Architect/Designer	Concept Design	Make a quick calculation of environmental indicators and cost impacts for real-concrete mix-designs	I3.M2	SM2	CMT
	Architect/Designer	Concept Design	Download relevant component BIM objects directly without needing to surf through several databases	I1.M4	SM2	OPT
	Architect/Designer	Concept design	Structural checking of specific precast concrete elements such as façade panels			FRCT
	Architect/Designer	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	Architect/Designer	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	Architect/Designer	Concept Design	Carry out a preliminary evaluation of different design alternatives for the HVAC system	I3.M1	SM4	ECOSIMPRO
	Architect/Designer	Concept Design	Evaluate the environmental impact of my design using SPHERE and use this to inform the design choice	I3.M2	SM2/SM4	EPESUS
	Architect/Designer	Concept Design	Upload detailed iterations of the building drawings to the platform	I1.M3	SM1	FLINK2GO
	Architect/Designer	Concept Design	Receive feedback and identify any instructions required by the client/building owner	I5.M1	SM3	FLINK2GO
	Architect/Designer	Concept Design	Analyse the energy demand and expected indoor comfort as early as possible	I3.M1	SM3	ROBMOS
	Engineer	Concept design	Structural checking of specific precast concrete elements such as façade panels			FRCT
	Engineer	Concept Design	Make a quick calculation of environmental indicators and cost impacts for real-concrete mix-designs	I3.M2	SM2	CMT
	Engineer	Concept Design	Download relevant component BIM objects directly without needing to surf through several databases	I1.M4	SM2	OPT
	MEP Engineer	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	MEP Engineer	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	MEP Engineer	Concept Design	Generate an energy conservation opportunity by supporting design decision making	I5.M1	SM2	ModSCO
	MEP Engineer	Concept Design	Investigate HVAC related energy demand, based on my elected installations	I3.M1	SM3	ROBMOS
	BIM Manager	Concept Design	Receive BIM models to be implemented in the BIM Building Design	I1.M4	SM2	FRCT
	BIM / DT Manager	Concept Design	Ensure project designers include in project DDBB all information/requirements for good maintenance			IMAN
	Contractor	Concept Design	Download relevant component BIM objects directly without needing to surf through several databases	I1.M4	SM2	OPT
	Build. Facility Manager	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	Build. Facility Manager	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	Build. Automation Team	Concept Design	Obtain additional value by offering a new sophisticated control solution	I3.M1	SM7	HTM
	Design Lead	Concept Design	Concept design project management activities	I2.M1	SM2	
	Design Lead	Concept Design	Concept design based on BIM	I2.M1	SM2	
	Design Team	Concept Design	Concept design based on BIM	I2.M1	SM2	
	Design Lead	Concept Design	Data collection from building physics Civil Engineers/MEP subcontractor (Meetings + Data Input)	I2.M.1	SM2	
	Site Manager	Concept Design	Data collection from building physics Civil Engineers/MEP subcontractor (Meetings + Data Input)	I2.M.1	SM2	
	Design Lead	Concept Design	Design size Iteration (sizing columns, components, windows)	I1.M4	SM2	
	Design Team	Concept Design	Design size Iteration (sizing columns, components, windows)	I1.M4	SM2	

	Design Expert	Concept Design	Preliminary Simulations	I3.M1	SM4	
	Design Expert	Concept Design	Life cycle assessment (LCA)	I3.M2	SM2	
	Project Manager	Concept Design	Contacting specialist for concept design	I1.M4	SM1	
	Design Lead	Concept Design	Contacting specialist for concept design	I1.M4	SM1	
	Project Manager	Concept Design	Early materials quantities/mass / BoQ - Cost analysis			
	Design Lead	Concept Design	Early materials quantities/mass / BoQ - Cost analysis			
	All Roles/IDDS	Concept Design	Concept Design Workshop (Design Team, Project Lead, Building Owner, CREE)	I2.M.1	SM2	
	Design Lead	Concept Design	Revision and finalising of the concept design	I4.M1	SM.1	

Table 16. User Stories for Concept Design for the Italian Pilot by DE5

US	As a	During	I want to	M	SM	Tools
	Building Owner	Concept Design	Preview the drawings, send feedback via the SPHERE platform	I1.M3	SM4	FLINK2GO
	Construction Manager	Concept Design	Cost-effective rating improvements in the sustainability certification by achieving mix-design optimizations			CMT
	Construction Manager	Concept Design	Request product and application pricing information	I3.M2	SM1	OPT
	Architect/Designer	Concept Design	Make a quick calculation of environmental indicators and cost impacts for real-concrete mix-designs	I3.M2	SM2	CMT
	Architect/Designer	Concept Design	Download relevant component BIM objects directly without needing to surf through several databases	I1.M4	SM2	OPT
	Architect/Designer	Concept design	Structural checking of specific precast concrete elements such as façade panels			FRCT
	Architect/Designer	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	Architect/Designer	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	Architect/Designer	Concept Design	Carry out a preliminary evaluation of different design alternatives for the HVAC system	I3.M1	SM4	ECOSIMPRO
	Architect/Designer	Concept Design	Evaluate the environmental impact of my design using SPHERE and use this to inform the design choice	I3.M2	SM2/SM4	EPESUS
	Architect/Designer	Concept Design	Upload detailed iterations of the building drawings to the platform	I1.M3	SM1	FLINK2GO
	Architect/Designer	Concept Design	Receive feedback and identify any instructions required by the client/building owner	I5.M1	SM3	FLINK2GO
	Architect/Designer	Concept Design	Analyse the energy demand and expected indoor comfort as early as possible	I3.M1	SM3	ROBMOS
	Engineer	Concept design	Structural checking of specific precast concrete elements such as façade panels			FRCT
	Engineer	Concept Design	Make a quick calculation of environmental indicators and cost impacts for real-concrete mix-designs	I3.M2	SM2	CMT
	Engineer	Concept Design	Download relevant component BIM objects directly without needing to surf through several databases	I1.M4	SM2	OPT
	MEP Engineer	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	MEP Engineer	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	MEP Engineer	Concept Design	Generate an energy conservation opportunity by supporting design decision making	I5.M1	SM2	ModSCO
	MEP Engineer	Concept Design	Investigate HVAC related energy demand, based on my elected installations	I3.M1	SM3	ROBMOS
	BIM Manager	Concept Design	Receive BIM models to be implemented in the BIM Building Design	I1.M4	SM2	FRCT
	BIM / DT Manager	Concept Design	Ensure that project designers include in project DDBB all information/requirements for good maintenance			IMAN
	Contractor	Concept Design	Download relevant component BIM objects directly without needing to surf through several databases	I1.M4	SM2	OPT
	Build. Facility Manager	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	Build. Facility Manager	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W

	Build. Autom. Team	Concept Design	Obtain additional value by offering a new sophisticated control solution	I3.M1	SM7	HTM
	Project Manager	Concept Design	Concept design project management activities	I2.M1/I3.M1	SM2/SM2	Refubify, VCMP
	Design Team	Concept Design	Concept design based on BIM	I2.M1	SM2	
	Design Team	Concept Design	Preliminary Simulations	I3.M1	SM1	ECOSIM/HTM/ CLARITY
	Design Team	Concept Design	Early materials quantities/mass / BoQ - Cost analysis			
	All Roles/IDDS	Concept Design	Concept Design Workshop	I2.M.1	SM.2	Refurbify
	Design Team	Concept Design	Revision and finalising of the concept design	I4.M.3/I4.M4 I3.M1	SM.3/SM1 All	ECOSIMPRO/MODS CO/HTM/CLARITY

Table 17. User Stories for Concept Design for the Finnish pilot by VTT-Caverion

US	As a	During	I want to	M	SM	Tool
	Building Owner	Concept Design	Preview the drawings, send feedback via the SPHERE platform	I1.M3	SM4	FLINK2GO
	Const. Manager	Concept Design	Make cost-effective rating improvements in the sustainability certification by achieving mix-design optimizations			CMT
	Const. Manager	Concept Design	Request product and application pricing information	I3.M2	SM1	OPT
	Architect/Designer	Concept Design	Make a quick calculation of environmental indicators and cost impacts for real-concrete mix-designs	I3.M2	SM2	CMT
	Architect/Designer	Concept Design	Download the relevant BIM objects of components directly without the need to surf through several databases	I1.M4	SM2	OPT
	Architect/Designer	Concept design	Structural checking of specific precast concrete elements such as façade panels			FRCT
	Architect/Designer	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	Architect/Designer	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	Architect/Designer	Concept Design	Carry out a preliminary evaluation of different design alternatives for the HVAC system	I3.M1	SM4	ECOSIMPRO
	Architect/Designer	Concept Design	Evaluate the environmental impact of my design using SPHERE and use this to inform the design choice	I3.M2	SM2/SM4	EPESUS
	Architect/Designer	Concept Design	Analyse the energy demand and expected indoor comfort as early as possible	I3.M1	SM3	ROBMOS
	Architect/Designer	Concept Design	Upload detailed iterations of the building drawings to the platform	I1.M3	SM1	FLINK2GO
	Architect/Designer	Concept Design	Receive feedback and identify any instructions required by the client/building owner	I5.M1	SM3	FLINK2GO
	Engineer	Concept design	Structural checking of specific precast concrete elements such as façade panels			FRCT

	Engineer	Concept Design	Make a quick calculation of environmental indicators and cost impacts for real-concrete mix-designs	I3.M2	SM2	CMT
	Engineer	Concept Design	Download the relevant BIM objects of components directly without the need to surf through several databases	I1.M4	SM2	OPT
	MEP Engineer	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	MEP Engineer	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	MEP Engineer	Concept Design	Generate an energy conservation opportunity by supporting design decision making	I5.M1	SM2	ModSCO
	MEP Engineer	Concept Design	Investigate HVAC related energy demand, based on my elected installations	I3.M1	SM3	ROBMOS
	BIM Manager	Concept Design	Receive BIM models to be implemented in the BIM Building Design	I1.M4	SM2	FRCT
	BIM / DT Manager	Concept Design	Ensure that project designers include in project DDBB all information/requirements for good maintenance			IMAN
	Contractor	Concept Design	Download the relevant BIM objects of components directly without the need to surf through several databases	I1.M4	SM2	OPT
	Build. Facility Manager	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM4	iESD_E
	Build. Facility Manager	Concept Design	Calculate and evaluate water availability (grey and rainwater) and water requirements of the building	I3.M2	SM5	iESD_W
	Build. Autom.Team	Concept Design	Obtain additional value by offering a new sophisticated control solution	I3.M1	SM7	HTM
	Project Lead	Concept Design	Concept design project management activities	I2.M1	SM2	
	Caverion	Concept Design	BIM Data Collection			
	Caverion	Concept Design	BIM Modeling using the survey data	I5.M2	SM4	
	Design Team	Concept Design	Detailed Simulations (Energy/Daylight/Ventilation) to assess system and performance for chosen option	I5.M2	SM4	
	Design Team	Concept Design	Concept Design	I5.M2	SM2	
	All Roles/IDDS	Concept Design	Concept Design Workshop	I5.M2	SM2	
	Caverion	Concept Design	Cost Analysis			
	Design Team	Concept Design	Revision and finalising of the concept design			

Table 18. User Stories for Concept Design for the Netherlands Pilot by TNO

US	As a	During	I want to	M	SM	Tool
	Design Expert	Concept Design	Calculate and evaluate the energy requirements of the building (heating, cooling, DHW and lighting)	I3.M1	SM2	ROBMOS/IEQ
	Design Lead	Concept Design	Carry out a preliminary evaluation of different design alternatives for the HVAC system	I3.M1	SM2	ROBMOS/IEQ
	MEP Engineer	Concept Design	Investigate HVAC related energy demand, based on my elected installations	I3.M1	SM3	ROBMOS/IEQ

Table 19. User Stories for Developed and Technical Design for the Austrian Pilot by CREE

US	As a	During	I want to	M	SM	Tool
	Precast Producer	Dev. & Tech Design	Optimize my production processes and create a database for corporate sustainability	I3.M2	SM1	CMT
	Contractor	Dev. & Tech Design	Assess the improvement potential of concrete in buildings			CMT
	Architect/Designer	Dev. & Tech Design	Understand the potential and implication of using innovative concrete solutions in structures	I3.M2	SM2	CMT
	Architect/Designer	Dev. & Tech Design	Study potential passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4	iESD_E
	Architect/Designer	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM5	iESD_W
	Architect/Designer	Dev. & Tech Design	Evaluate different design alternatives for the HVAC System	I3.M1	SM4	ECOSIMPRO
	Architect/Designer	Dev. & Tech Design	Basic guidelines to implement HTM control (spacedata monitoring/occupant data/BAS integration)	I3.M1	SM7	HTM
	Architect/Designer	Dev. & Tech Design	Evaluate the environmental impact of my design using SPHERE and log my “As Designed” Performance			EPESUS
	Architect/Designer	Dev. & Tech Design	Upload detailed iterations of the building drawings to the platform	I5.M1	SM3	FLINK2GO
	Architect/Designer	Dev. & Tech Design	Receive feedback and identify any instructions required by the client/building owner	I3.M2	SM2	FLINK2GO
	Engineer	Dev. & Tech Design	Understand the potential and implication of using innovative concrete solutions in structures	I3.M2	SM2	CMT
	MEP Engineer	Dev. & Tech Design	Study potential passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	MEP Engineer	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	MEP Engineer	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	MEP Engineer	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M2	SM7	iESD_W
	Maint Service company	Dev. & Tech Design	Download relevant component BIMobjects directly without needing to surf through several databases	I1.M4	SM2	OPT
	Building Owner	Dev. & Tech Design	Preview the drawings, send feedback via the SPHERE platform	I1.M3	SM4	FLINK2GO
	Building Owner	Dev. & Tech Design	Study potential passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	Building Owner	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	Building Owner	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	Building Owner	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M2	SM7	iESD_W
	Build. Facility Manager	Dev. & Tech Design	Study potential passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	Build. Facility Manager	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	Build. Facility Manager	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	Build. Facility Manager	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M1	SM5	iESD_W
	Build. Automation Team	Dev. & Tech Design	Analyse HVAC Control Strategies and their building performance impacts	I3.M1	SM4/SM5	ECOSIMPRO
	Build. Automation Team	Dev. & Tech Design	Definitions for data transfer and APIs (e.g. reading space-data/occupant experiences/writing set-points)	I3.M1	SM7	HTM
	BIM / DT Manager	Dev. & Tech Design	Ensure that project designers include in DDBB all information/requirements for good maintenance			IMAN

	Digital Twin Conf. Man.	Dev. & Tech Design	Configure different design alternatives of the HVAC system for comparison purposes	I3.M1	SM4/SM5	ECOSIMPRO
	Design Lead	Dev. & Tech Design	Developed & Technical Design preparation	I2.M1	SM.2	
	Design Team	Dev. & Tech Design	Developed & Technical Design Design based on BIM	I3.M3	SM1	
	Design Team	Dev. & Tech Design	Simulations (Energy, daylight, ventilation simulations)	I3.M1.	SM5	
	Design Team	Dev. & Tech Design	Life cycle assessment (LCA)	I3.M2	SM2	
	Project Manager	Dev. & Tech Design	Contacting subcontractors and suppliers - quotes for technical design			
	Building Owner	Dev. & Tech Design	Contacting subcontractors and suppliers - quotes for technical design			
	Design Lead	Dev. & Tech Design	Final Material quantities/mass/BoQ - Cost analysis			
	Design Team	Dev. & Tech Design	Final Material quantities/mass/BoQ - Cost analysis			
	Project Manager	Dev. & Tech Design	Design Workshops	I2.M1	SM.2	
	Design Team	Dev. & Tech Design	Design Workshops	I2.M1	SM.2	
	Building Owner	Dev. & Tech Design	Design Workshops	I2.M1	SM.2	
	Design Lead	Dev. & Tech Design	Revision and finalising of the dev. & tech. designs and optimisation of the prefabrication components	I4.M4	SM1	
	Design Team	Dev. & Tech Design	Revision and finalising of the dev. & tech. designs and optimisation of the prefabrication components	I4.M4	SM1	

Table 20. User Stories for Developed and Technical Design for the Italian pilot by DE5

US	As a	During	I want to	M	SM	Tool
	Precast producer	Dev. & Tech Design	Optimize my production processes and create a database for corporate sustainability	I3.M2	SM1	CMT
	Contractor	Dev. & Tech Design	Assess the improvement potential of concrete in buildings			CMT
	Architect/Designer	Dev. & Tech Design	Understand the potential and implication of using innovative concrete solutions in structures	I3.M2	SM2	CMT
	Architect/Designer	Dev. & Tech Design	Study passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4	iESD_E
	Architect/Designer	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM5	iESD_W
	Architect/Designer	Dev. & Tech Design	Evaluate different design alternatives for the HVAC System	I3.M1	SM4	ECOSIMPRO
	Architect/Designer	Dev. & Tech Design	Basic guidelines to implement HTM control (spacedata monitoring/occupant data/BAS integration)	I3.M1	SM7	HTM
	Architect/Designer	Dev. & Tech Design	Evaluate the environmental impact of my design using SPHERE and log my “As Designed” Performance			EPESUS
	Architect/Designer	Dev. & Tech Design	Upload detailed iterations of the building drawings to the platform	I5.M1	SM3	FLINK2GO
	Architect/Designer	Dev. & Tech Design	Receive feedback and identify any instructions required by the client/building owner	I3.M2	SM2	FLINK2GO
	Engineer	Dev. & Tech Design	Understand the potential and implication of using innovative concrete solutions in structures	I3.M2	SM2	CMT
	MEP Engineer	Dev. & Tech Design	Study passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	MEP Engineer	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	MEP Engineer	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	MEP Engineer	Dev. & Tech Design	Determine the most efficient equipment for building installation given water demand profiles	I3.M2	SM7	iESD_W
	Maint Service company	Dev. & Tech Design	Download relevant component BIMobjects directly without needing to surf through several databases	I1.M4	SM2	OPT
	Building Owner	Dev. & Tech Design	Preview the drawings, send feedback via the SPHERE platform	I1.M3	SM4	FLINK2GO
	Building Owner	Dev. & Tech Design	Study passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	Building Owner	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	Building Owner	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	Building Owner	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M2	SM7	iESD_W

	Build. Facility Manager	Dev. & Tech Design	Study passive+active solutions for building installation & analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	Build. Facility Manager	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	Build. Facility Manager	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	Build. Facility Manager	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M1	SM5	iESD_W
	Build. Automation Team	Dev. & Tech Design	Analyse HVAC Control Strategies and their building performance impacts	I3.M1	SM4/SM5	ECOSIMPRO
	Build. Automation Team	Dev. & Tech Design	Definitions for data transfer & APIs (e.g. reading space data/occupant experiences/writing set-points)	I3.M1	SM7	HTM
	BIM / DT Manager	Dev. & Tech Design	Ensure project designers include in project DDBB all information/requirements for good maintenance			IMAN
	Digital Twin Conf. Man.	Dev. & Tech Design	Configure different design alternatives of the HVAC system for comparison purposes	I3.M1	SM4/SM5	ECOSIMPRO
	Project Manager	Dev. & Tech Design	Developed & Technical Design preparation	I3.M3	SM.1	Refurbify,VCMP
	Design Team	Dev. & Tech Design	Developed & Technical Design based on BIM	I3.M3	SM.1	Clarity
	Design Team	Dev. & Tech Design	Simulations	I3.M.1	SM.3	ECOSIMPRO/HTM/CLARITY
	Design Team	Dev. & Tech Design	Life cycle assessment (LCA)	I3.M2	SM2	OPT/EPESUS
	Design Team	Dev. & Tech Design	Life Cycle Cost (LCC) Analysis	I3.M2	SM3	OPT/EPESUS
	Design Team	Dev. & Tech Design	Final Material quantities/mass/BoQ - Cost analysis	I2.M.1	SM.2	
	All Roles/IDDS	Dev. & Tech Design	Design Workshops	I2.M.1	SM.2	Refurbify
	Design Team	Dev. & Tech Design	Revision and finalising of the dev. & tech. designs and optimisation of the prefabrication components	I3.M.2	SM.1	ECOMSIMPRO/ModSCO/HTM/EPESUS/CLARITY

Table 21. User Stories for Developed and Technical Design for the Finnish pilot by VTT-Caverion

US	As a	During	I want to	M	SM	Tool
	Precast producer	Dev. & Tech Design	Optimize my production processes and create a database for corporate sustainability	I3.M2	SM1	CMT
	Contractor	Dev. & Tech Design	Assess the improvement potential of concrete in buildings			CMT
	Architect/Designer	Dev. & Tech Design	Understand the potential and implication of using innovative concrete solutions in structures	I3.M2	SM2	CMT
	Architect/Designer	Dev. & Tech Design	Study potential passive+active solutions for building installation and analyse impacts (energy/cost/env.)	I3.M1	SM4	iESD_E
	Architect/Designer	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM5	iESD_W
	Architect/Designer	Dev. & Tech Design	Evaluate different design alternatives for the HVAC System	I3.M1	SM4	ECOSIMPRO
	Architect/Designer	Dev. & Tech Design	Have basic guidelines to implement HTM control (spacedata monitoring/occupant data/BAS integration)	I3.M1	SM7	HTM
	Architect/Designer	Dev. & Tech Design	Upload detailed iterations of the building drawings to the platform	I1.M3	SM1	FLINK2GO
	Architect/Designer	Dev. & Tech Design	Receive feedback and identify any instructions required by the client/building owner	I5.M1	SM3	FLINK2GO
	Architect/Designer	Dev. & Tech Design	Evaluate the environmental impact of my design using SPHERE and log my “As Designed” Performance	I3.M2	SM2	EPESUS
	Engineer	Dev. & Tech Design	Understand the potential and implication of using innovative concrete solutions in structures	I3.M2	SM2	CMT
	MEP Engineer	Dev. & Tech Design	Study passive+active solutions for installation in the building and analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	MEP Engineer	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	MEP Engineer	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	MEP Engineer	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M2	SM7	iESD_W
	Maint Service Company	Dev. & Tech Design	Download the relevant BIM objects of components directly without the need to surf through several databases	I1.M4	SM2	OPT

	Building Owner	Dev. & Tech Design	Preview the drawings, send feedback via the SPHERE platform	I1.M3	SM4	FLINK2GO
	Building Owner	Dev. & Tech Design	Study passive+active solutions for installation in the building and analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	Building Owner	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	Building Owner	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	Building Owner	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M2	SM7	iESD_W
	Build. Facility Manager	Dev. & Tech Design	Study passive+active solutions for installation in the building and analyse impacts (energy/cost/env.)	I3.M1	SM4/SM5	iESD_E
	Build. Facility Manager	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on demand profiles	I3.M1	SM5	iESD_E
	Build. Facility Manager	Dev. & Tech Design	Evaluate suitable water treatment technologies in terms of water, costs and sustainability	I3.M2	SM7	iESD_W
	Build. Facility Manager	Dev. & Tech Design	Determine the most efficient equipment to be installed in the building based on water demand profiles	I3.M1	SM5	iESD_W
	Build. Automation Team	Dev. & Tech Design	Analyse HVAC Control Strategies and their building performance impacts	I3.M1	SM4/SM5	ECOSIMPRO
	Build. Automation Team	Dev. & Tech Design	Definitions for data transfer & APIs (e.g. reading space data/occupant experiences/writing set-points)	I3.M1	SM7	HTM
	BIM / DT Manager	Dev. & Tech Design	Ensure project designers include in project DDBB all information/requirements for good maintenance			IMAN
	Digital Twin Conf. Man.	Dev. & Tech Design	Configure different design alternatives of the HVAC system for comparison purposes	I3.M1	SM4/SM5	ECOSIMPRO
	Project Lead	Dev. & Tech Design	Update project execution plan	I4.M2	SM4	

Table 22. User Stories for Developed and Technical Design for the Netherlands Pilot by TNO

US	As a	During	I want to	M	SM	Tool
	Architect/Designer	Dev. & Tech Design	Study potential passive + active solutions for building installation and analyse impacts (energy/cost/env.)	I3.M1	SM4	ROBMOS, IEQ, ECOSIMPRO
	Architect/Designer	Dev. & Tech Design	Evaluate different design alternatives for the HVAC System	I3.M1	SM4	ROBMOS, IEQ, ECOSIMPRO
	Design Expert	Concept Design	Simulations	I3.M1	SM1	ROBMOS,ECOSIMPRO, IEQ
	Design Lead	Concept Design	Revision and finalising developed & technical designs and optimisation of prefabrication components	I3.M1	SM2	ROBMOS,IEQ
	Build. Automation Team	Dev. & Tech Design	Analyse HVAC Control Strategies and their building performance impacts	I3.M1	SM4/SM5	ROBMOS,IEQ
	Digital Twin Conf. Man.	Dev. & Tech Design	Configure different design alternatives of the HVAC system for comparison purposes	I3.M1	SM4/SM5	ROBMOS,IEQ

5.4. Pilot and tool user stories for Tendering

Table 23. User Stories for Tendering (Italy)

	As a	During	I want to	M	SM	Tool
20	Building Owner	Tendering	Tendering for project manager and construction manager	I1.M5	SM1	Refurbify&Clarity
21	Construction Manager	Tendering	Tendering for construction team formation	I1.M5	SM1	Refurbify&Clarity
22	Construction Manager	Tendering	Tendering brief preparation	I1.M5	SM1	Refurbify&Clarity
23	Construction Manager	Tendering	Tendering documents collection from multiple bidders	I1.M5	SM1	Refurbify&Clarity,VCMP
24	Construction Manager	Tendering	Tendering bid review & acceptance	I1.M5	SM1	Refurbify&Clarity
25	Construction Manager	Tendering	Contract Agreement	I1.M5	SM1,SM2	Refurbify&Clarity

5.5. Pilot and tool user stories for the Construction and Assembly

Table 24. User Stories for Construction and Assembly or Renovation for the Austrian Pilot by CREE

US	As a	During	I want to	M	SM	Tool
	Concrete Producer	Const./Renovation	Provide transparency and optimize the environmental footprint of concrete versus costs	I3.M2	SM2/SM3	CMT
	Concrete Producer	Const./Renovation	Answer the customer's requests for the life cycle data on concrete	I3.M2	SM2	CMT
	Cons. Lead	Const./Renovation	Create tasks/issues, scheduling, assigning to internal/external responsible and mark location in building 2D drawing	I4.M2	SM1	FLINK2GO
	Cons. Lead	Const./Renovation	Initiate approval directly on the SPHERE platform to report/validate the subcontractors work	I4.M1	SM1	FLINK2GO
	Const. Manager	Const./Renovation	Download the relevant BIM objects of components directly without the need to surf through several databases	I1.M4	SM2	OPT
	Const. Manager	Const./Renovation	Obtain an EPD for construction product(s) that I want to use in my project to comply with requirements	I2.M1	SM3	TBD
	Const. Manager	Const./Renovation	Manage my construction process and schedule my tasks against a project plan	I1.M2	SM1/SM2	Refurbify
	Const. Manager	Const./Renovation	Calculate the costs and benefits of total or partial steel reinforcement replacements in façade panels & slabs	I3.M2	SM3	FRCT
	Const. Manager	Const./Renovation	Gather all information on preventive and predictive maintenance operations for proper maintenance	I5.M1	SM4	IMAN
	Const. Manager	Const./Renovation	Demand maintenance information gathering from subcontractors and suppliers of equipment/materials	I5.M1	SM4	IMAN
	Const. Manager	Const./Renovation	Handover maintenance information to person in charge of the IMAN	I4.M6	SM1	IMAN
	Contractor	Const./Renovation	Compare different solutions for my projects based on BIM objects and pricing information.	I1.M4	SM2/SM3	OPT
	Contractor	Const./Renovation	Request product and application pricing information	I1.M4	SM2/SM3	OPT
	Contractor	Const./Renovation	Calculate the costs and benefits of total or partial steel reinforcement replacements in façade panels & slabs			FRCT
	Contractor	Const./Renovation	Upload certificates/qualifications for my employees/allowing them access to particular job-types			Refurbify
	Certification Cons.	Const./Renovation	Obtain information about resource efficiency, CO2 performance, water use, materials and waste	I3.M2	SM2	EPESUS
	Project Manager	Const./Renovation	Have an overview on the overall project status for monitoring purposes. (Delayed tasks, urgent issues)	I4.M2	SM4	FLINK2GO
	Surveyor	Const./Renovation	Initiate detailed site surveys focusing on specific issues	I4.M2	SM2	FLINK2GO
	Surveyor	Const./Renovation	Save all the obtained information of the survey on the platform and shared among the concerned parties	I4.M2	SM2	FLINK2GO
	Surveyor	Const./Renovation	Effectively plan my survey activities and use the SPHERE platform to schedule my tasks	I4.M2	SM1	Refurbify
	Project Manager	Const./Renovation	Construction Project Management	I2.M1.SM2/I4.M1.SM3/I4.M2.SM1		
	Construction Lead	Const./Renovation	Construction Project Management	I2.M1.SM2/I4.M1.SM3/I4.M2.SM1		
	Subcontractors	Const./Renovation	Construction Project Management	I2.M1.SM2/I4.M1.SM3/I4.M2.SM1		
	Construction Lead	Const./Renovation	Prefabrication Manufacturing			
	Subcontractors	Const./Renovation	Prefabrication Manufacturing			
	Construction Lead	Const./Renovation	Construction of foundation and core of the building (reinforced concrete core)	I4.M2 (SM1,2,3), I4.M3 (SM1,2), I4.M1.SM1)		
	Subcontractors	Const./Renovation	Construction of foundation and core of the building (reinforced concrete core)	I4.M2 (SM1,2,3), I4.M3 (SM1,2), I4.M1.SM1)		
	Construction Lead	Const./Renovation	Prefabrication Delivery to the site (by subcontractors + suppliers)	I4.M2/I4.M3	SM1,SM4/SM2	
	Subcontractors	Const./Renovation	Prefabrication Delivery to the site (by subcontractors + suppliers)	I4.M2/I4.M3	SM1,SM4/SM2	
	Construction Lead	Const./Renovation	Assembly of the hybrid prefabricated elements (by subcontractors + suppliers)	I4.M2 (SM1,2,3), I4.M3 (SM1,2,3), I4.M1.SM1)		
	Subcontractors	Const./Renovation	Assembly of the hybrid prefabricated elements (by subcontractors + suppliers)			

	IDDS	Const./Renovation	Continuous Status Monitoring and Reporting (Construction Lead, subcontractors + suppliers)	I4.M2/I4.M2/I4.M1/ SM/SM1,3/SM1		
	Build. Autom. Team	Const./Renovation	Commissioning & Building automation installation (by subcontractors + suppliers)	I4.M2/I4.M3/I4.M5	SM1,SM4/SM1/SM 1	
	Subcontractors	Const./Renovation	Commissioning & Building automation installation (by subcontractors + suppliers)	I4.M2/I4.M3/I4.M5	SM1,SM4/SM1/SM 1	
	Suppliers	Const./Renovation	Commissioning & Building automation installation (by subcontractors + suppliers)	I4.M2/I4.M3/I4.M5	SM1,SM4/SM1/SM 1	

Table 25. User Stories for Construction and Assembly or Renovation for the Italian Pilot by DE5

US	As a	During	I want to	M	SM	Tool
	Concrete Producer	Const./Renovation	Provide transparency and optimize the environmental footprint of concrete versus costs	I3.M2	SM2/SM3	CMT
	Concrete producer	Const./Renovation	Answer the customer's requests for the life cycle data on concrete	I3.M2	SM2	CMT
	Cons. Lead	Const./Renovation	Create tasks/issues, scheduling, assigning to internal/external responsible and mark location in building 2D drawing	I4.M2	SM1	FLINK2GO
	Cons. Lead	Const./Renovation	Initiate approval directly on the SPHERE platform to report/validate the subcontractors work	I4.M1	SM1	FLINK2GO
	Construction Manager	Const./Renovation	Download relevant BIM objects of components directly without the need to surf through several databases	I1.M4	SM2	OPT
	Construction Manager	Const./Renovation	Obtain an EPD for construction product(s) that I want to use in my project to comply with requirements	I2.M1	SM3	EPESUS
	Construction Manager	Const./Renovation	Manage my construction process and schedule my tasks against a project plan	I1.M2	SM1/SM2	Refurbify
	Construction Manager	Const./Renovation	Calculate the costs and benefits of total or partial steel reinforcement replacements in façade panels & slabs	I3.M2	SM3	FRCT
	Construction Manager	Const./Renovation	Gather all information on preventive and predictive maintenance operations for proper maintenance	I5.M1	SM4	IMAN
	Construction Manager	Const./Renovation	Demand maintenance information gathering from subcontractors and suppliers of equipment/materials	I5.M1	SM4	IMAN
	Construction Manager	Const./Renovation	Handover maintenance information to person in charge of the IMAN	I4.M6	SM1	IMAN
	Contractor	Const./Renovation	Compare different solutions for my projects based on BIM objects and pricing information	I1.M4	SM2/SM3	OPT
	Contractor	Const./Renovation	Request product and application pricing information	I1.M4	SM2/SM3	OPT
	Contractor	Const./Renovation	Calculate the costs and benefits of total or partial steel reinforcement replacements in façade panels & slabs			FRCT
	Contractor	Const./Renovation	Upload certificates/qualifications for my employees/allowing them access to particular job-types			Refurbify
	Certification Consult.	Const./Renovation	Obtain information about resource efficiency, CO2 performance, water use, materials and waste	I3.M2	SM2	EPESUS
	Project Manager	Const./Renovation	Have an overview on the overall status of the project for the monitoring purposes. (Delayed tasks, urgent issues)	I4.M2	SM4	FLINK2GO
	Surveyor	Const./Renovation	Initiate detailed site surveys focusing on specific issues	I4.M2	SM2	FLINK2GO
	Surveyor	Const./Renovation	Save all the obtained information of the survey on the platform and shared among the concerned parties	I4.M2	SM2	FLINK2GO
	Surveyor	Const./Renovation	Effectively plan my survey activities and use the SPHERE platform to schedule my tasks	I4.M2	SM1	Refurbify
	Construction Manager	Const./Renovation	Construction Project Management	I4.M.1	SM.3	Refurbify, VCMP
	General Contractor	Const./Renovation	Start work and provisioning of construction materials	I4.M.2	SM.1	Refurbify, VCMP
	General Contractor	Const./Renovation	Site preparation and provisional works	I4.M.3	SM.2	Refurbify, VCMP, FLINK2GO
	General Contractor	Const./Renovation	Construction of foundation and core structural	I4.M.2	SM.2	
	General Contractor	Const./Renovation	General construction work (wall, plaster and windows)	I4.M.1	SM.3	
	General Contractor	Const./Renovation	MEP and implant installations	I4.M.2	SM.4	

	General Contractor	Const./Renovation	Finishing (flooring, paint and doors)	I4.M.2	SM.4	
	IDDS	Const./Renovation	Continuous Status Monitoring and Reporting (managed by construction manager)	I4.M.2	SM.4	
	Commissioning Team	Const./Renovation	Commissioning & Building automation installation	I1.M.3	SM.2	Refurbify, VCMP, CLARITY

Table 26. User Stories for Construction and Assembly or Renovation for the Finnish pilot by VTT-Caverion

US	As a	During	I want to	M	SM	Tool
	Concrete Producer	Const./Renovation	Provide transparency and optimize the environmental footprint of concrete versus costs	I3.M2	SM2/SM3	CMT
	Concrete producer	Const./Renovation	Answer the customer's requests for the life cycle data on concrete	I3.M2	SM2	CMT
	Cons. Lead	Const./Renovation	Create tasks/issues, scheduling, assigning to internal/external responsible and mark location in building 2D drawing	I4.M2	SM1	FLINK2GO
	Cons. Lead	Const./Renovation	Initiate approval directly on the SPHERE platform to report/validate the subcontractors work	I4.M1	SM1	FLINK2GO
	Const. Manager	Const./Renovation	Download relevant component BIM objects directly without needing to surf through several databases	I1.M4	SM2	OPT
	Const. Manager	Const./Renovation	Obtain an EPD for construction product(s) that I want to use in my project to comply with requirements	I2.M1	SM3	TBD
	Const. Manager	Const./Renovation	Manage my construction process and schedule my tasks against a project plan	I1.M2	SM1/SM2	Refurbify
	Const. Manager	Const./Renovation	Calculate costs and benefits of total or partial steel reinforcement replacements in façade panels & slabs	I3.M2	SM3	FRCT
	Const. Manager	Const./Renovation	Gather all information on preventive and predictive maintenance operations for proper maintenance	I5.M1	SM4	IMAN
	Const. Manager	Const./Renovation	Demand maintenance information gathering from subcontractors and suppliers of equipment/materials	I5.M1	SM4	IMAN
	Const. Manager	Const./Renovation	Handover maintenance information to person in charge of the IMAN	I4.M6	SM1	IMAN
	Contractor	Const./Renovation	Compare different solutions for my projects based on BIM objects and pricing information	I1.M4	SM2/SM3	OPT
	Contractor	Const./Renovation	Request product and application pricing information	I1.M4	SM2/SM3	OPT
	Contractor	Const./Renovation	Calculate costs and benefits of total or partial steel reinforcement replacements in façade panels & slabs			FRCT
	Contractor	Const./Renovation	Upload certificates/qualifications for my employees/allowing them access to particular job-types			Refurbify
	Certification cons.	Const./Renovation	Obtain information about resource efficiency, CO2 performance, water use, materials and waste	I3.M2	SM2	EPESUS
	Project Manager	Const./Renovation	Have an overview on the overall status of the project for the monitoring purposes. (Delayed tasks, urgent issues)	I4.M2	SM4	FLINK2GO
	Surveyor	Const./Renovation	Initiate detailed site surveys focusing on specific issues	I4.M2	SM2	FLINK2GO
	Surveyor	Const./Renovation	Save all the obtained information of the survey on the platform and shared among the concerned parties	I4.M2	SM2	FLINK2GO
	Surveyor	Const./Renovation	Effectively plan my survey activities and use the SPHERE platform to schedule my tasks	I4.M2	SM1	Refurbify
	Construction Lead	Const./Renovation	Scheduling of the Renovation Works	I4.M2	SM1	
	Caverion	Const./Renovation	Communication of the Renovation with the Housing Occupants			
	Caverion	Const./Renovation	Renovation Implementation & Building Automation Installation			
	All Roles/IDDS	Const./Renovation	Continuous Status Monitoring and Reporting	I4.M2	SM4	
	Commissioning Team	Const./Renovation	Commissioning	I4.M5	SM1	

Table 27. User Stories for Construction and Assembly or Renovation for the Netherlands Pilot by TNO

US	As a	During	I want to	M	SM	Tool
	Construction lead	Const./Renovation	Manage my construction process and schedule my tasks against a project plan	I1.M2	SM1/SM2	Refurbify
	Surveyor	Const./Renovation	Effectively plan my survey activities and use the SPHERE platform to schedule my tasks	I4.M2	SM1	Refurbify
	Construction Lead	Construction & Assembly	Prefabrication Manufacturing	I4.M2	SM2	Refurbify
	Building Automation Team	Construction & Assembly	Commissioning & Building automation installation	I4.M5	SM1	Refurbify
	Subcontractors	Construction & Assembly	Commissioning & Building automation installation	I I4.M3	SM1	Refurbify
	Suppliers	Construction & Assembly	Commissioning & Building automation installation	I4.M2	SM2	Refurbify

5.6 Pilot and tool user stories for the Handover & Close-Out Phase

Table 28. User Stories for Handover and Close Out for the Austrian Pilot by CREE

US	As a	During	I want to	M	SM	Tool
	Build. Automation Team	Hand. & Close-out	Speed up commissioning and detect problems in advance	I4.M5	SM1	ECOSIMPRO, RobMOS
	Build. Automation Team	Hand. & Close-out	Conduct field test period and analyse results (occupant satisfaction and energy consumption	I5.M2	SM5	HTM
	Maint. Service Company	Hand. & Close-out	Assess services against required standards prior to and post commissioning	I4.M4	SM1	Clarity
	Build. Facility Manager	Hand. & Close-out	Analyse building services data to ensure commissioning has been carried out correctly	I4.M5	SM1	Clarity
	Build. Facility Manager	Hand. & Close-out	Dialogue with BIM platform to use DT simulation tool to optimise energy operating costs of building	I5.M2	SM3	IMAN/ModSCO/ECOSIMPRO
	Surveyor	Hand. & Close-out	Carry out handover surveys & submit results for approval. Access re-works jobs & submit for handover	I4.M6	SM1	VCMP
	Project Manager	Hand. & Close-out	Utilise the document management facility to store and retrieve project documents	I4.M6	SM1	VCMP
	Constr. Sub-contractor	Hand. & Close-out	Submit completed works for handover.	I4.M6	SM1	VCMP
	Constr. Sub-contractor	Hand. & Close-out	View failed handover details and re-submit following remedial works	I4.M6	SM1	VCMP
	Project Manager	Hand. & Close-out	Undertake the tasks listed in the Handover Strategy	I4.M2.SM4/I4.M6.SM1		VCMP
	Build. Automation Team	Hand. & Close-out	Undertake the tasks listed in the Handover Strategy	I4.M2.SM4/I4.M6.SM1		Clarity
	Build. Automation Team	Hand. & Close-out	Manage updating of As Built Information and review progress and performance of construction	I4.M1.SM1/I4.M6.SM1		VCMP
	Building Owner	Hand. & Close-out	Manage updating of As Built Information and review progress and performance of construction	I4.M1.SM1/I4.M6.SM1		VCMP
	Design Team	Hand. & Close-out	Manage updating of As Built Information and review progress and performance of construction	I4.M1.SM1/I4.M6.SM1		VCMP

Table 29. User Stories for Handover and Close Out for the Italian Pilot by DE5

US	As a	During	I want to	M	SM	Tool
	Build. Automation Team	Hand. & Close-out	Speed up commissioning and detect problems in advance	I4.M5	SM1	ECOSIMPRO
	Build. Automation Team	Hand. & Close-out	Conduct field test period and analyse results (occupant satisfaction and energy consumption	I5.M2	SM5	HTM
	Maint. Service Company	Hand. & Close-out	Assess services against required standards prior to and post commissioning	I4.M4	SM1	Clarity
	Build. Facility Manager	Hand. & Close-out	Analyse building services data to ensure commissioning has been carried out correctly	I4.M5	SM1	Clarity
	Build. Facility Manager	Hand. & Close-out	Dialogue with BIM platform to use DT simulation tool to optimise energy operating costs of building	I5.M2	SM3	IMAN
	Surveyor	Hand. & Close-out	Carry out handover surveys & submit results for approval. Access re-works jobs & submit for handover	I4.M6	SM1	VCMP
	Project Manager	Hand. & Close-out	Utilise the document management facility to store and retrieve project documents	I4.M6	SM1	VCMP
	Constr. Sub-contractor	Hand. & Close-out	Submit completed works for handover.	I4.M6	SM1	VCMP
	Constr. Sub-contractor	Hand. & Close-out	View failed handover details and re-submit following remedial works	I4.M6	SM1	VCMP
	Construction Manager	Hand. & Close-out	Undertake the tasks listed in the Handover Strategy	I4.M1.SM1/I4.M2.SM4		
	IDDS	Hand. & Close-out	Manage updating of As Built Information and review progress and performance of construction	I4.M3.SM1/I4.M6.SM1		

Table 30. User Stories for Handover and Close Out for the Finnish pilot by VTT-Caverion

US	As a	During	I want to	M	SM	Tool
	Build. Automation Team	Handover & Close-out	Speed up commissioning and detect problems in advance	I4.M5	SM1	Ecosimpro
	Build. Automation Team	Handover & Close-out	Conduct field test period and analyse results (occupant satisfaction and energy consumption	I5.M2	SM5	HTM
	Maint. Service Company	Handover & Close-out	Assess services against required standards prior to and post commissioning	I4.M4	SM1	Clarity
	Build. Facility Nanager	Handover & Close-out	Analyse building services data to ensure commissioning has been carried out correctly	I4.M5	SM1	Clarity
	Build. Facility Manager	Handover & Close-out	Dialogue with BIM platform to use DT simulation tool to optimise energy operating costs of building	I5.M2	SM3	CMMS
	Surveyor	Handover & Close-out	Carry out handover surveys & submit the results for approval. Access re-works jobs and submit for handover	I4.M6	SM1	VCMP
	Project Manager	Handover & Close-out	Utilise the document management facility to store and retrieve project documents	I4.M6	SM1	VCMP
	Constr. Sub-contractor	Handover & Close-out	Submit completed works for handover.	I4.M6	SM1	VCMP
	Constr. Sub-contractor	Handover & Close-out	View failed handover details and re-submit following remedial works	I4.M6	SM1	VCMP
	Construction Manager	Handover & Close-Out	Undertake the tasks listed in the Handover Strategy	I4.M6	SM1	
	IDDS	Handover & Close-Out	Manage updating of As Built Information and review progress and performance of construction	I4.M3	SM1	

Table 31. User Stories for Handover and Close Out for the Dutch Pilot by TNO

US	As a	During	I want to	M	SM	Tool
	Build. Automation Team	Construction & Assembly	Continuous monitoring and reporting	I5.M2	SM1	RobMOS,IEQ (reporting)
	Build. Facility Manager	Construction & Assembly	Continuous monitoring and reporting	I5.M2	SM4	ROBMOS,IEQ (reporting)

5.7 Pilot and tool user stories for the In Use Phase

Table 32. User Stories for In Use Phase for the Austrian pilot by CREE

US	As a	During	I want to	M	SM	Tool
	Build. Facility Manager	In Use	See the baseline energy operation and evaluate alternatives	I5.M2	SM3	ECOSIMPRO
	Build. Facility Manager	In Use	Have new remote management capabilities and additional value from improved occupant satisfaction/energy eff.	I5.M2	SM5,SM6	EN-MS/HTM
	Build. Facility Manager	In Use	Understand how well my building is performing environmentally relative to “As designed & As built” expectations	I4.M3	SM1	EPESUS
	Build. Facility Manager	In Use	Optimize the HVAC setting by comparing real data with the baseline model (generated by the ROM)	I5.M2	SM3	ModSCO
	Build. Facility Manager	In Use	Obtain information to define a maintenance strategy	I5.M2	SM6	En-MS
	Build. Facility Manager	In Use	Obtain information for monitoring, managing & optimizing efficiency, energy consumption and occupant comfort	I5.M2	SM6	En-MS
	Build. Facility Manager	In Use	Create alerts for system downtime/interruption to connectivity	I5.M2	SM1	Clarity
	Build. Facility Manager	In Use	Manage building issues created by the tenants and assign them to the responsible Maintenance Service Company	I5.M1	SM3	FLINK2GO
	Build. Facility Manager	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS
	Maint Service Company	In Use	Compare the baseline energy operation with measured variables to detect problems	I5.M2	SM3	ECOSIMPRO
	Maint Service Company	In Use	Correct the operation of HVAC systems	I5.M2	SM3	ModSCO
	Maint Service Company	In Use	Consult daily/weekly performance reports and monitor energy conservation opportunities	I5.M2	SM3	ModSCO
	Maint Service Company	In Use	Obtain information to define a maintenance strategy	I5.M1	SM1	En-MS
	Maint Service Company	In Use	Obtain information for monitoring, managing and optimizing the efficiency of building systems	I5.M2	SM1	En-MS
	Maint Service Company	In Use	Access reports to investigate downtime to services	I5.M2	SM1	Clarity
	Maint Service Company	In Use	Ensure that IMAN contains the necessary information for all the units of work subject to maintenance	I5.M1	SM1	IMAN
	Maint Service Company	In Use	Ensure that IMAN is linked to all necessary sensors are installed to detect a future fault and for predictive actions	I5.M1	SM3	IMAN
	Maint Service Company	In Use	Ensure that the IMAN is compatible with the simulation tools of the DT platform to improve operations	I5.M2	SM1	IMAN
	Maint Service Company	In Use	Investigate if my installations need service, or investigate the cause of the energy and comfort performance gap	I5.M2	SM3	RobMOS
	BIM Manager	In Use	Use the SPHERE platform to visualise my device locations	I5.M2	SM2	Clarity
	BIM Manager	In Use	Access live or near-live data relating to a building element or BIM object	I5.M2	SM1	Clarity
	Digital Twin Sim. Man.	In Use	Decide on different operation alternatives related to the HVAC system for comparison	I5.M2	SM3	ECOSIMPRO
	Building Owner	In Use	Receive automated reports of realized occupant’s thermal satisfaction and energy efficiency	I5.M2	SM5	HTM
	Building Owner	In Use	Investigate if the real energy demand of the building is in line with the predicted energy demand	I5.M2	SM3	RobMOS
	Build. Automation Team	In Use	Receive valid information about functionality of HTM technology to update Building Automation Systems	I5.M2	SM5	HTM
	Tenant	In Use	Have additional value from improved occupant satisfaction	I5.M2	SM5	HTM
	Tenant	In Use	Report issues to the Building Facility Manager	I5.M1	SM4	FLINK2GO
	Tenant	In Use	Obtain information for optimizing efficiency, energy consumption and occupant comfort	I5.M2	SM6	En-MS
	Contractor	In Use	Adjust to changing project requirements and receive crucial product-in-use information for project-planning steps			
	Constr. Sub-contractor	In Use	Submit completed works for handover	I4.M6	SM1	VCMP
	Constr. Sub-contractor	In Use	View failed handover details and re-submit following remedial works	I4.M6	SM1	VCMP
	Architect/Designer	In Use	Receive valid information about functionality of HTM technology to improve design guidelines	I5.M2	SM5	HTM
	Certification Consult.	In Use	Analyse the ideal (generated by ROM) vs actual performance of a building following M&V protocols	I5.M2	SM3/SM6	ModSCO

	Surveyor	In Use	Receive alerts or notifications when surveys are due or overdue	I5.M2	SM7	VCMP
	Surveyor	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS
	Project Manager	In Use	Track the progress of my retrofit works.	I5.M1	SM.2	VCMP
	Project Manager	In Use	Identify and schedule works	I5.M1	SM.1	VCMP
	Building Owner	In Use	Takeover and deliver to occupants	I4.M.6	SM.1	
	Building Owner	In Use	Continuous monitoring and reporting	I5.M.2	SM.1	
	Facility Manager	In Use	Continuous monitoring and reporting	I5.M.2	SM.1	
	Maint. Service Company	In Use	Reactionary and Planned Maintenance	I5.M.1	SM.1	

Table 33. User Stories for In Use Phase for the Italian Pilot by DE5

US	As a	During	I want to	M	SM	Tool
	Build. Facility Manager	In Use	See the baseline energy operation and evaluate alternatives	I5.M2	SM3	ECOSIMPRO
	Build. Facility Manager	In Use	Have new remote management capabilities & additional value from improved occupant satisfaction/energy eff.	I5.M2	SM5,SM6	HTM
	Build. Facility Manager	In Use	Understand how well my building is performing environmentally relative to “As designed & As built” expectations	I4.M3	SM1	EPESUS
	Build. Facility Manager	In Use	Optimize the HVAC setting by comparing real data with the baseline model (generated by the ROM)	I5.M2	SM3	ModSCO
	Build. Facility Manager	In Use	Obtain information to define a maintenance strategy	I5.M2	SM6	En-MS
	Build. Facility Manager	In Use	Obtain information for monitoring, managing and optimizing efficiency, energy consumption and occupant comfort	I5.M2	SM6	En-MS
	Build. Facility Manager	In Use	Create alerts for system downtime/interruption to connectivity	I5.M2	SM1	Clarity
	Build. Facility Manager	In Use	Manage building issues created by the tenants and assign them to the responsible Maintenance Service Company	I5.M1	SM3	FLINK2GO
	Build. Facility Manager	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS
	Maint Service Company	In Use	Compare the baseline energy operation with measured variables to detect problems	I5.M2	SM3	ECOSIMPRO
	Maint Service Company	In Use	Correct the operation of HVAC systems	I5.M2	SM3	ModSCO
	Maint Service Company	In Use	Consult daily/weekly performance reports and monitor energy conservation opportunities	I5.M2	SM3	ModSCO
	Maint Service Company	In Use	Obtain information to define a maintenance strategy	I5.M1	SM1	En-MS
	Maint Service Company	In Use	Obtain information for monitoring, managing and optimizing the efficiency of building systems	I5.M2	SM1	En-MS
	Maint Service Company	In Use	Access reports to investigate downtime to services	I5.M2	SM1	Clarity
	Maint Service Company	In Use	Ensure that IMAN contains the necessary information for all the units of work subject to maintenance	I5.M1	SM1	IMAN
	Maint Service Company	In Use	Ensure that IMAN is linked to all necessary sensors are installed to detect a future fault and for predictive actions	I5.M1	SM3	IMAN
	Maint Service Company	In Use	Ensure that the IMAN is compatible with the simulation tools of the DT platform to improve operations	I5.M2	SM1	IMAN
	Maint Service Company	In Use	Investigate if my installations need service, or investigate the cause of energy and comfort performance gap	I5.M2	SM3	RobMOS
	BIM Manager	In Use	Use the SPHERE platform to visualise my device locations	I5.M2	SM2	Clarity
	BIM Manager	In Use	Access live or near-live data relating to a building element or BIM object	I5.M2	SM1	Clarity
	Digital Twin Sim. Man.	In Use	Decide on different operation alternatives related to the HVAC system for comparison	I5.M2	SM3	ECOSIMPRO
	Building Owner	In Use	Receive automated reports of realized occupant’s thermal satisfaction and energy efficiency	I5.M2	SM5	HTM
	Building Owner	In Use	Investigate if the real energy demand of the building is in line with the predicted energy demand	I5.M2	SM3	RobMOS
	Build. Automation Team	In Use	Receive valid information about functionality of HTM technology to update Building Automation Systems	I5.M2	SM5	HTM
	Tenant	In Use	Have additional value from improved occupant satisfaction	I5.M2	SM5	HTM
	Tenant	In Use	Report issues to the Building Facility Manager	I5.M1	SM4	FLINK2GO

	Tenant	In Use	Obtain information for optimizing efficiency, energy consumption and occupant comfort	I5.M2	SM6	En-MS
	Contractor	In Use	Adjust to changing project requirements and receive crucial product-in-use information for project-planning steps			
	Constr. Sub-contractor	In Use	Submit completed works for handover	I4.M6	SM1	VCMP
	Constr. Sub-contractor	In Use	View failed handover details and re-submit following remedial works	I4.M6	SM1	VCMP
	Architect/Designer	In Use	Receive valid information about functionality of HTM technology to improve design guidelines	I5.M2	SM5	HTM
	Certification Consult.	In Use	Analyse the ideal (generated by ROM) vs actual performance of a building following M&V protocols	I5.M2	SM3/SM6	ModSCO
	Surveyor	In Use	Receive alerts or notifications when surveys are due or overdue	I5.M2	SM7	VCMP
	Surveyor	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS
	Project Manager	In Use	Track the progress of my retrofit works.	I5.M1	SM.2	VCMP
	Project Manager	In Use	Identify and schedule works	I5.M1	SM.1	VCMP
	Building Owner	In Use	Takeover and deliver to occupants	I4.M6	SM.1	Refurbify, VCMP
	Building Owner	In Use	Continuous monitoring and reporting	I5.M2	SM.1	HTM, RobMOS,Clarity, Refurbify, En-MS, MANI
	Facility Manager	In Use	Continuous monitoring and reporting	I5.M2	SM.1	
	Maint. Service Company	In Use	Reactionary and Planned Maintenance	I5.M1	SM.1	Refurbify, MANI, VCMP

Table 34. User Stories for In Use Phase for the Finnish pilot by VTT-Caverion

US	As a	During	I want to	M	SM	Tool
	Build. Facility Manager	In Use	See the baseline energy operation and evaluate alternatives	I5.M2	SM3	ECOSIMPRO
	Build. Facility Manager	In Use	Have new remote management capabilities and additional value from improved occupant satisfaction/energy eff.	I5.M2	SM5,SM6	EN-MS/HTM
	Build. Facility Manager	In Use	Understand how well my building is performing environmentally relative to “As designed & As built” expectations	I4.M3	SM1	TBD
	Build. Facility Manager	In Use	Optimize the HVAC setting by comparing real data with the baseline model (generated by the ROM)	I5.M2	SM3	ModSCO
	Build. Facility Manager	In Use	Obtain information to define a maintenance strategy	I5.M2	SM6	En-MS
	Build. Facility Manager	In Use	Obtain information for monitoring, managing & optimizing efficiency, energy consumption and occupant comfort	I5.M2	SM6	En-MS
	Build. Facility Manager	In Use	Create alerts for system downtime/interruption to connectivity	I5.M2	SM1	Clarity
	Build. Facility Manager	In Use	Manage building issues created by the tenants and assign them to the responsible Maintenance Service Company	I5.M1	SM3	FLINK2GO
	Build. Facility Manager	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS
	Maint Service Company	In Use	Compare the baseline energy operation with measured variables to detect problems	I5.M2	SM3	ECOSIMPRO
	Maint Service Company	In Use	Correct the operation of HVAC systems	I5.M2	SM3	ModSCO
	Maint Service Company	In Use	Consult daily/weekly performance reports and monitor energy conservation opportunities	I5.M2	SM3	ModSCO
	Maint Service Company	In Use	Obtain information to define a maintenance strategy	I5.M1	SM1	En-MS
	Maint Service Company	In Use	Obtain information for monitoring, managing and optimizing the efficiency of building systems	I5.M2	SM1	En-MS
	Maint Service Company	In Use	Access reports to investigate downtime to services	I5.M2	SM1	Clarity
	Maint Service Company	In Use	Ensure that IMAN contains the necessary information for all the units of work subject to maintenance	I5.M1	SM1	IMAN
	Maint Service Company	In Use	Ensure that IMAN is linked to all necessary sensors are installed to detect a future fault and for predictive actions	I5.M1	SM3	IMAN
	Maint Service Company	In Use	Ensure that the IMAN is compatible with the simulation tools of the DT platform to improve operations	I5.M2	SM1	IMAN
	Maint Service Company	In Use	Investigate if my installations need service, or investigate the cause of the energy and comfort performance gap	I5.M2	SM3	RobMOS
	BIM Manager	In Use	Use the SPHERE platform to visualise my device locations	I5.M2	SM2	Clarity
	BIM Manager	In Use	Access live or near-live data relating to a building element or BIM object	I5.M2	SM1	Clarity

	Digital Twin Sim. Man.	In Use	Decide on different operation alternatives related to the HVAC system for comparison	I5.M2	SM3	ECOSIMPRO
	Building Owner	In Use	Receive automated reports of realized occupant's thermal satisfaction and energy efficiency	I5.M2	SM5	HTM
	Building Owner	In Use	Investigate if the real energy demand of the building is in line with the predicted energy demand	I5.M2	SM3	RobMOS
	Build. Automation Team	In Use	Receive valid information about functionality of HTM technology to update Building Automation Systems	I5.M2	SM5	HTM
	Tenant	In Use	Have additional value from improved occupant satisfaction	I5.M2	SM5	HTM
	Tenant	In Use	Report issues to the Building Facility Manager	I5.M1	SM4	FLINK2GO
	Tenant	In Use	Obtain information for optimizing efficiency, energy consumption and occupant comfort	I5.M2	SM6	En-MS
	Contractor	In Use	Adjust to changing project requirements and receive crucial product-in-use information for project-planning steps			
	Constr. Sub-contractor	In Use	Submit completed works for handover	I4.M6	SM1	VCMP
	Constr. Sub-contractor	In Use	View failed handover details and re-submit following remedial works	I4.M6	SM1	VCMP
	Architect/Designer	In Use	Receive valid information about functionality of HTM technology to improve design guidelines	I5.M2	SM5	HTM
	Certification Consult.	In Use	Analyse the ideal (generated by ROM) vs actual performance of a building following M&V protocols	I5.M2	SM3/SM6	ModSCO
	Surveyor	In Use	Receive alerts or notifications when surveys are due or overdue	I5.M2	SM7	VCMP
	Surveyor	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS
	Project Manager	In Use	Track the progress of my retrofit works.	I5.M1	SM.2	VCMP
	Project Manager	In Use	Identify and schedule works	I5.M1	SM.1	VCMP
	Building Owner	In Use	Deliver to building owner and service company that operates the building			
	Building Automation	In Use	Continuous monitoring and reporting			
	Caverion	In Use	Update the digital data during the in-use phase			
	Maint. Service Company	In Use	Reactionary and Planned Maintenance	I5.M1	SM3	

Table 35. User Stories for In Use Phase for the Netherlands Pilot by TNO

US	As a	During	I want to	M	SM	Tool
	Build. Facility Manager	In Use	See the baseline energy operation and evaluate alternatives	I5.M2	SM3	ROBMOS,IEQ
	Build. Facility Manager	In Use	Optimize the HVAC setting by comparing real data with the baseline model (generated by the ROM)	I5.M2	SM3	ROBMOS,IEQ
	Build. Facility Manager	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS,IEQ
	Maint Service Company	In Use	Consult daily/weekly performance reports and monitor energy conservation opportunities	I5.M2	SM3	ROBMOS,IEQ
	Maint Service Company	In Use	Investigate if my installations need service, or investigate the cause of the energy and comfort performance gap	I5.M2	SM3	RobMOS,IEQ
	Building Owner	In Use	Investigate if the real energy demand of the building is in line with the predicted energy demand	I5.M2	SM3	RobMOS,IEQ
	Surveyor	In Use	Investigate causes of the energy performance gap between digital twin and real building	I5.M2	SM3	RobMOS,IEQ

6 SPHERE Platform Information Flow Requirements

The delivered user stories and features described by four pilot partners (DE5, CAV, CREE, TNO) for Austria, Italy, Finland and Netherlands, were utilised to create a concise overview of the sequence of activities and information flow diagrams in these pilots based on the platforms. Together they form a set of required functionality needs in sequence for the piloting, as a start of developing a pilot implementation plan. The diagrams document both the actors involved, the activity, and the information flows (inputs and outputs) that form a basis for describing also the data flows from/to the platform in the technical architecture definitions in work-package 3.

6.1 Activity & Information Flow Process Diagrams For the Austrian Pilot

Figure 7. Austrian Pilot Strategic Definition Phase Activity & Information Flow Process Diagram

1. Strategic definition

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Brief & target data/documents	Strategy and target setting	Brief template Strategic brief export	to be able to identify the overarching objective and performance criteria of the project	CREE	- Data integration, data standardisation and access to the data (for the authorised actors). - Brief template export & sharing options. - Basic project information and requirements/targets stored as a standard form. - Assessment of Digital Twin scope/configuration.
B	Brief & target data/documents	Assess data needs for early understanding of outcomes	Findings report	to identify the survey needs	Collaborative (IDDS)	- Data sharing across multiple actors. - Basic project information and requirements/targets stored as a standard form. - Assessment of Digital Twin data needs.

Figure 8. Austrian Pilot Preparation and Brief Phase Activity & Information Flow Process Diagram

2. Preparation and brief

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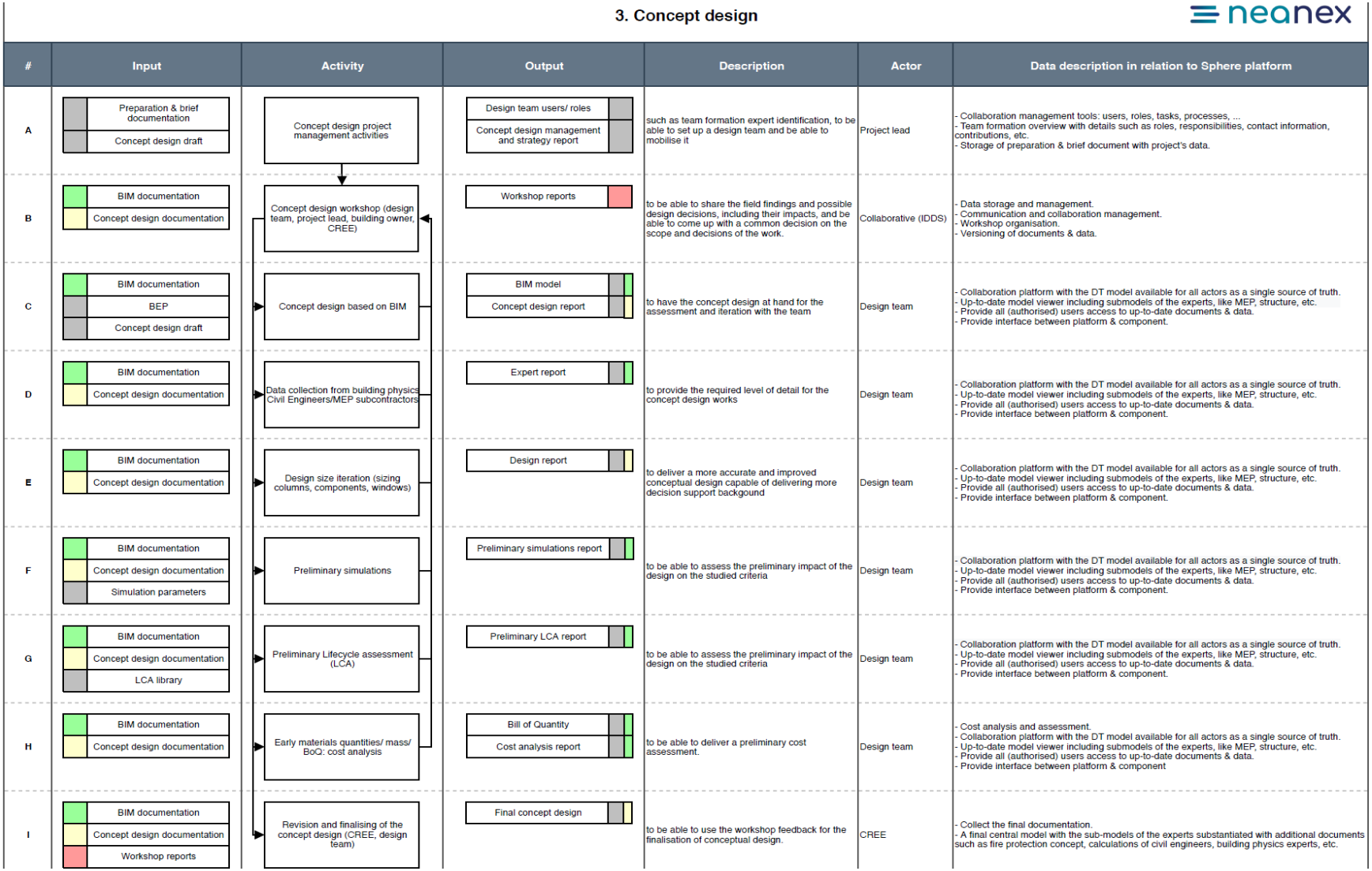
#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Brief & target data/ documents	Start technical assessment and team formation	Team formation (users & roles) Phases & processes Survey needs	to assign and mobilise team.	Project lead	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - Storage of technical assessment information (type of construction system or software used). - Storage of brief & target setting data, including the survey data.
B	Previous findings Survey needs	Site surveying - meeting	Meeting agenda Team formation (users & roles) Survey data	to have an initial field assessment and identify/ share responsibilities	Surveyors	- Meeting agenda - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - The survey data should be integrated through a common data type.
C	Survey data Brief & target data/ documents	Early concept design draft	Target setting BIM Execution Plan (BEP) Concept design draft	to be able to assess the scope of works	CREE	- Definition of requirements & needs. - BIM Execution Plan as a document, available for all (authorised) users. - Concept design report: a document with all the requirements and needs from the owner, like number of flats, size, number of rooms, levels, etc.
D	Concept design draft Survey data	Assessment of site survey, cost and targets (CREE, building owner)	Site survey, concept design and targets report	to be able to collect correct information from site and hire / mobilise the related professionals for the work	Collaborative (IDDS)	- Team formation tools: users, roles, tasks, processes, ... - Access to survey data and concept design draft for all (authorised) users.

Figure 9. Austrian Pilot Concept Design Phase Activity & Information Flow Process Diagram



3. Concept design

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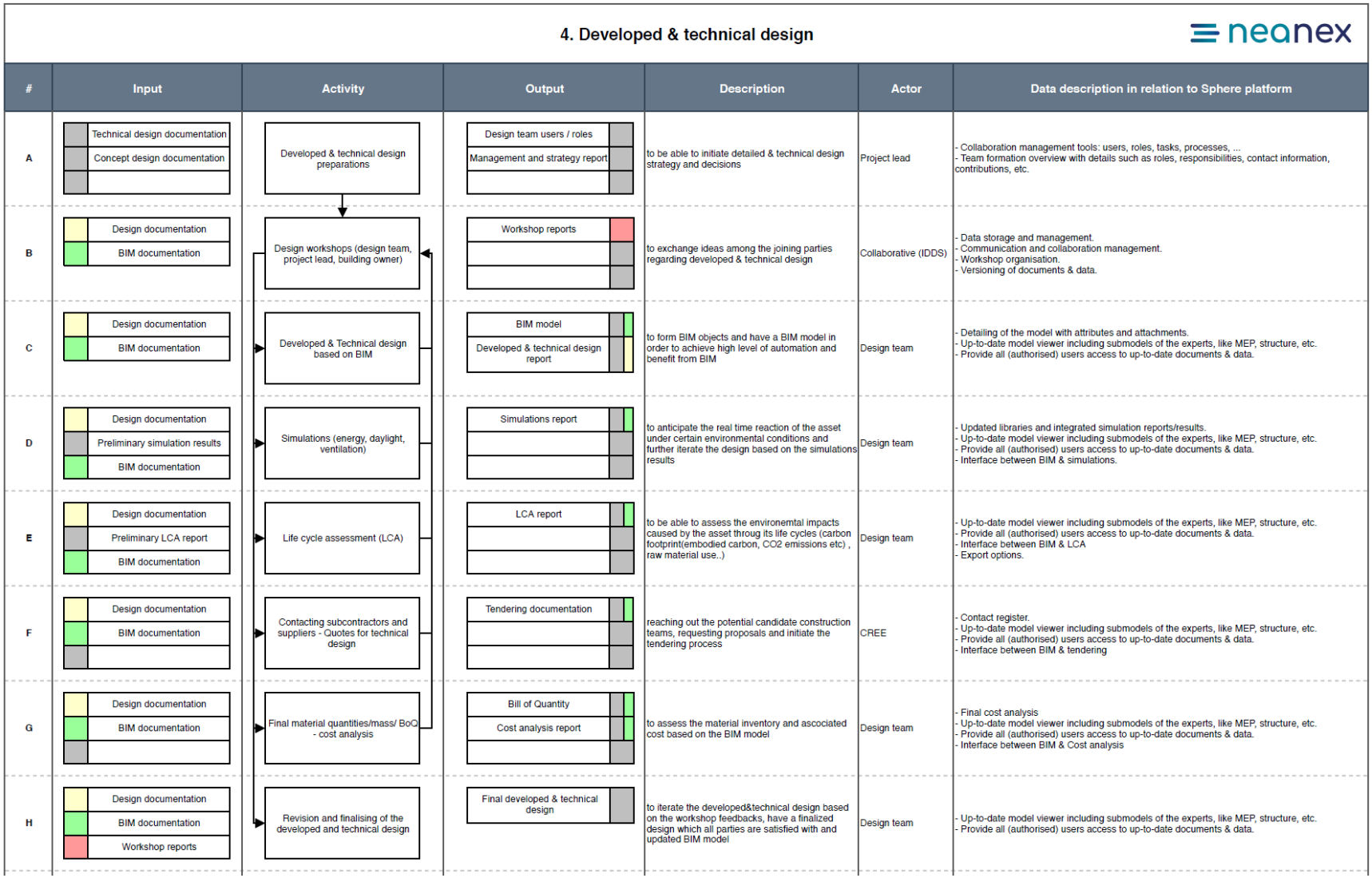
#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Preparation & brief documentation Concept design draft	Concept design project management activities	Design team users/ roles Concept design management and strategy report	such as team formation expert identification, to be able to set up a design team and be able to mobilise it	Project lead	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - Storage of preparation & brief document with project's data.
B	BIM documentation Concept design documentation	Concept design workshop (design team, project lead, building owner, CREE)	Workshop reports	to be able to share the field findings and possible design decisions, including their impacts, and be able to come up with a common decision on the scope and decisions of the work.	Collaborative (IDDS)	- Data storage and management. - Communication and collaboration management. - Workshop organisation. - Versioning of documents & data.
C	BIM documentation BEP Concept design draft	Concept design based on BIM	BIM model Concept design report	to have the concept design at hand for the assessment and iteration with the team	Design team	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Provide interface between platform & component.
D	BIM documentation Concept design documentation	Data collection from building physics Civil Engineers/MEP subcontractors	Expert report	to provide the required level of detail for the concept design works	Design team	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Provide interface between platform & component.
E	BIM documentation Concept design documentation	Design size iteration (sizing columns, components, windows)	Design report	to deliver a more accurate and improved conceptual design capable of delivering more decision support backgound	Design team	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Provide interface between platform & component.
F	BIM documentation Concept design documentation Simulation parameters	Preliminary simulations	Preliminary simulations report	to be able to assess the preliminary impact of the design on the studied criteria	Design team	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Provide interface between platform & component.
G	BIM documentation Concept design documentation LCA library	Preliminary Lifecycle assessment (LCA)	Preliminary LCA report	to be able to assess the preliminary impact of the design on the studied criteria	Design team	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Provide interface between platform & component.
H	BIM documentation Concept design documentation	Early materials quantities/ mass/ BoQ: cost analysis	Bill of Quantity Cost analysis report	to be able to deliver a preliminary cost assessment.	Design team	- Cost analysis and assessment. - Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Provide interface between platform & component
I	BIM documentation Concept design documentation Workshop reports	Revision and finalising of the concept design (CREE, design team)	Final concept design	to be able to use the workshop feedback for the finalisation of conceptual design.	CREE	- Collect the final documentation. - A final central model with the sub-models of the experts substantiated with additional documents such as fire protection concept, calculations of civil engineers, building physics experts, etc.

Figure 10. Austrian Pilot Developed & Technical Design Phase Activity & Information Flow Process Diagram



4. Developed & technical design

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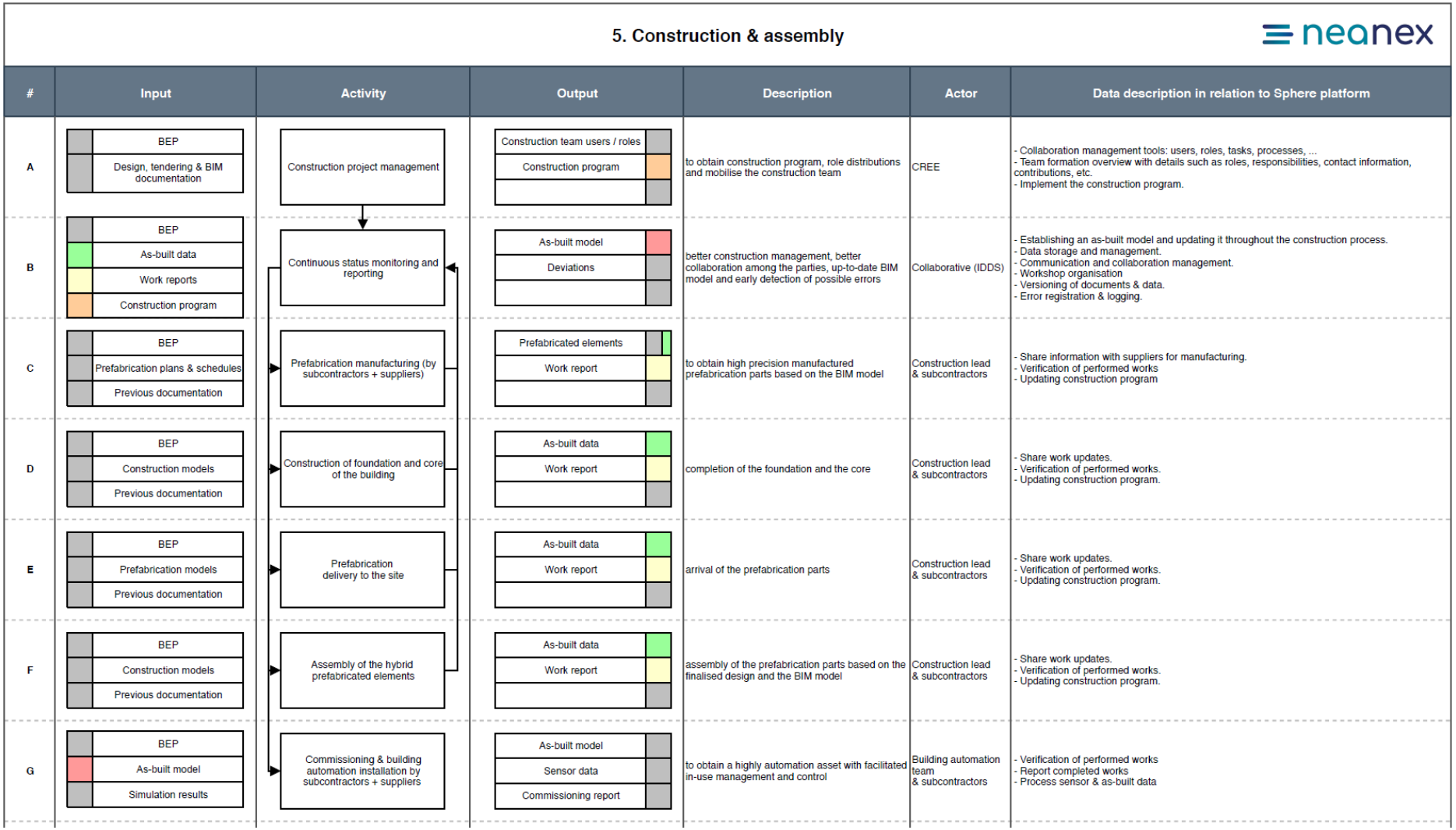
#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Technical design documentation Concept design documentation	Developed & technical design preparations	Design team users / roles Management and strategy report	to be able to initiate detailed & technical design strategy and decisions	Project lead	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc.
B	Design documentation BIM documentation	Design workshops (design team, project lead, building owner)	Workshop reports	to exchange ideas among the joining parties regarding developed & technical design	Collaborative (IDDS)	- Data storage and management. - Communication and collaboration management. - Workshop organisation. - Versioning of documents & data.
C	Design documentation BIM documentation	Developed & Technical design based on BIM	BIM model Developed & technical design report	to form BIM objects and have a BIM model in order to achieve high level of automation and benefit from BIM	Design team	- Detailing of the model with attributes and attachments. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data.
D	Design documentation Preliminary simulation results BIM documentation	Simulations (energy, daylight, ventilation)	Simulations report	to anticipate the real time reaction of the asset under certain environmental conditions and further iterate the design based on the simulations results	Design team	- Updated libraries and integrated simulation reports/results. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Interface between BIM & simulations.
E	Design documentation Preliminary LCA report BIM documentation	Life cycle assessment (LCA)	LCA report	to be able to assess the environemtal impacts caused by the asset throug its life cycles (carbon footprint(embodied carbon, CO2 emissions etc) , raw material use..)	Design team	- Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Interface between BIM & LCA - Export options.
F	Design documentation BIM documentation	Contacting subcontractors and suppliers - Quotes for technical design	Tendering documentation	reaching out the potential candidate construction teams, requesting proposals and initiate the tendering process	CREE	- Contact register. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Interface between BIM & tendering
G	Design documentation BIM documentation	Final material quantities/mass/ BoQ - cost analysis	Bill of Quantity Cost analysis report	to assess the material inventory and ascociated cost based on the BIM model	Design team	- Final cost analysis - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Interface between BIM & Cost analysis
H	Design documentation BIM documentation Workshop reports	Revision and finalising of the developed and technical design	Final developed & technical design	to iterate the developed&technical design based on the workshop feedbacks, have a finalized design which all parties are satisfied with and updated BIM model	Design team	- Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data.

Figure 11. Austrian Pilot Construction & Assembly / Renovation Phase Activity & Information Flow Process Diagram



5. Construction & assembly

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#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	BEP Design, tendering & BIM documentation	Construction project management	Construction team users / roles Construction program	to obtain construction program, role distributions and mobilise the construction team	CREE	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - Implement the construction program.
B	BEP As-built data Work reports Construction program	Continuous status monitoring and reporting	As-built model Deviations	better construction management, better collaboration among the parties, up-to-date BIM model and early detection of possible errors	Collaborative (IDDS)	- Establishing an as-built model and updating it throughout the construction process. - Data storage and management. - Communication and collaboration management. - Workshop organisation - Versioning of documents & data. - Error registration & logging.
C	BEP Prefabrication plans & schedules Previous documentation	Prefabrication manufacturing (by subcontractors + suppliers)	Prefabricated elements Work report	to obtain high precision manufactured prefabrication parts based on the BIM model	Construction lead & subcontractors	- Share information with suppliers for manufacturing. - Verification of performed works - Updating construction program
D	BEP Construction models Previous documentation	Construction of foundation and core of the building	As-built data Work report	completion of the foundation and the core	Construction lead & subcontractors	- Share work updates. - Verification of performed works. - Updating construction program.
E	BEP Prefabrication models Previous documentation	Prefabrication delivery to the site	As-built data Work report	arrival of the prefabrication parts	Construction lead & subcontractors	- Share work updates. - Verification of performed works. - Updating construction program.
F	BEP Construction models Previous documentation	Assembly of the hybrid prefabricated elements	As-built data Work report	assembly of the prefabrication parts based on the finalised design and the BIM model	Construction lead & subcontractors	- Share work updates. - Verification of performed works. - Updating construction program.
G	BEP As-built model Simulation results	Commissioning & building automation installation by subcontractors + suppliers	As-built model Sensor data Commissioning report	to obtain a highly automation asset with facilitated in-use management and control	Building automation team & subcontractors	- Verification of performed works - Report completed works - Process sensor & as-built data

Figure 12. Austrian Pilot Handover & Close Out Phase Activity & Information Flow Process Diagram

6. Handover and close out

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin Handover strategy	Undertake the tasks listed in the handover strategy	Completed handover	smooth and facilitated handover process	Project lead	- Digital Twin handover. - Clear definition of Digital Twin information in the performance report and building automation data.
B	As-built model Building automation data Deviations	Manage updating of 'As built' information and monitor/ review progress and performance of construction	As-built model Performance reports	up-to-date BIM model, verification of the progress documents as per defects and deviations based on BIM	Collaborative (IDDS)	- Provide custom exports to specific data according to the actor, such as building owner, planner, facility manager, ... - Process building automation data and report - Store as-built models & reports (+ versioning) - Verification process

Figure 13. Austrian Pilot In Use Phase Activity & Information Flow Process Diagram

7. In use

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin	Takeover and deliver to occupants	Occupant users / roles Facility manager	delivery	Building owner	- Facility management tool. - Custom exports. - New users & roles added for the asset maintenance.
B	Maintenance tasks Simulation results	Continuous monitoring and reporting (to building owner and CREE)	Maintenance prediction Building optimisation Updated Digital Twin	to detect maintenance requirements, ensure occupant comfort, reduced operational costs (energy,water savings etc..)	Building owner	- Provide contacts for subcontractors/maintenance companies for dedicated maintenance or repairs. - Continuous data monitoring and reporting. - Alerts when action is required.
C	Maintenance tasks Maintenance data BIM model	Reactionary and planned maintenance	Maintenance users / roles Maintenance reports Updated asset data	effective maintenance planning with reduced operation time and cost, efficient and on time intervention	Maintenance Service Company	- Maintenance logs & reports. - Maintenance users & roles. - Alerts when action is required.

6.2 Activity & Information Flow Process Diagrams For The Italian Pilot

Figure 14. Italian Pilot Strategic Definition Phase Activity & Information Flow Process Diagram

1. Strategic definition

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Brief & target data/documents	Strategy and target setting	Brief template Strategic brief export	Centric definition of tools, identification of metrics from pre-given options (e.g. energy, environmental performance, etc.)	Building owner (DE5)	- Project & collaboration management tools. - Data integration, data standardisation and access to the data (for authorised actors). - Brief template export & sharing options. - Basic project information and requirements/targets stored as a standard form. - Assessment of Digital Twin scope/configuration.

Figure 15. Italian Pilot Preparation & Brief Phase Activity & Information Flow Process Diagram

2. Preparation and brief

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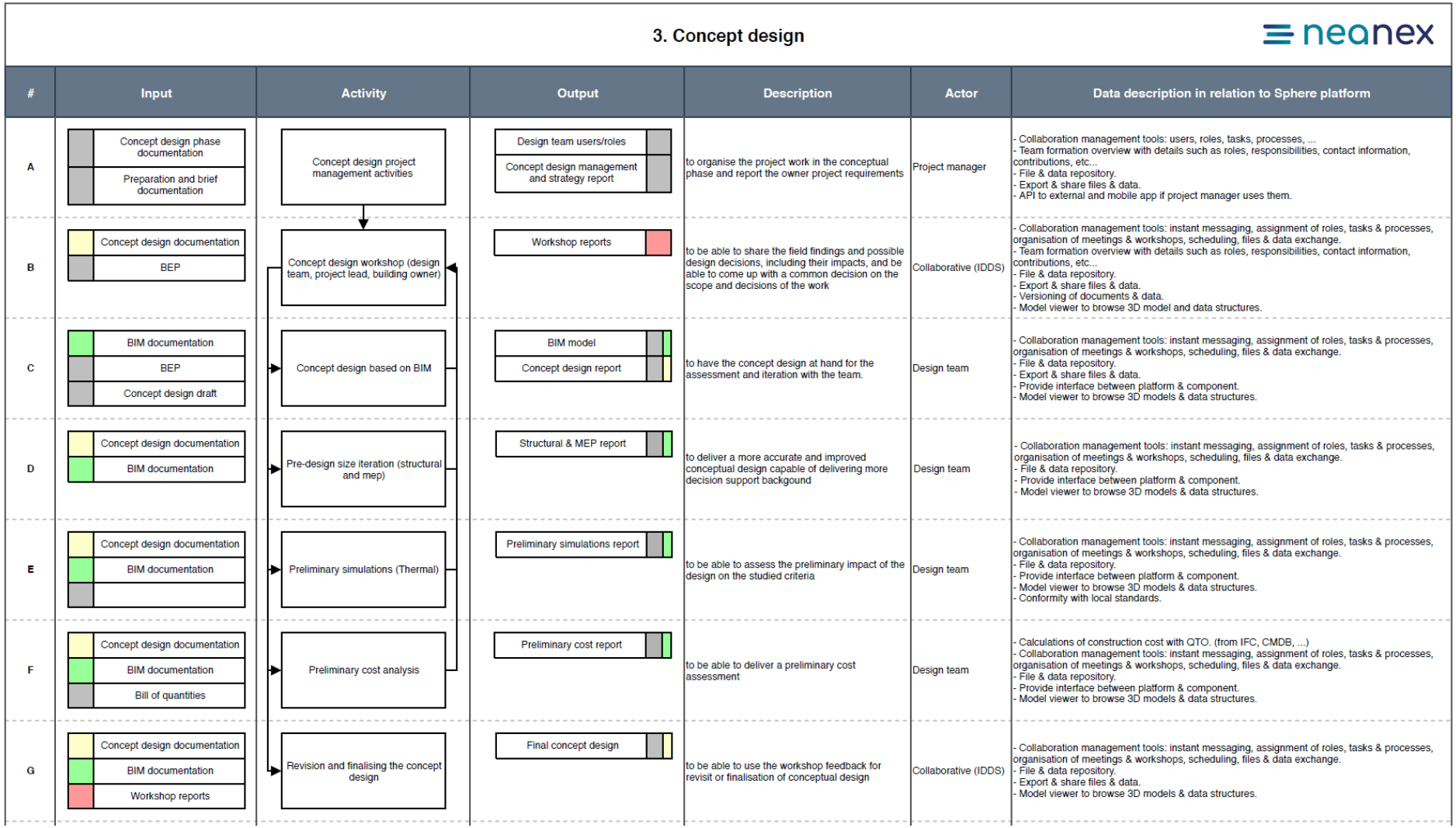
#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Brief & target setting documents Brief & target setting data	Start technical assessment and team formation	Team formation (users & roles) Technical assessment info Survey types BEP	definition of roles and survey types with additional sustainability and acoustic surveys, technical assessment info and the establishment of a BEP to implement a BIM methodology	Project manager	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - Storage of technical assessment information (type of construction system or software used). - Storage of brief & target setting data, including the survey data. - Meeting agenda
B	Survey types Previous findings	Surveying & data collection for BIM	Survey data BIM model	to have an initial field assessment / data for BIM	Surveyors	- Assign survey tasks. - File repository. - Load survey templates based on survey types. - Accommodate different types of survey data. - Export and share documents/files processed on the platform.
C	Survey data Preliminary cost calculation BEP	Basic cost estimation	Basic cost estimation report	to be able to evaluate foreseen costs, discuss scope and possible design options	Project manager	- Calculations of construction cost in according to standard unit cost of a residential type building. - Access to survey data & preliminary cost calculation. - File repository for cost reports. - Project management for timeline, work schedule, WBS, ...
D	Survey data Basic cost estimation report BEP	Assessment of site survey, cost and targets (DE5, building owner)	Site survey, costs and targets report	to be able to collect correct information from site and hire/ mobilise the related professionals for the work	Collaborative (IDDS)	- Both on- and offline meetings. - Model viewer to browse 3D models and data structures. - Access to survey data, BEP and basic cost estimation. The ability to discuss and assess.

Figure 16. Italian Pilot Concept Design Phase Activity & Information Flow Process Diagram



3. Concept design

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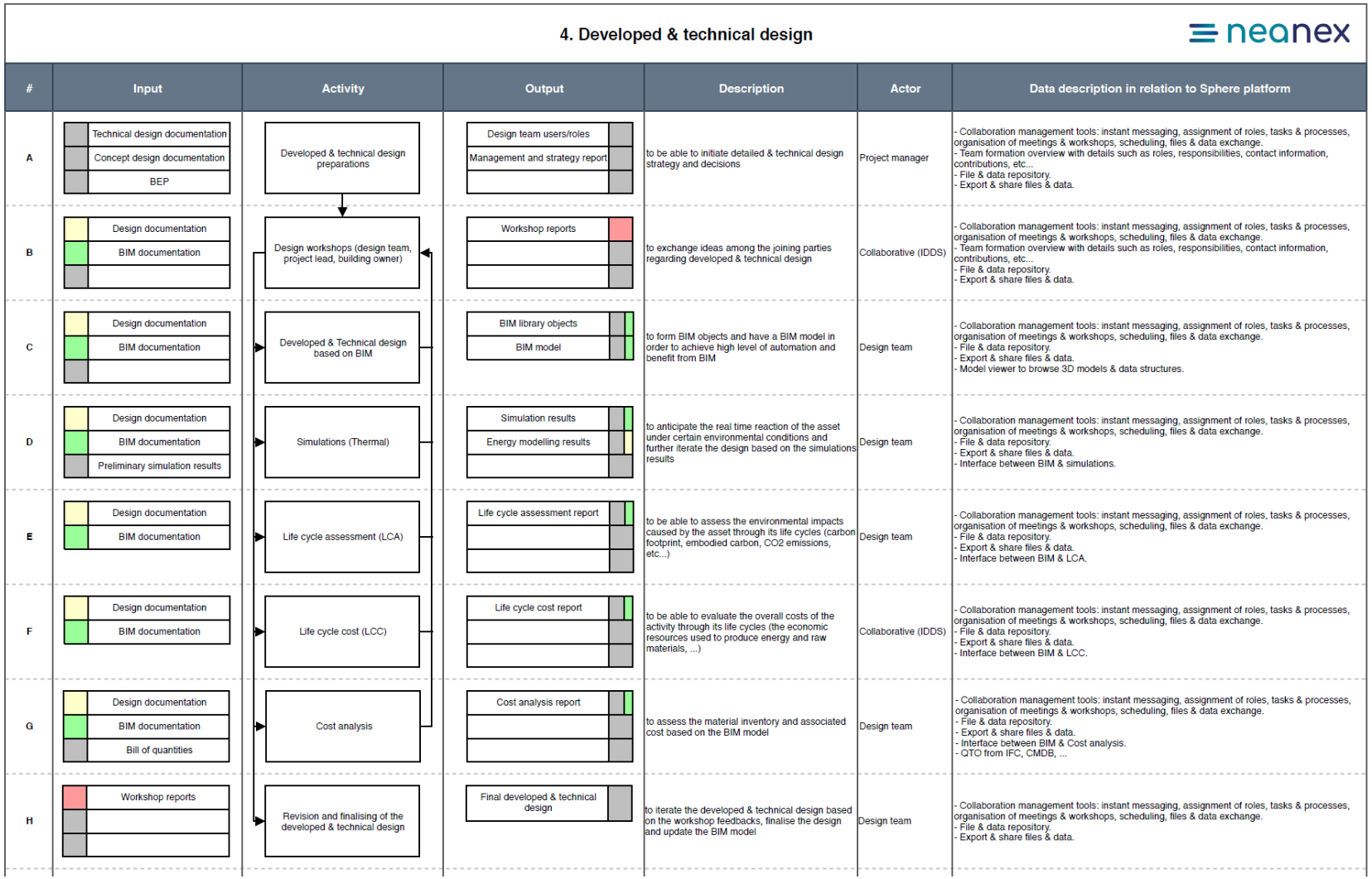
#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Concept design phase documentation Preparation and brief documentation	Concept design project management activities	Design team users/roles Concept design management and strategy report	to organise the project work in the conceptual phase and report the owner project requirements	Project manager	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - File & data repository. - Export & share files & data. - API to external and mobile app if project manager uses them.
B	Concept design documentation BEP	Concept design workshop (design team, project lead, building owner)	Workshop reports	to be able to share the field findings and possible design decisions, including their impacts, and be able to come up with a common decision on the scope and decisions of the work	Collaborative (IDDS)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - File & data repository. - Export & share files & data. - Versioning of documents & data. - Model viewer to browse 3D model and data structures.
C	BIM documentation BEP Concept design draft	Concept design based on BIM	BIM model Concept design report	to have the concept design at hand for the assessment and iteration with the team.	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data. - Provide interface between platform & component. - Model viewer to browse 3D models & data structures.
D	Concept design documentation BIM documentation	Pre-design size iteration (structural and mep)	Structural & MEP report	to deliver a more accurate and improved conceptual design capable of delivering more decision support backgound	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Provide interface between platform & component. - Model viewer to browse 3D models & data structures.
E	Concept design documentation BIM documentation	Preliminary simulations (Thermal)	Preliminary simulations report	to be able to assess the preliminary impact of the design on the studied criteria	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Provide interface between platform & component. - Model viewer to browse 3D models & data structures. - Conformity with local standards.
F	Concept design documentation BIM documentation Bill of quantities	Preliminary cost analysis	Preliminary cost report	to be able to deliver a preliminary cost assessment	Design team	- Calculations of construction cost with QTO. (from IFC, CMDB, ...) - Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Provide interface between platform & component. - Model viewer to browse 3D models & data structures.
G	Concept design documentation BIM documentation Workshop reports	Revision and finalising the concept design	Final concept design	to be able to use the workshop feedback for revisit or finalisation of conceptual design	Collaborative (IDDS)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data. - Model viewer to browse 3D models & data structures.

Figure 17. Italian Pilot Developed & Technical Design Phase Activity & Information Flow Process Diagram



4. Developed & technical design

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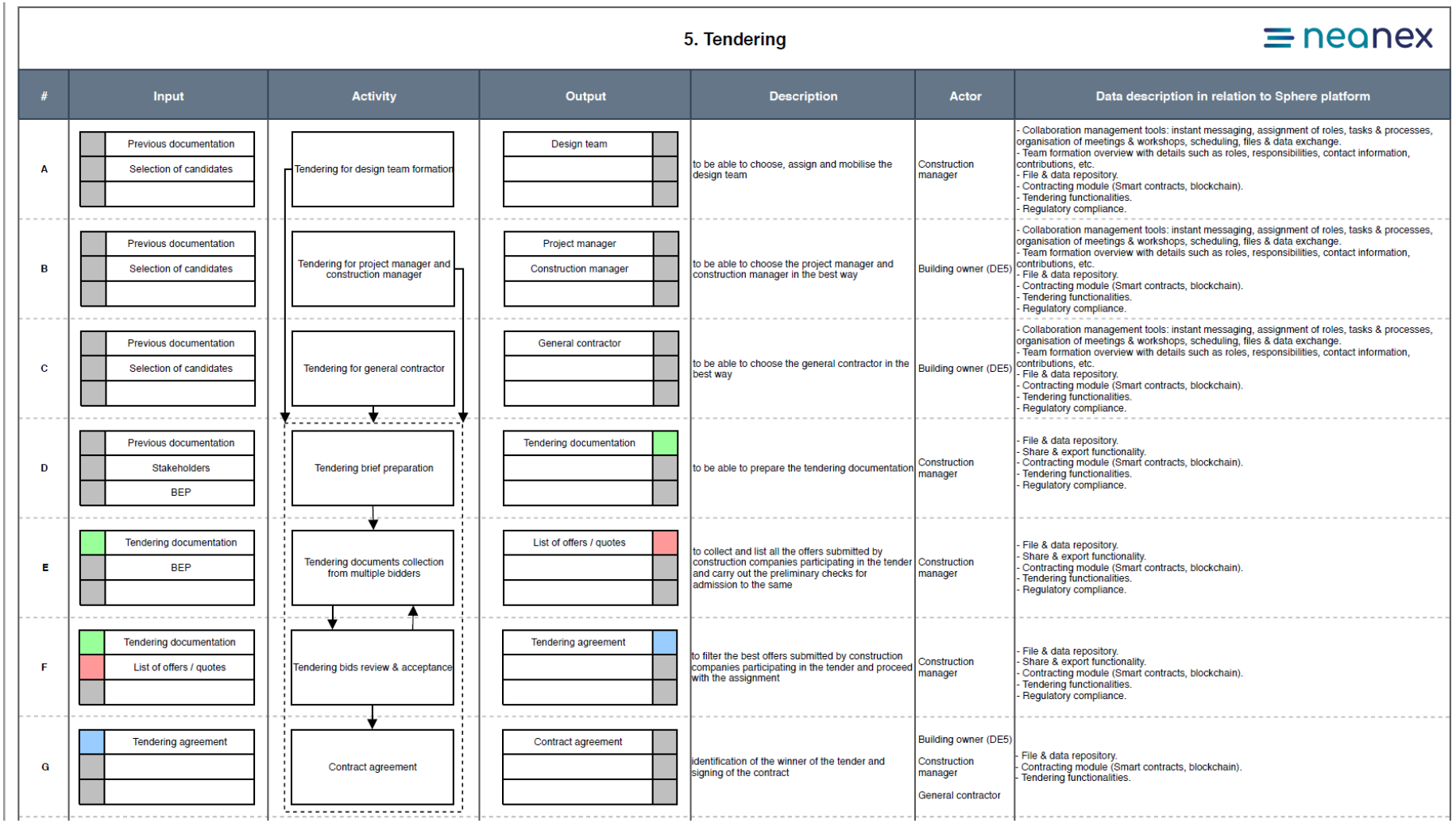
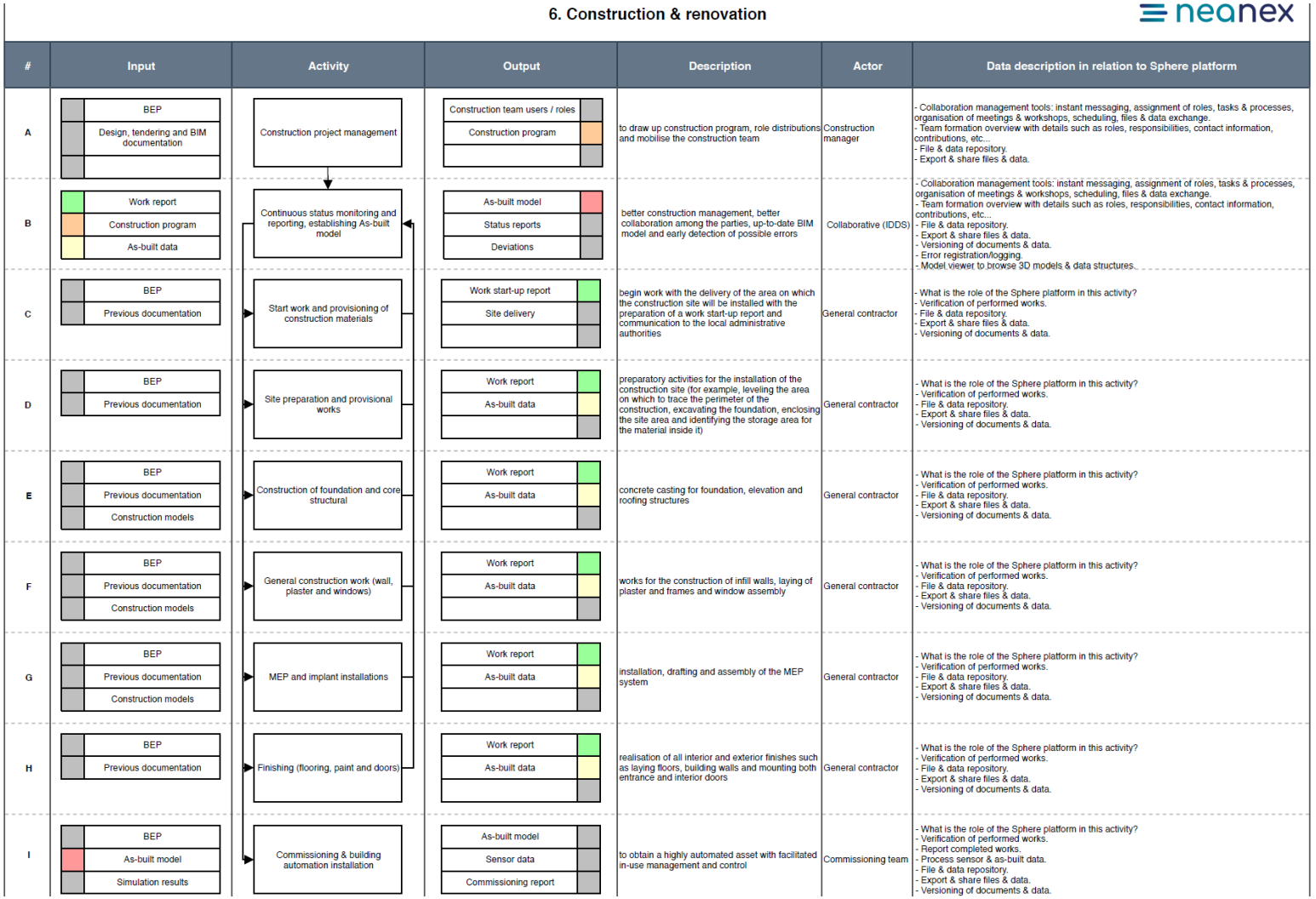
#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Technical design documentation Concept design documentation BEP	Developed & technical design preparations	Design team users/roles Management and strategy report	to be able to initiate detailed & technical design strategy and decisions	Project manager	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - File & data repository. - Export & share files & data.
B	Design documentation BIM documentation	Design workshops (design team, project lead, building owner)	Workshop reports	to exchange ideas among the joining parties regarding developed & technical design	Collaborative (IDDS)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - File & data repository. - Export & share files & data.
C	Design documentation BIM documentation	Developed & Technical design based on BIM	BIM library objects BIM model	to form BIM objects and have a BIM model in order to achieve high level of automation and benefit from BIM	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data. - Model viewer to browse 3D models & data structures.
D	Design documentation BIM documentation Preliminary simulation results	Simulations (Thermal)	Simulation results Energy modelling results	to anticipate the real time reaction of the asset under certain environmental conditions and further iterate the design based on the simulations results	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data. - Interface between BIM & simulations.
E	Design documentation BIM documentation	Life cycle assessment (LCA)	Life cycle assessment report	to be able to assess the environmental impacts caused by the asset through its life cycles (carbon footprint, embodied carbon, CO2 emissions, etc...)	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data. - Interface between BIM & LCA.
F	Design documentation BIM documentation	Life cycle cost (LCC)	Life cycle cost report	to be able to evaluate the overall costs of the activity through its life cycles (the economic resources used to produce energy and raw materials, ...)	Collaborative (IDDS)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data. - Interface between BIM & LCC.
G	Design documentation BIM documentation Bill of quantities	Cost analysis	Cost analysis report	to assess the material inventory and associated cost based on the BIM model	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data. - Interface between BIM & Cost analysis. - QTO from IFC, CMDB, ...
H	Workshop reports	Revision and finalising of the developed & technical design	Final developed & technical design	to iterate the developed & technical design based on the workshop feedbacks, finalise the design and update the BIM model	Design team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Export & share files & data.

Figure 18. Italian Pilot Tendering Phase Activity & Information Flow Process Diagram



#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Previous documentation Selection of candidates	Tendering for design team formation	Design team	to be able to choose, assign and mobilise the design team	Construction manager	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - File & data repository. - Contracting module (Smart contracts, blockchain). - Tendering functionalities. - Regulatory compliance.
B	Previous documentation Selection of candidates	Tendering for project manager and construction manager	Project manager Construction manager	to be able to choose the project manager and construction manager in the best way	Building owner (DE5)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - File & data repository. - Contracting module (Smart contracts, blockchain). - Tendering functionalities. - Regulatory compliance.
C	Previous documentation Selection of candidates	Tendering for general contractor	General contractor	to be able to choose the general contractor in the best way	Building owner (DE5)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - File & data repository. - Contracting module (Smart contracts, blockchain). - Tendering functionalities. - Regulatory compliance.
D	Previous documentation Stakeholders BEP	Tendering brief preparation	Tendering documentation	to be able to prepare the tendering documentation	Construction manager	- File & data repository. - Share & export functionality. - Contracting module (Smart contracts, blockchain). - Tendering functionalities. - Regulatory compliance.
E	Tendering documentation BEP	Tendering documents collection from multiple bidders	List of offers / quotes	to collect and list all the offers submitted by construction companies participating in the tender and carry out the preliminary checks for admission to the same	Construction manager	- File & data repository. - Share & export functionality. - Contracting module (Smart contracts, blockchain). - Tendering functionalities. - Regulatory compliance.
F	Tendering documentation List of offers / quotes	Tendering bids review & acceptance	Tendering agreement	to filter the best offers submitted by construction companies participating in the tender and proceed with the assignment	Construction manager	- File & data repository. - Share & export functionality. - Contracting module (Smart contracts, blockchain). - Tendering functionalities. - Regulatory compliance.
G	Tendering agreement	Contract agreement	Contract agreement	identification of the winner of the tender and signing of the contract	Building owner (DE5) Construction manager General contractor	- File & data repository. - Contracting module (Smart contracts, blockchain). - Tendering functionalities.

Figure 19. Italian Pilot Construction & Assembly Phase Activity & Information Flow Process Diagram



6. Construction & renovation

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	BEP Design, tendering and BIM documentation	Construction project management	Construction team users / roles Construction program	to draw up construction program, role distributions and mobilise the construction team	Construction manager	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - File & data repository. - Export & share files & data.
B	Work report Construction program As-built data	Continuous status monitoring and reporting, establishing As-built model	As-built model Status reports Deviations	better construction management, better collaboration among the parties, up-to-date BIM model and early detection of possible errors	Collaborative (IDDS)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - File & data repository. - Export & share files & data. - Versioning of documents & data. - Error registration/logging. - Model viewer to browse 3D models & data structures.
C	BEP Previous documentation	Start work and provisioning of construction materials	Work start-up report Site delivery	begin work with the delivery of the area on which the construction site will be installed with the preparation of a work start-up report and communication to the local administrative authorities	General contractor	- What is the role of the Sphere platform in this activity? - Verification of performed works. - File & data repository. - Export & share files & data. - Versioning of documents & data.
D	BEP Previous documentation	Site preparation and provisional works	Work report As-built data	preparatory activities for the installation of the construction site (for example, leveling the area on which to trace the perimeter of the construction, excavating the foundation, enclosing the site area and identifying the storage area for the material inside it)	General contractor	- What is the role of the Sphere platform in this activity? - Verification of performed works. - File & data repository. - Export & share files & data. - Versioning of documents & data.
E	BEP Previous documentation Construction models	Construction of foundation and core structural	Work report As-built data	concrete casting for foundation, elevation and roofing structures	General contractor	- What is the role of the Sphere platform in this activity? - Verification of performed works. - File & data repository. - Export & share files & data. - Versioning of documents & data.
F	BEP Previous documentation Construction models	General construction work (wall, plaster and windows)	Work report As-built data	works for the construction of infill walls, laying of plaster and frames and window assembly	General contractor	- What is the role of the Sphere platform in this activity? - Verification of performed works. - File & data repository. - Export & share files & data. - Versioning of documents & data.
G	BEP Previous documentation Construction models	MEP and implant installations	Work report As-built data	installation, drafting and assembly of the MEP system	General contractor	- What is the role of the Sphere platform in this activity? - Verification of performed works. - File & data repository. - Export & share files & data. - Versioning of documents & data.
H	BEP Previous documentation	Finishing (flooring, paint and doors)	Work report As-built data	realisation of all interior and exterior finishes such as laying floors, building walls and mounting both entrance and interior doors	General contractor	- What is the role of the Sphere platform in this activity? - Verification of performed works. - File & data repository. - Export & share files & data. - Versioning of documents & data.
I	BEP As-built model Simulation results	Commissioning & building automation installation	As-built model Sensor data Commissioning report	to obtain a highly automated asset with facilitated in-use management and control	Commissioning team	- What is the role of the Sphere platform in this activity? - Verification of performed works. - Report completed works. - Process sensor & as-built data. - File & data repository. - Export & share files & data. - Versioning of documents & data.

Figure 20. Italian Pilot Handover & Close Out Phase Activity & Information Flow Process Diagram

7. Handover and close out

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin Handover strategy	Undertake the tasks listed in the handover strategy	Completed handover	smooth and facilitated handover process	Construction manager	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Collecting building automation data. - File & data repository.
B	As-built model Building automation data Deviations	Delivery of As built information and monitor/ review progress and performance of construction (design team construction manager)	As-built models Performance reports	up-to-date BIM model, verification of the progress documents as per defects and deviations based on BIM	Collaborative (IDDS)	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Process building automation data and report. - File & data repository. - Versioning of documents & data. - Verification process. - Model viewer to check as-built data.

Figure 21. Italian Pilot In Use Phase Activity & Information Flow Process Diagram

8. In use

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin	Takeover and deliver to occupants	Occupant user / roles Facility manager	delivery	Building owner	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - File & data repository. - Contracting module (Smart contracts, blockchain) - Export & share files & data.
B	Maintenance tasks Simulation results Digital Twin	Continuous monitoring and reporting (to building owner and DE5)	Maintenance prediction Building optimisation Updated Digital Twin	to detect maintenance requirements, ensure occupant comfort, reduced operational costs (energy, water savings etc..)	Building automation team	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Continuous data monitoring and reporting. - Alerts when action is required. - File & data repository.
C	Maintenance tasks Maintenance data BIM model	Reactionary and planned maintenance	Maintenance reports Updated asset data	effective maintenance planning with reduced operation time and cost, efficient and on time intervention	Maintenance Service Company	- Collaboration management tools: instant messaging, assignment of roles, tasks & processes, organisation of meetings & workshops, scheduling, files & data exchange. - Maintenance logs/ tracking. - Alerts when action is required. - Model viewer to check & coordinate maintenance operation and cost verification. - Tools to optimise maintenance efficiency. - File & data repository.

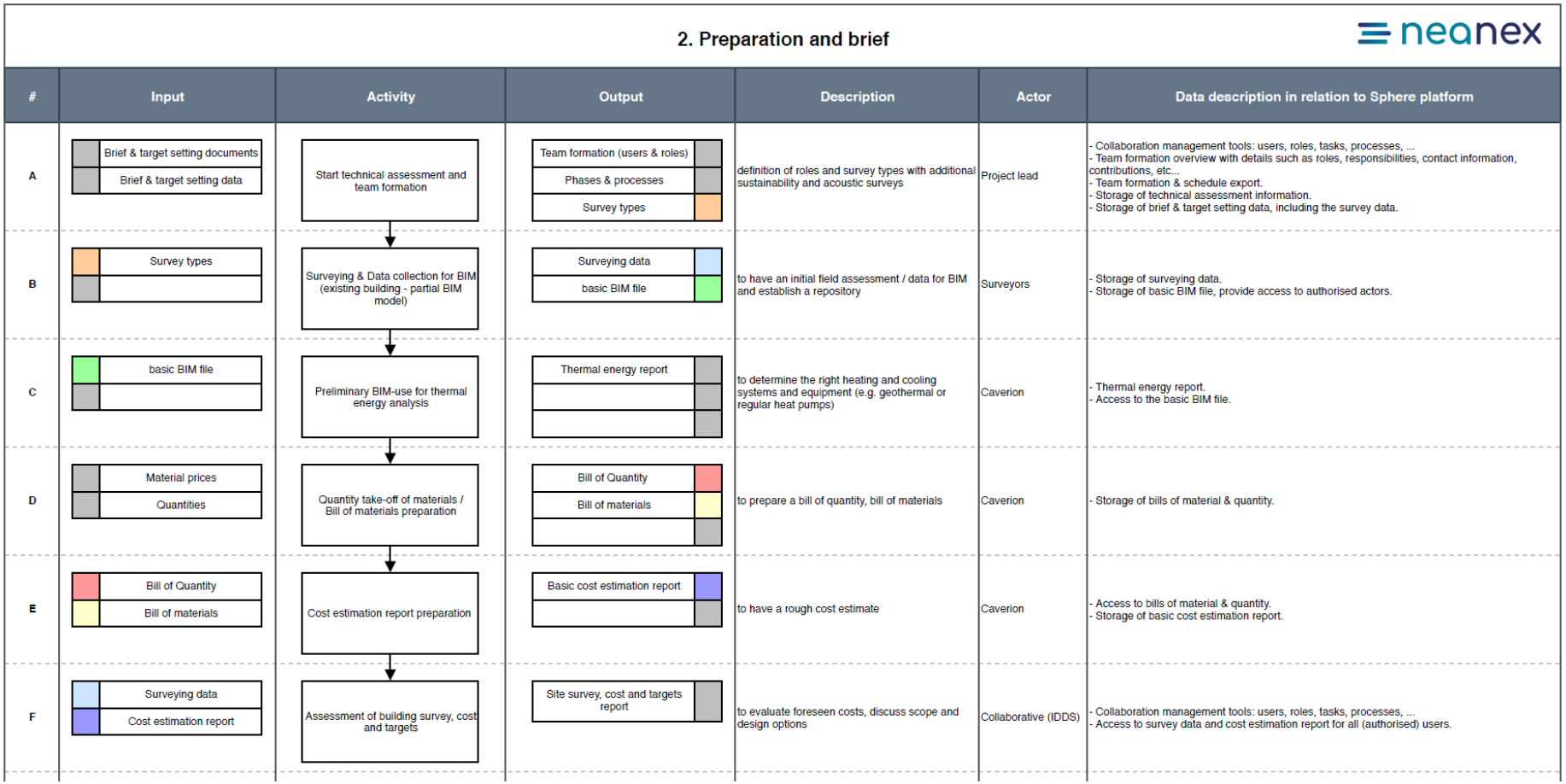
6.3 Activity & Information Flow process diagrams for the Finnish Pilot

Figure 22. Finnish Pilot Strategic Definition Phase Activity & Information Flow Process Diagram

1. Strategic definition

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Brief & target data/documents	Strategy and target setting	Brief template Strategic brief export	To be able to identify the overarching objective and performance criteria of the project	Caverion	- Project & collaboration management tools. - Data integration, data standardisation and access to the data (for authorised actors). - Brief template export & sharing options. - Basic project information and requirements/targets stored as a standard form. - Assessment of Digital Twin scope/configuration.

Figure 23. Finnish Pilot Preparation & Brief Phase Activity & Information Flow Process Diagram

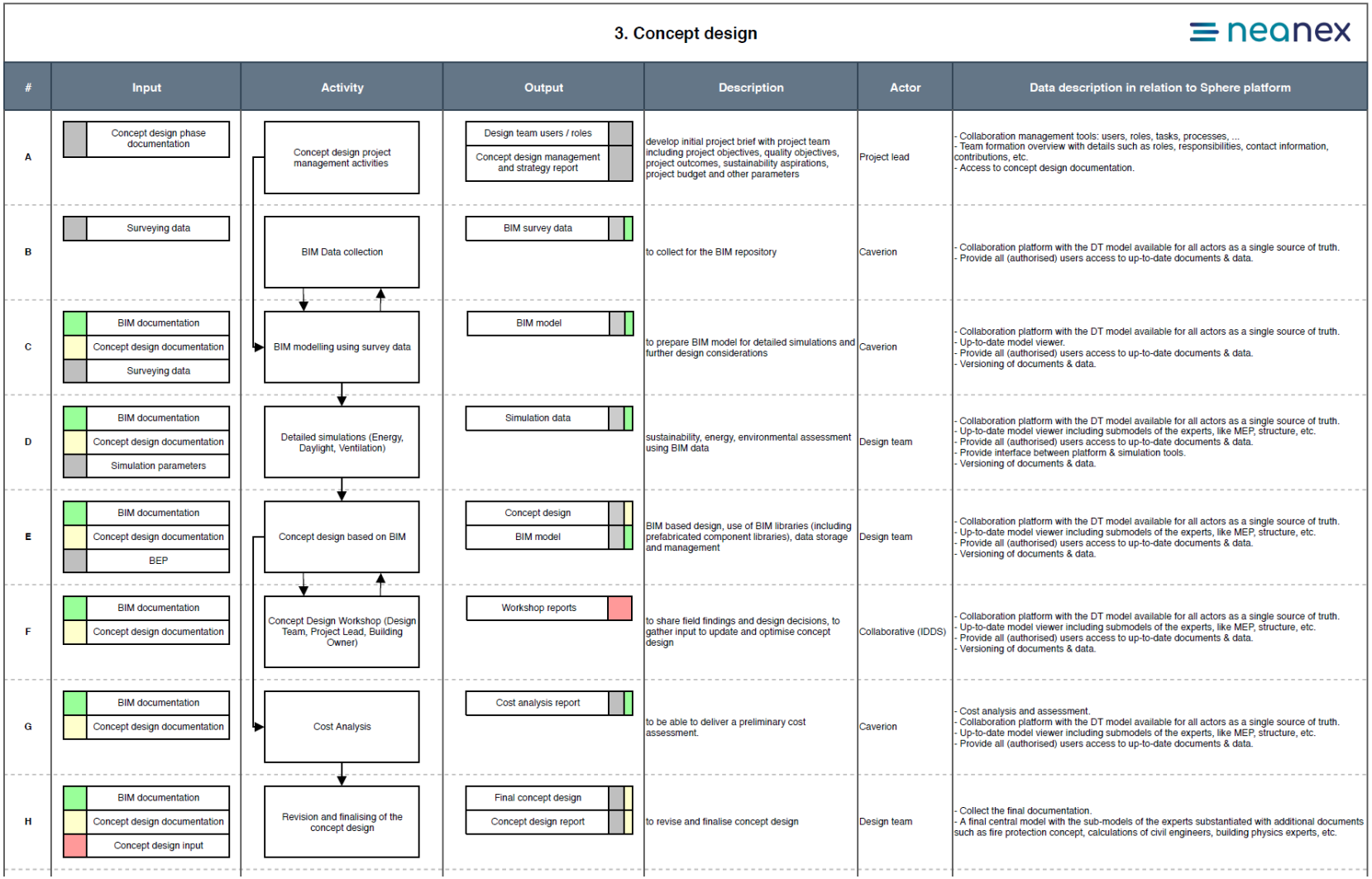


2. Preparation and brief

neanex

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Brief & target setting documents Brief & target setting data	Start technical assessment and team formation	Team formation (users & roles) Phases & processes Survey types	definition of roles and survey types with additional sustainability and acoustic surveys	Project lead	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - Team formation & schedule export. - Storage of technical assessment information. - Storage of brief & target setting data, including the survey data.
B	Survey types	Surveying & Data collection for BIM (existing building - partial BIM model)	Surveying data basic BIM file	to have an initial field assessment / data for BIM and establish a repository	Surveyors	- Storage of surveying data. - Storage of basic BIM file, provide access to authorised actors.
C	basic BIM file	Preliminary BIM-use for thermal energy analysis	Thermal energy report	to determine the right heating and cooling systems and equipment (e.g. geothermal or regular heat pumps)	Caverion	- Thermal energy report. - Access to the basic BIM file.
D	Material prices Quantities	Quantity take-off of materials / Bill of materials preparation	Bill of Quantity Bill of materials	to prepare a bill of quantity, bill of materials	Caverion	- Storage of bills of material & quantity.
E	Bill of Quantity Bill of materials	Cost estimation report preparation	Basic cost estimation report	to have a rough cost estimate	Caverion	- Access to bills of material & quantity. - Storage of basic cost estimation report.
F	Surveying data Cost estimation report	Assessment of building survey, cost and targets	Site survey, cost and targets report	to evaluate foreseen costs, discuss scope and design options	Collaborative (IDDS)	- Collaboration management tools: users, roles, tasks, processes, ... - Access to survey data and cost estimation report for all (authorised) users.

Figure 24. Finnish Pilot Concept Design Phase Activity & Information Flow Process Diagram



3. Concept design

neanex

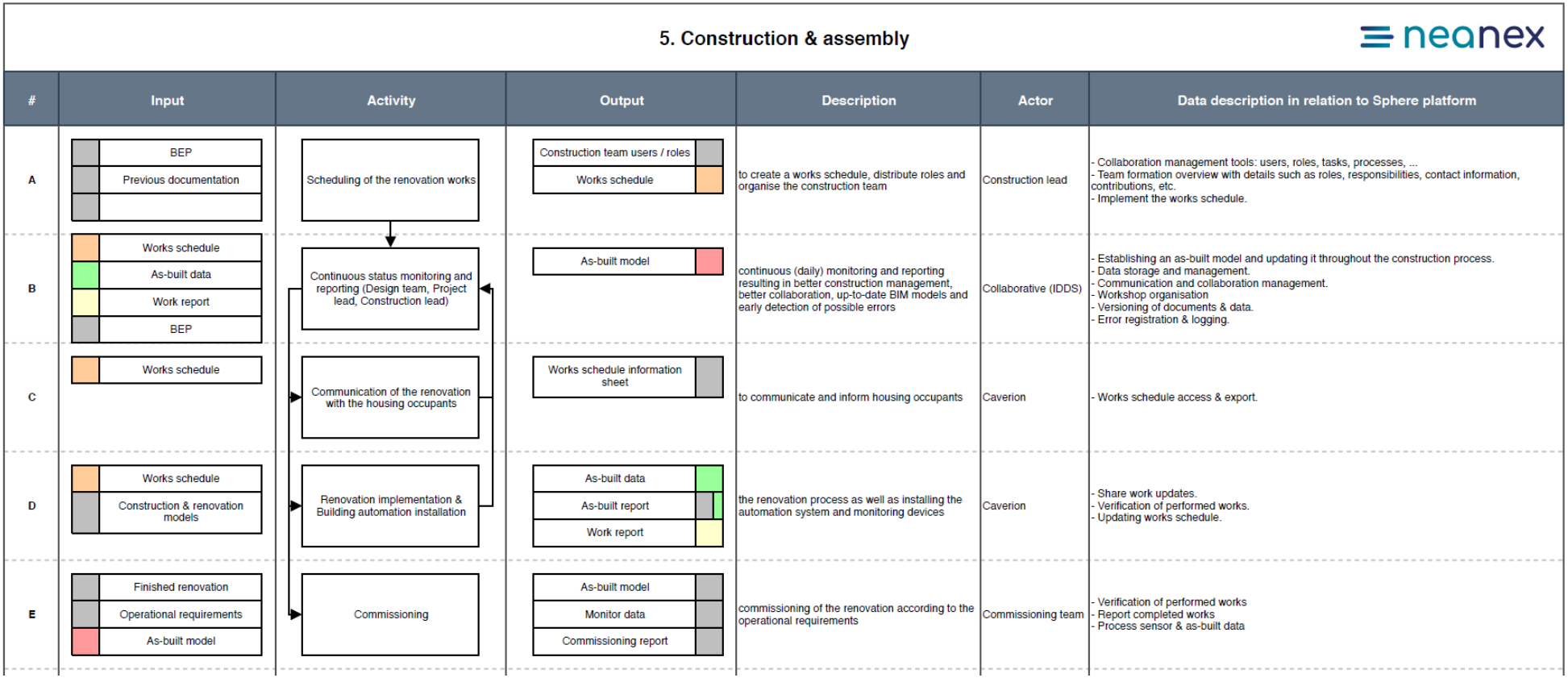
#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Concept design phase documentation	Concept design project management activities	Design team users / roles Concept design management and strategy report	develop initial project brief with project team including project objectives, quality objectives, project outcomes, sustainability aspirations, project budget and other parameters	Project lead	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - Access to concept design documentation.
B	Surveying data	BIM Data collection	BIM survey data	to collect for the BIM repository	Caverion	- Collaboration platform with the DT model available for all actors as a single source of truth. - Provide all (authorised) users access to up-to-date documents & data.
C	BIM documentation Concept design documentation Surveying data	BIM modelling using survey data	BIM model	to prepare BIM model for detailed simulations and further design considerations	Caverion	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer. - Provide all (authorised) users access to up-to-date documents & data. - Versioning of documents & data.
D	BIM documentation Concept design documentation Simulation parameters	Detailed simulations (Energy, Daylight, Ventilation)	Simulation data	sustainability, energy, environmental assessment using BIM data	Design team	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Provide interface between platform & simulation tools. - Versioning of documents & data.
E	BIM documentation Concept design documentation BEP	Concept design based on BIM	Concept design BIM model	BIM based design, use of BIM libraries (including prefabricated component libraries), data storage and management	Design team	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Versioning of documents & data.
F	BIM documentation Concept design documentation	Concept Design Workshop (Design Team, Project Lead, Building Owner)	Workshop reports	to share field findings and design decisions, to gather input to update and optimise concept design	Collaborative (IDDS)	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data. - Versioning of documents & data.
G	BIM documentation Concept design documentation	Cost Analysis	Cost analysis report	to be able to deliver a preliminary cost assessment.	Caverion	- Cost analysis and assessment. - Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data.
H	BIM documentation Concept design documentation Concept design input	Revision and finalising of the concept design	Final concept design Concept design report	to revise and finalise concept design	Design team	- Collect the final documentation. - A final central model with the sub-models of the experts substantiated with additional documents such as fire protection concept, calculations of civil engineers, building physics experts, etc.

Figure 25. Finnish Pilot Developed & Technical Design Phase Activity & Information Flow Process Diagram

4. Developed & technical design

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A		Given the size of the project - no iteration of technical design		to review and update project execution plan (BEP) based on the given size of the project (no iteration of technical design)	Project lead	

Figure 26. Finnish Pilot Construction and Assembly / Renovation Phase Activity & Information Flow Process Diagram



5. Construction & assembly

neanex

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	BEP Previous documentation	Scheduling of the renovation works	Construction team users / roles Works schedule	to create a works schedule, distribute roles and organise the construction team	Construction lead	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - Implement the works schedule.
B	Works schedule As-built data Work report BEP	Continuous status monitoring and reporting (Design team, Project lead, Construction lead)	As-built model	continuous (daily) monitoring and reporting resulting in better construction management, better collaboration, up-to-date BIM models and early detection of possible errors	Collaborative (IDDS)	- Establishing an as-built model and updating it throughout the construction process. - Data storage and management. - Communication and collaboration management. - Workshop organisation - Versioning of documents & data. - Error registration & logging.
C	Works schedule	Communication of the renovation with the housing occupants	Works schedule information sheet	to communicate and inform housing occupants	Caverion	- Works schedule access & export.
D	Works schedule Construction & renovation models	Renovation implementation & Building automation installation	As-built data As-built report Work report	the renovation process as well as installing the automation system and monitoring devices	Caverion	- Share work updates. - Verification of performed works. - Updating works schedule.
E	Finished renovation Operational requirements As-built model	Commissioning	As-built model Monitor data Commissioning report	commissioning of the renovation according to the operational requirements	Commissioning team	- Verification of performed works - Report completed works - Process sensor & as-built data

Figure 27. Finnish Pilot Handover and Close Out Phase Activity & Information Flow Process Diagram

6. Handover and close out

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin Handover strategy	Undertake the tasks listed in the handover strategy	Completed handover	smooth and facilitated handover process	Construction lead	- Digital Twin handover. - Clear definition of Digital Twin information in the performance report and building automation data.
B	As-built model Building automation data Deviations	Manage updating of 'As built' information and monitor/review progress and performance of construction	As-built model Performance reports	up-to-date BIM model, verification of the progress documents as per defects and deviations based on BIM	Design team	- Provide custom exports to specific data according to the actor, such as building owner, planner, facility manager, ... - Process building automation data and report - Store as-built models & reports (+ versioning) - Verification process

Figure 28. Finnish Pilot In Use Phase Activity & Information Flow Process Diagram

7. In use

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin	Deliver to building owner and service company that operates the building	Occupant users / roles	delivery	Building owner	- Facility management tool. - Custom exports. - New users & roles added for the asset maintenance.
B	Digital Twin Maintenance tasks Building automation data	Continuous monitoring and reporting (to building owner and Caverion)	Digital Twin Building optimisation Maintenance prediction	data provided from building automation system, directly provided to Caverion	Building automation	- Provide contacts for subcontractors/maintenance companies for dedicated maintenance or repairs. - Continuous data monitoring and reporting. - Alerts when action is required.
C	Digital Twin Building automation data	Update the digital data during the in-use phase (in parallel with maintenance)	Updated asset data	digital energy data, BIM data, maintenance information	Caverion	- Continuous data monitoring and reporting. - Asset data update. - Alerts when action is required.
D	Digital Twin Maintenance tasks Maintenance data	Reactionary and planned maintenance	Maintenance users / roles Maintenance reports Updated asset data	effective maintenance planning with reduced operation time and cost, efficient and on time intervention	Maintenance Service Company	- Maintenance logs & reports. - Maintenance users & roles. - Alerts when action is required.

6.4 Activity & Information Flow Process Diagrams for The Netherlands Pilot

Figure 29. Netherlands Pilot Activities for Strategic Definition Information Flow Process Diagram

1. Strategic definition

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Brief & target data/documents	Strategy and target setting	Brief template Strategic brief export	To be able to identify the overarching objective and performance criteria of the project with focus on energy and thermal comfort	TNO, Koppen Bouwexpert	-Format of KPI on thermal comfort and energy demand -Data integration, data standardisation and access to the data (for authorised actors). - Brief template export & sharing options. - Basic project information and requirements/targets stored as a standard form. - Assessment of Digital Twin scope/configuration.

Figure 30. Netherlands Pilot Activities for Preparation and Brief Activity & Information Flow Process Diagram

2. Preparation and brief

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	B&T setting documents B&T setting data	Start technical assessment and team formation	Team formation (users Phases & processes	definition of roles	TNO / Bouwexperts	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc... - Team formation & schedule export. - .
B	First 3D drafts	First 3D drafts	basic BIM file	to have an initial data for BIM and establish a repository	Koppen Bouwexperts	- - Storage of basic BIM file, provide access to authorised actors.
C	basic BIM file	Preliminary BIM-use for thermal energy analysis	Thermal energy report Energy caclulations	to determine the right heating and cooling systems and equipment (e.g. geothermal or regular heat pumps)	TNO Koppen Bouwexperts	- Thermal energy report. - Access to the basic BIM file - Energy calculation report.

Figure 31. Netherlands Pilot Activities for Design phases Activity & Information Flow Process Diagram

3. Concept design

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Concept design phase documentation	Concept design project management activities	Design team users / Concept design management and strategy report	develop initial project brief with project team including project objectives, quality objectives, project outcomes, sustainability aspirations, project budget and other parameters	TNO	- Collaboration management tools: users, roles, tasks, processes, ... - Team formation overview with details such as roles, responsibilities, contact information, contributions, etc. - Access to concept design documentation.
B	Surveying data	BIM Data collection	BIM survey data	to collect for the BIM repository	TNO	- Collaboration platform with the DT model available for all actors as a single source of truth. - Provide all (authorised) users access to up-to-date BIM file.
C	BIM documentation Concept design Surveying data	BIM modelling using survey data	BIM model	to prepare BIM model for detailed simulations and further design considerations	TNO	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer. - Provide all (authorised) users access to up-to-date documents & data. - Versioning of BIM & data.
D	BIM documentation Concept design Simulation parameters	Detailed simulations (Energy, Thermal comfort)	Simulation data	Energy and thermal comfortt using BIM data	TNO & Koppen Bouwexperts	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date BIM model - Provide all (authorised) users access to up-to-date BIM model & data. - Provide interface between platform & simulation tools. - Versioning of BIM & data.
E	BIM documentation Concept design BEP	Concept design based on BIM	Concept design BIM model	BIM based design, use of BIM libraries (including prefabricated component libraries), data storage and management	TNO & Koppen Bouwexperts & Contractor & Manufactorer	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date BIM model - Provide all (authorised) users access to up-to-date BIM Model & data. - Versioning of documents & data.
F	BIM documentation Concept design documentation	Concept Design Workshop (Design Team, Project Lead, Building Owner)	Workshop reports	to share field findings and design decisions, to gather input to update and optimise concept design	Collaborative (IDDS) TNO & Koppen Bouwexperts & Contrator & Manufactorer	- Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date BIM model - Provide all (authorised) users access to up-to-date BIM model & data. - Versioning of BIM Model & data.
G	BIM documentation Concept design documentation	Energy and thermal analysis	Energy and thermal comfort analysis	to be able to deliver a preliminary thermal and energy analysis	TNO & Koppen Bouwexperts	- Cost analysis and assessment. - Collaboration platform with the DT model available for all actors as a single source of truth. - Up-to-date model viewer including submodels of the experts, like MEP, structure, etc. - Provide all (authorised) users access to up-to-date documents & data.
H	BIM documentation Concept design documentation Concept design input	Revision and finalising of the concept design	Final concept design Concept design report	to revise and finalise concept design	Koppen Bouwexperts	Collect the final BIM file

Figure 32. Netherlands Pilot Activities for Handover and Close Out phases Activity & Information Flow Process Diagram

6. Handover and close out

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin Handover strategy	Undertake the tasks listed in the handover strategy	Completed handover	smooth and facilitated handover process	TNO / Koppen Bouwexperts	- Digital Twin handover. - Clear definition of Digital Twin information in the performance report and building automation data.
B	As-built model Building automation Deviations	Manage updating of 'As built' information and monitor/review progress and performance of construction	As-built model Performance reports	up-to-date BIM model, verification of the performance of building and system as per defects and deviations based on BIM	TNO /Koppen Bouwexperts /Contractor / Manufactorer	- Provide custom exports to specific data according to the actor, such as building owner, planner, facility manager, ... - Process building automation data and report - Store as-built models & reports (+ versioning) - Verification process

Figure 33: Netherlands Pilot Activities for In Use Phase Activity & Information Flow Process Diagram

7. In use

#	Input	Activity	Output	Description	Actor	Data description in relation to Sphere platform
A	Digital Twin	Deliver to building owner and Developer (NeroZero bv) responsable for the performance contractors	Occupant users / roles	delivery	Building owner/occupant Developer TNO Koppen Bouwexperts	- Micro services for energy and thermal comfort. -.
B	Digital Twin Maintenance tasks Building automation data	Continuous monitoring and reporting (to building owner and Nero Zero Bv)	Digital Twin Energy performance Thermal comfort	data provided for calculation thermal comfort and energy	TNO Koppen Bouw Experts Manufacturer	- Provide information for - Continuous data monitoring and reporting.
C	Digital Twin Building automation	Update the digital data during the in-use phase (in parallel with maintenance)	Updated Digital twin	digital energy data, BIM data, updated parameters of digital twins	TNO	- Continuous data monitoring and reporting. - Digital Twin update.
D	Digital Twin Maintenance tasks Maintenance data	Comparing garanteed performanceon energy and thermal comfort with actual performance	Feedback to Feeedback to occupant Complaince or non-compliance	Deriviation in performance, insight in causes either to occupant behaviour or buidling and installation performance	Nero Zero BV	Performance reports Compliance

7. User Scenarios and Interface Mock-ups

The series of user stories as identified in Chapter 5 can also be divided based on the roles for each type of AECO stakeholder. As such a pattern emerges of what user stories and related sub-modules a particular role, such as an architect or a building facility manager would carry out, and what interactions with the platform can be foreseen. A synthesis has been made based on the summary from the platform from these works as delivered in this chapter, in addition to an initial archetypical user interface that provides for the flexibility to deliver a scenario driven click-through for a user.

This Chapter will draw on the SPHERE platform functionality requirements and specifications, identified above, to produce a mock-up design of the SPHERE end-user platform. UCD and UX related principles will be used to justify the general aesthetic which is being displayed. This is an iterative process and therefore this deliverable aims to solely provide a basic foundation to be built upon in following work pages of the SPHERE project.

7.1 User Based UX Design

The platform will be of functional use for a variety of users during the lifecycle of a construction/renovation project. The general aesthetic of the SPHERE platform must remain consistent to ensure corporate identity and therefore the variety of users engaging with the platform must be considered in its design. The platform will be tailored to user groups, providing limited access to functionalities and stored documents. This will be achieved through admin-controlled authorisation for the logged in user.

A grid service listing approach will be used a basis for interfaces, this provides users with a clear overview of the functionalities available as well as providing guidance of the path to be followed to complete each user story experience. This will adhere to the simplicity and predictability usability heuristics. In addition, the platform will draw on the usability heuristics as shown in Figure 34 below to ensure that functionalities are clear and platform engagement experience is highly rated. [1]

20 Usability Heuristics	
User Control	Technical Clarity
Human Limitations	Flexibility
Modal Integrity	Fulfilment
Accommodation	Cultural Property
Linguistic Clarity	Sustainable Tempo
Aesthetic Integrity	Consistency
Simplicity	User Support
Predictability	Precision
Interpretation	Forgiveness
Accuracy	Responsiveness

Figure 34. Overview of heuristics to take into account for user experiences

[1] Weinschenk, S. & Barker, D., 2000. *Designing Effective Speech Interfaces / Weinschenk, Susan.* 1st ed.,

7.2 Adaptive UI Design Allowing Potential Scenarios for Backend Integration

The mock-ups for the SPHERE platform are presented with the potential to firstly use the services as external cloud services with existing user interfaces, where the whole service is delivered in the SPHERE platform within a container (frame). And secondly for the SPHERE platform to reach out to those services and calls via the predefined APIs based on the required functionalities and provide the received data and information into a standalone user interface.

7.2.1 Platform Interfaces

Here we will define potential navigational features that would successfully integrate the functionality requirements of the platform along with guiding users through the user stories in a cohesive and simple way.

Table 36. Operation of the SPHERE Platform is managed in two ways (pillars)

Life Cycle Phases	Direct access menu items
Strategic Definition	Messages
Preparation and Brief	Team
Concept Design	Tasks
Developed and Technical Design	Repository
Construction and Assembly/ Renovation	Synch
Hand over and Close Out	Account
In Use	

7.2.2 User Story Example

In order to demonstrate the potential use of the platform a mock-up of the interfaces that meet the requirements of an example user story is developed. During the course of the previous tasks, tasks in each phase for the pilots and the use of SPHERE Platform sub modules in each task were identified. Then software tool providers were asked to match their software with the SPHERE sub modules considering the functionalities of their software product. Based on these works, a mock-up for the User Story 34 in the Austrian Workflow is demonstrated.

Austrian Pilot: User Story 34 (Hand over & Close out)
After the Construction/Assembly Phase and commissioning of the asset, the Property Manager and Building Automation Team want to undertake the tasks listed in the Handover Strategy in order to achieve a smooth and facilitated handover process. As identified during the workshops with CREE**,** to carry on these activities on SPHERE Platform, Property Manager and Building Automation Team need to use the submodules ; *I4.M2.SM4 Progress Monitoring I4.M6.SM1 Handover Data Management,* which are matched with Flink2Go and Refurbify respectively.

To traverse through the user interface the user will carry out a selection of actions based on the building phase they are interested in (in the example handover and close out), and then select the desired operation of interest. An example this is shown below.

Actions: Select Phase Tasks menu → Select Hand Over and Close Out → Select Construction Operation → **Select I4.M.2.SM4. Progress Monitoring:** Constantly monitor the progress

Figure 35. Example Home Landing Page Interface

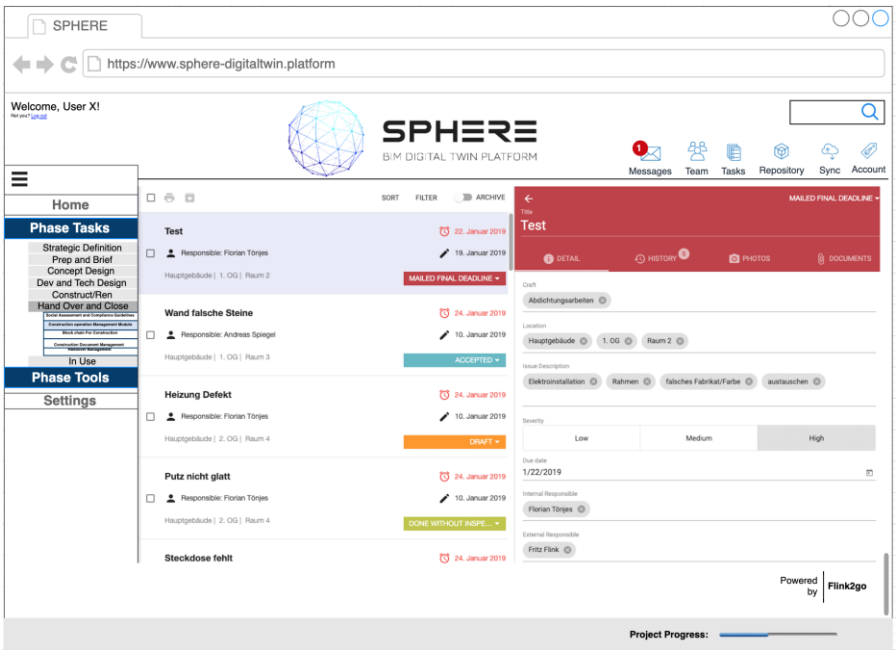


Figure 36. Sample Screenshot of the progress monitoring tool Flink2Go in SPHERE Platform

To proceed to other task user has to do the followings using the Handover & Close out menu → Select Handover Management Module → **Select I4.M.6.SM1. Handover Data Management:** Complete the handover using the building automation data and the Handover strategy

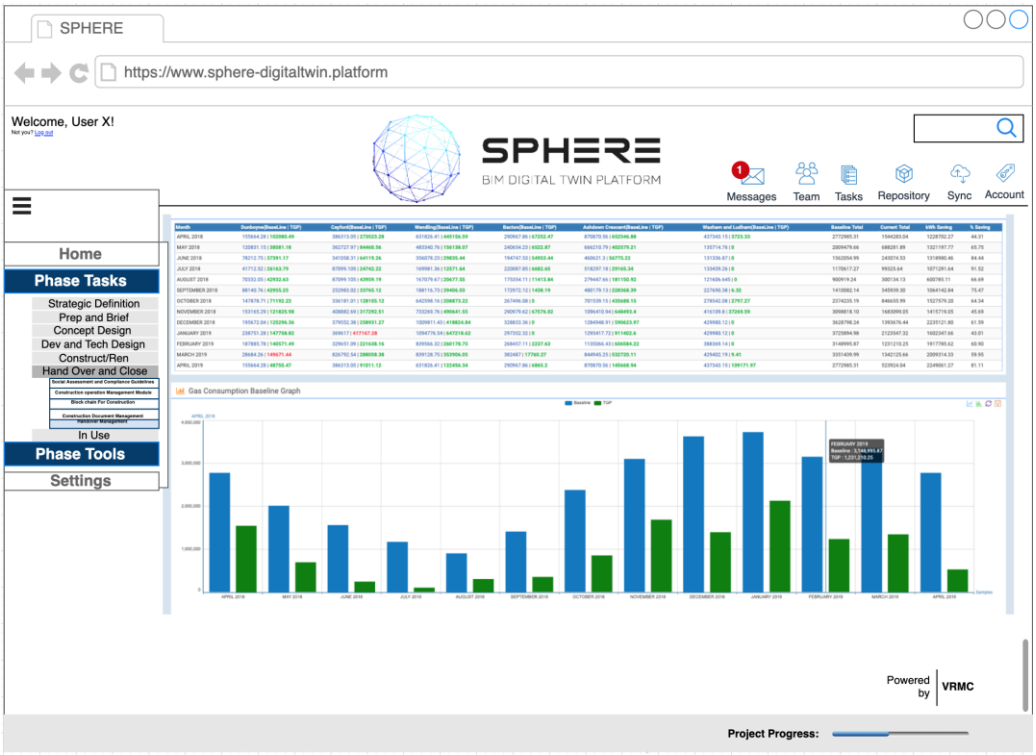


Figure 37. FLINK2GO Handover and Close Out with a different interface in the SPHERE wrapper

Once the task is completed → Select SPHERE icon to return to home screen or log out.

7.3 Future Interface Works:

As previously mentioned, these mock-ups aim to provide an initial overview of how platform functionalities will be integrated aesthetically into the SPHERE platform. This will be continued and expanded by the following work packages:

- **Task 2.4**: will carry out the User Centric Design and User Experience approach to ensure that the platform meets the usability heuristics.
- **WP3:** will deliver the architecture that will have an impact on the grid and presentation approach
- **WP4 and WP5:** will deliver the customised services of the platform along with further design and UX specifications. Additionally, within these work packages decisions on the use of style sheets and corporate identity shall be made to finalise the SPHERE platform aesthetic

8 Agile Development Methodology

8.1 What is Agile Development

Agile methodology allows the continuous iteration of development and testing throughout the software development life cycle of the project[2]. Known and expected benefits include:

- Stakeholder Engagement
- Transparency
- Early and Predictable Delivery
- Predictable Costs and Schedule
- Allows for Change
- Focuses on Business Value
- Focuses on Users
- Improves Quality

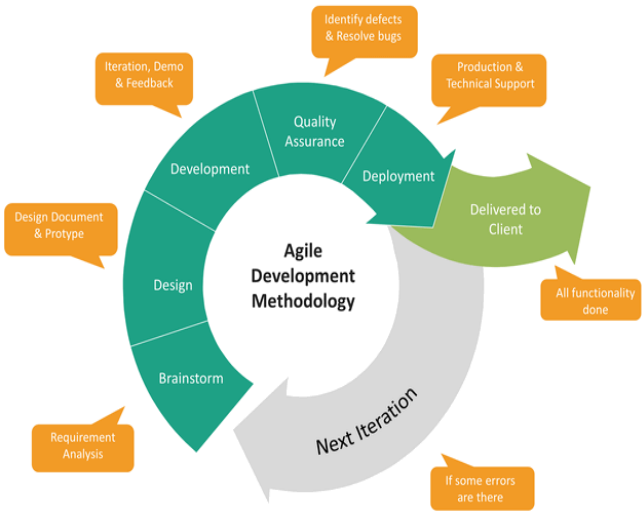


Figure 38. Agile development process and product launch stages

The process allows the delivery of selected (if necessary unstructured) components of the complete flow. The usually less formal and reduced scope of this approach also allows to speed up or bypass one or more life cycle phases when necessary.
Considering the interdisciplinary and complex requirements of the SPHERE project, a lot of which are very dependent on the digital building twin data structures that are emerging, the agile approach appears as a very good option for the continuous development of the functionalities.

The pilot actions and the various stakeholders involved in the pilots will also serve as a client-side feedback and approval mechanism in the project. The continuous development approach is also compliant with the cloud-based PaaS architecture, which allows easy and seamless integration and test of services. The agile approach will thus serve as a framework for the micro-management of the delivery of the value propositions foreseen in this document.

8.2 User Stories in Agile Development

User stories play a crucial role for the bottom up needs definition and the delivery of the intended user benefits. The user stories are simple narratives where the actors, their intentions and the set of actions they need to perform are identified. They provide the the developement team important context and associate tasks with the value they bring. User stories serve a number of key benefits as defined in Table 30 below.

[2] Jira, Agile development Online: https://www.atlassian.com/agile/project-management/workflow

Table 37. User Story Benefits and Utilisation to Support SPHERE

User Story Benefits	User Story Utilisation and Support to SPHERE
Stories keep the focus on the user. A To Do list keeps the team focused on tasks that need checked off, but a collection of stories keeps the team focused on solving problems for real users	The user centric approach of the SPHERE is supported by the user stories. Task 2.4 further elaborates the findings. **The final product is expected to provide direct benefits to the identified users within the studied workflows.**
Stories enable collaboration. With the end goal defined, the team can work together to decide how best to serve the user and meet that goal.	The user stories of SPHERE allow the integration of various backend services to deliver the expected benefits. Functional Input/Output definitions are made with relation to the user stories. **The Digital Twin data backend serves as a consolidating data service to support the collaboration.**
Stories drive creative solutions. Stories encourage the team to think critically and creatively about how to best solve for an end goal	The user story approach has been utilised with the pilot field users and potential stakeholders. **The approach serves as an innovative platform for the transition of the use of digitised processes and common digital twin configuration practices.**
Stories create momentum. With each passing story the development team enjoys a small challenges and a small win, driving momentum	The SPHERE project relies on the integration of the various background and customised tools. **The agile approach, supported by a central data backend service, provides the independent progress of the capabilities, thus allowing the parallel processing and integration when applicable. Teams will have autonomy on the delivery of the story requirements and ability to use their own performance metrics.**

The stories serve both a top down approach where high level ambitions, called initiatives are used to define the needs, as well as a bottom up approach, where free text needs can be identified and later clustered as presented in the figure [on the right]. The below figure delivers an exemplary breakdown of the use of user stories for the overarching ambition of SPHERE, broken down as a module and its user stories.

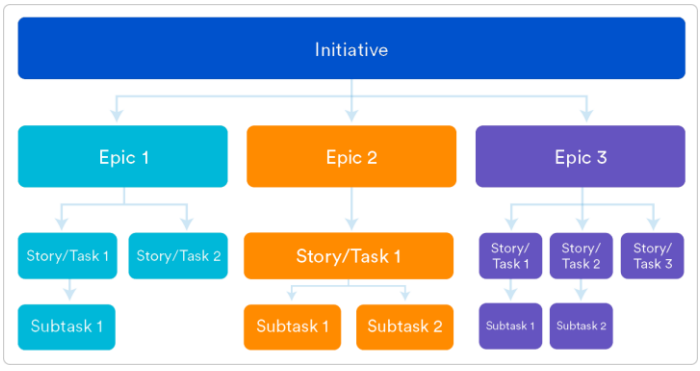


Figure 39. Breakdown of work in Initiatives, Epics, Tasks and Subtasks

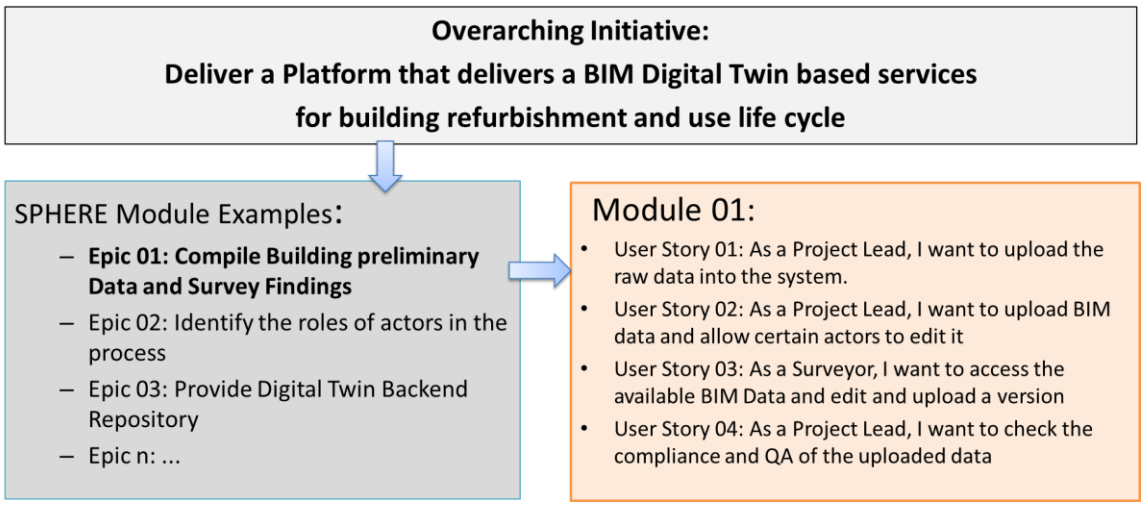


Figure 40. Example of an Initiative, Epic and User Story relationship

8.3 SPHERE Project's use of Agile Development

As a market oriented innovative product development project, SPHERE methodology and work packages are designed to serve the agile approach. The core steps of learning, building and measuring of the delivered results, are carried out in the respected work packages in an iterative approach .As figure 41 showcases, the initial phase of needs assessment and definitions, which have been carried in relation to the Pilot stakeholders' and market needs, will be further designed, developed and delivered. The continuous iteration of the project will provide an efficient and beneficial final SPHERE platform.

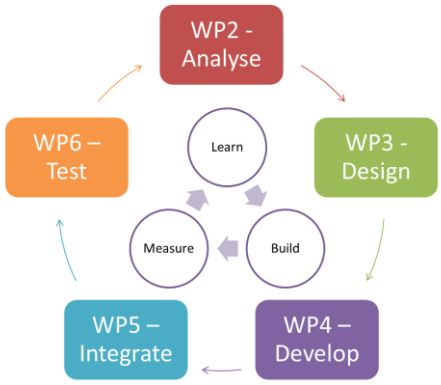


Figure 41. Work-Package relationships

Benefits of the Agile Integration Approach Existing Services and Technologies

The related software capabilities of all partners are defined that allow the exploitation of previously tested and utilised functionalities to be integrated into the workflows of SPHERE and strengthen the value proposition of the platform. The collected background information includes:

- The known barriers / pains and how the solutions propose to relieve them (Deliverable 2.1)
- The functions related to the renovation and construction process and SPHERE platform (Chapter
- The input/output data structures (Work-package 3 based on information flows in Chapter 6)
- The accessibility and architecture (Work-package 3)

This chapter forms a section of the Software Functional Specifications, identifying the existing situation and allowing the SPHERE platform to build on top the assets. The works will be moved forward in the XWIKI SPHERE platform (described in section 3.12).

9 Conclusions

9.1 Summary of Achievements

At a technical level the works in this deliverable have achieved the purposes as set out in the project's Description of Activities (DoA). To provide for the user stories for the SPHERE platform including new Integrated Design and Delivery Service (IDDS) user stories (Chapter 5), the related features to create full use cases (Appendices A and B), and the relations to the demonstration pilot company needs to start the user scenarios. Also a full listing of platform needs in terms of software modules and sub-modules has been delivered (Chapter 4). Creating the **platform functionality requirements** (chapter 4), the more detailed **user requirements** based on the user stories (Chapter 5), as well as the information flow requirements based on the piloting activities (Chapter 6).

The achievements also include the groundwork for user interfaces and user experiences, by delivering a methodology for setting user scenarios (Chapter 7). Including how different users would experience traversing through the interfaces and how different software tool interfaces could be integrated into the SPHERE platform overall interface, so as to provide for a united single service platform environment. A number of mock-ups where created for an example user scenario and described to other partners for feedbacks. Finally, the Agile Software Methodology is described (chapter 8) for the software implementation approach of the platform, in combination with the Quality Assurance Methodology and the implementation platform of the XWIKI that contains a digital version of all the information in this deliverable (described briefly in section 3.12 and in more detail in deliverable 2.4).

9.2 Relation to Continued Developments

The works in this report will be carried forward to establish the technical architecture of the SPHERE platform. It will help to make key decisions, including what needs to be improved within the existing software tools to be advanced to fit with the AECOO user requirements, what additional functionalities will need to be developed in the architecture for the SPHERE platform to fit with the demonstration company needs. It also helps by providing the groundwork for defining the data architecture of the platform, by having compiled a large number of needed information flows, and by starting to define specific features that components in the platform will need to have. And finally, it provides the basis for implementing an IDDS guideline sub-module, that will guide the implementation of IDDS as a collaborative practice across the building life cycle. As such, the report provides a compass for future development, in the form of a critical overview of the integrated capabilities of the platform for further development. More specific relating to further tasks in the SPHERE project has been described in section 2.5 of Chapter 2.

9.3 Lessons Learned

The works carried out with all 19 partners demonstrate the living practice of collaborations in a large multi-year European project. Communication and collaboration mostly through the internet, for delivery of the needs of users for a complex platform that is envisioned by the SPHERE consortium has been complicated and has required a constructive and problem-solving approach with substantial

patience in delivering meaningful insights and ideas. One of the challenges has been to break-down the development work sufficiently into smaller tasks and generate a structure for collaborations rapidly, without being overwhelmed by knowledge gaps or uncertainty, so as to deliver outputs at the right pace and right level. To this end a new approach is proposed for working on the same deliverable with such a large group, based on the idea of one or more core-groups and a wider task group. The core-groups consisting of up to 5 organisations representatives at maximum, to work on particular parts. Subsequently these are sent for review and discussed by the large group in the consortium. In this manner there is more space for specific discussions and interactions that works more effectively. This structure has been found to work well especially when the works can be broken down well and distributed easily among different core groups and wider task group.

Beyond the operational lessons learnt, also a number of new insights have come about in the deliverable works for the SPHERE project. The further study of IDDS practices from Deliverable 2.1 has led to the creation of a number of user stories that will help to integrate IDDS further in the SPHERE platform. The study of the 18 software tools by providers has led to cross-learnings for the platform consortium partners about each of the tools to be brough into the platform. The evaluation of the user requirements by the pilot partners as users has delivered lessons for the tool providers on more specific needs for their tools. And finally, the evaluation of the user interfaces and agile development practices has led to the basis for delivery in the project and provides alignment lessons for the consortium partners.

10 Acronyms

Table 38. Acronyms utilised in the SPHERE Project

1	**2D**	Second Dimension in BIM (plane)
2	**3D**	Third Dimension in BIM (volume)
3	**4D**	Fourth Dimension in BIM (Time, Scheduling, Planning)
4	**5D**	Fifth Dimension in BIM (Cost, Budget)
5	**6D**	Sixth Dimension in BIM (Sustainability)
5	**7D**	Seventh Dimension in BIM (Facilities Management, Life Cycle)
6	**8D**	Eighth Dimension in BIM (Safety & Security)
7	**9D**	Ninth Dimension in BIM (Lean Construction)
8	**AC**	Activities Table (CPIC Uniclass 2)
9	**ACE**	Architects Council of Europe
10	**ACFM**	Associació Catalana de Facility Management
11	**ACT**	American Council for Technology
12	**AD4**	Asset Data Dictionary Definition Document (Crossrail Limited)
13	**ADM**	Activity Definition Model
14	**ADMM**	Asset Data Management Manual (Highways Agency)
15	**ADQ**	Actual Digital Questions (from BIM Acronyms Dictionary)
16	**AEC**	Architecture, Engineering and Construction
17	**AECO**	Architecture, Engineering, Construction and Owner (or Owner-operated, or Operation)
18	**AEV**	Alternative Equivalent Value
19	**AGC**	Associated General Contractors (USA)
20	**AIA**	American Institute of Architects
21	**AIM**	Asset Information Model/Modelling
22	**AIMS**	Asset Information Management System (Crossrail Limited)
23	**AIR**	Asset Information Requirements
24	**ALM**	Asset Lifecycle Management
25	**ALM**	Application Lifecycle Management
26	**AM**	Asset Management
27	**AMF**	Asset Management Framework

28	**AMO**	Asset Management Office (Highways Agency)
29	**AMP**	Agreed Maximum Price
30	**AMR**	Automatic Meter Reading
31	**APCE**	Associació de Promotors i Constructors d'Edificis de Catalunya
32	**API**	Application Programming Interface
33	**APM**	Association for Project Management
34	**APPs**	Applications
35	**ASHRAE**	American Society of Heating Refrigerating and Air-Conditioning Engineers
36	**AR**	Augmented Reality
37	**AS**	Appraisal of Service
38	**ASP**	Application Service Provider
39	**ATTR**	Average Time to Repair (see MTTR)
40	**Avanti**	(UK Government sponsored to assist collaboration)
41	**B&ES**	Building and Engineering Services Association (formerly, till 2012, known as HVCA). (See BESA)
42	**BACS**	Building Automation and Control System
43	**BAS**	Building Automation System
44	**BCF**	BIM Collaboration Format
45	**BCHS**	Barcode Housing System
46	**bcXML**	Building and Construction eXtensible mark-up Language
47	**BDS**	Building Description System
48	**BEIF**	Built Environment Information Fabric
49	**BEIS**	Business, Energy and Industrial Strategy
50	**BEM**	Building Energy Management
51	**BEMS**	Building Energy Management System
52	**BEP**	BIM Execution Plan
53	**BEP**	Building Energy Performance
54	**BERR**	Business, Enterprise and Regulatory Reform
55	**BES**	Building Energy Simulation
56	**BESA**	Building Engineering Services Association (See B&ES)
57	**BIM**	Building Information Model/Modelling/Management
58	**BIM(M)**	Building Information Modelling and Management

59	**BIS**	Business, Innovation and Skills (See BEIS)
60	**BLIS**	Building Lifecycle Interoperable Software
61	**BLPU**	Basic Land and Property Unit
62	**BMS**	Building Management System
63	**BMS**	Battery Management System
64	**BOM**	Building Office Manager
65	**BOM's**	Building Object Models
66	**BOOT**	Build-own-operate-transfer (See BOT)
67	**BOQ**	Bill of Quantities (See BOQ)
68	**BOT**	Build-Operate Transfer (See BOOT)
69	**BPEP**	BIM Project Execution Plan
70	**BPI**	Building Performance Indicator
71	**BPIC**	Building Project Information Committee
72	**BPMN**	Business Process Model and Notation
73	**BQ**	Bill of Quantities (See BOQ)
74	**BQBS**	Bill of Quantities (or BQ) Breakdown Structure
75	**BRE**	Building Research Establishment
76	**BREEAM**	Building Research Establishment Environmental Assessment Method
77	**BRep**	Boundary Representation
78	**BrIM**	Bridge Information Model
79	**BS**	British Standard
80	**BSA**	Building Smart Alliance
81	**BSD**	Building Systems Design
82	**bSDD**	buildingSMART Data Dictionary
83	**BSI**	British Standards Institute
84	**BSI**	Building Smart International
85	**BSIM**	Building Services Information Model (See BIM)
86	**BSRIA**	Building Services Research and Information Association
87	**CA**	Contract Administrator
88	**CAATEEB**	Col·legi de'Aparelladors, Arquitectes Tècnics i Enginyers d'Edificació de Catalunya
89	**CAD**	Computer-Aided Design

90	**CADD**	Computer-Aided Design and Drafting
91	**CAFM**	Computer-Aided Facility Management
92	**CAM**	Computer Aided Manufacture
93	**CAPex**	Capital Expenditure
94	**CAR**	Collection, Assessment and Response
95	**CASBEE**	Comprehensive Assessment System for Building Environmental Efficiency
96	**CATIA**	Computer Aided Three-dimensional Interactive Application
97	**CAWS**	Common Arrangement of Work Sections
98	**CBC**	Construction Blockchain Consortium
99	**CBS**	Cost Breakdown Structure
100	**CCIP**	Contractor Controller Insurance Program
101	**CCMS**	Construction Coordination Management Services
102	**CCOs**	Contract Change Orders
103	**CD**	Compact Disc
104	**CDE**	Common Data Environment
105	**CDF**	Common Data Format
106	**CDM**	Construction (Design and Management) Regulations
107	**CDPA**	Copyright, Designs and Patent Act
108	**CE**	Construction Excellence
109	**CEC**	Commission for Environmental Cooperation
110	**CECE**	Committee for European Construction Equipment
111	**CEN**	European Committee for Stantardisation
112	**CEO**	Chief Executive Officer
113	**CERL**	Construction Engineering Research Laboratory (USACE)
114	**CFC**	Chlorofluorocarbon
115	**CFD**	Computational Fluid Dynamics
116	**CFR**	Central Facilities Repository
117	**CFRP**	Carbon Fiber Reinforcement Polymer
118	**C/I**	Civils/Infrastructure
119	**CI**	Configuration Item
120	**CI**	Continuous Improvement (the same as CIP and CPI)

121	**CIAT**	Chartered Institute of Architectural Technologists
122	**CIB**	International Council for Research and Innovation in Building and Construction (Ant. Conseil International du Bâtiment)
123	**CIBSE**	Chartered Institution of Building Services Engineers
124	**CIC**	Construction Industry Council
125	**CIFE**	Center for Integrated Facility Engineering (Stanford University)
126	**CIM**	City Information Modelling
127	**CIOB**	The Chartered Institute of Building
128	**CIP**	Continuous Improvement Process
129	**CIR**	Contractor's Information Requirements
130	**CIS**	Construction Information Service
131	**CITE**	Construction Industry Trading Electronically
132	**CityGML**	City Geography Markup Language
133	**CL**	Construction Lean (see Lean Construction)
134	**CM**	Construction Manager
135	**CMa**	Construction Manager Advisor
136	**CMAA**	Construction Management Association of America
137	**CMAR**	Construction Management At Risk (the same as CMc)
138	**CMc**	Construction Manager as Constructor (the same as CMAR)
139	**CMDB**	Configuration Management Database
140	**CMM**	Capacity Maturity Model
141	**CMM**	Coordinate Measurement Machine
142	**CMMS**	Computerized Maintenance Management System
143	**CO**	Complexes Table (CPCI Uniclass 2)
144	**COAC**	Col·legi Oficial d'Arquitectes de Catalunya
145	**COBie**	Construction Operations Building information Exchange
146	**COEIC**	Col·legi Oficial d'Enginyers Industrials de Catalunya
147	**COINS**	Construction Industry Software
148	**COP**	Coefficient of Practice
149	**COP**	Coefficient of Performance
150	**COS**	Conditions of Satisfaction
151	**CPD**	Continuing Professional Development

152	**CPI**	Coordinated Project Information
153	**CPI**	Continuous Process Improvement (the same as CIP)
154	**CPIC**	Construction Project Information Committee (also named CPI)
155	**CPIX**	Construction Project Information Xchange
156	**CPMS**	Capital Planning and Management System
157	**CPR**	Construction Progress Reporting
158	**CPS**	Cyber Physical Systems
159	**CPU**	Central Processing Unit
160	**CR**	Clash Rendition
161	**CRC**	Carbon Reduction Commitment
162	**CRL**	Crossrail Limited
163	**CRS**	Coordinate Reference System
164	**CRV**	Capitalised Replacement Value
165	**CSA**	Coordination and Support Actions
166	**CSCW**	Computer Supported Collaborative Working
167	**CSG**	Constructive Solid Geometry
168	**CSI**	Construction Specifications Institute
169	**CTE**	Código Técnico de Edificación (Spain)
170	**CURT**	Construction Users Roundtable
171	**D**	Deliverable
172	**D2RQ**	Database to RDF Query
173	**DB – D&B**	Design-Build
174	**DB**	Documento Básico (Spain)
175	**DBB**	Design-Bid-Build
176	**DBC**	Design Build Contract
177	**DBFM**	Design-Build-Finance-Maintain
178	**DBFO**	Design, Build, Finance, Operate
179	**DBIA**	Design Build Institute of America
180	**DBMS**	Data Base Management System
181	**DDBB**	Databases
182	**DBB**	Design Bid Build
183	**DCF**	Discounted Cash Flow

184	**DCLG**	Department for Communities and Local Government
185	**DDS**	Data Design System
186	**DFMA**	Design for Manufacturer and Assembly
187	**DfT**	Department for Transport
188	**DIUS**	Department for Innovation, Universities and Skills
189	**DL**	Description Logic
190	**DL**	Deadline
191	**DL**	Deep Learning
192	**DLT**	Distributed Ledger Technology
193	**DGNB**	Deutsche Gesellschaft für Nachhaltiges Bauen
194	**DHW**	Domestic Heat Water
195	**DMP**	Data Management Plan
196	**DMS**	Document Management System
197	**DNA**	Deoxyribonucleic acid
198	**DoA**	Description of Action
199	**DPB**	Discounted Pay-Back
200	**DPP**	Developed Constructor Proposal
201	**DRC**	Depreciated Reinstatement Cost
202	**DSM**	Design Structure Matrix
203	**DSS**	Data Security Standard
204	**DSS**	Decision Support System
205	**DT**	Digital Twin
206	**DTA**	Digital Twin Aggregate
207	**DTE**	Digital Twin Environment
208	**DTI**	Digital Twin Instance
209	**DTI**	Digital Twin Institute
210	**DTP**	Digital Twin Platform
211	**DTP**	Digital Twin Prototype
212	**DTT**	Digital Twin Technologies
213	**DTV**	Design Transfer View
214	**DU**	Dumb, Uncommunicative
215	**DXF**	Drawing eXchange Format

216	**DXF**	DaTA eXchange Format
217	**EAB**	External Advisory Board
219	**EAM**	Enterprise Asset Management
219	**EBS**	European BIM Summit
220	**EC**	European Commission/Committee
221	**ECAS**	European Commission Authentication Service
222	**ECD**	Entorno Común de Datos
223	**ECI**	European Construction Institute
224	**ECI**	Early Contractor Involvement
225	**ECI**	Environmental Cost Indicator
226	**ECM's**	Energy Conservation Measures
227	**EDCE**	Energy Demand Calculation Engine
228	**EDI**	Electronic Data Interchange
229	**EDM**	Electronic Distance Measurement
230	**EDMS**	Electronic Distance Measurement System
231	**Ee**	Elements Table (CPIC Uniclass 2)
232	**EE**	Energy Efficiency
233	**EEAB**	External Expert Advisory Board
234	**EEB**	European Environmental Bureau
235	**EED**	Energy Efficiency Directive
236	**EEO's**	Energy Efficiency Obligations
237	**EER**	Energy Efficiency Ratio
238	**EF**	Environmental Footprint
239	**EIF**	European Interoperability Framework
240	**EIR**	Employer's Information Requirements
241	**ELCD**	European Reference Life Cycle Database
242	**ELSC**	Enterprise Leadership Steering Committee
243	**EMS**	Energy Management System
244	**En**	Entities Table (CPIC Unicalss 2)
245	**EN**	EuroNorm
246	**EOL**	End of Life
247	**EOTA**	European Organisation for Technical Approvals

248	**EP**	European Parliament
249	**EPBD**	Energy Performance of Buildings Directive
250	**EPC**	Energy Performance Contract
251	**EPC**	Energy Performance Certificate
252	**EPPM**	Engineering, Project, and Production Management
253	**EQM**	European Quality Mark
254	**ER**	Exchange Requirements
255	**ERDC**	Engineering Research and Development Center
256	**ERP**	Enterprise Resource Planning
257	**ESCO**	Energy Service Company
258	**ESR**	Evaluation Summary Report
259	**ESEER**	European Seasonal Energy Efficiency Ratio
260	**ETC**	Engineering and Technology Board
261	**ETCP**	European Construction Technology Platform
262	**ETL**	Extract, Transform and Load
263	**ETPIS**	European Technology Platform on Industrial Safety
264	**ETSI**	European Telecommunication Standards Institute
265	**EUI**	Energy Use Intensity
266	**EUPPD**	European Union Public Procurement Directive
267	**EUQ**	Element Unit Quantity
268	**EUR**	Element Unit Rate
269	**EVA**	Earned Value Analysis
270	**EVO**	Efficiency Valuation Organization
271	**EWP**	Early Works Packages
272	**FAIR**	Findable, Accessible, Interoperable, Reusable
273	**FCI**	Facilities Condition Index
274	**FCI**	Function Condition Indexation
275	**FEE**	Fabric Energy Efficiency
276	**FET**	The field-effect transistor
277	**FFE**	Furniture, Fitting and Equipment
278	**FFL**	Finished Floor Level
279	**FFP**	Fitness for Purpose

280	**FIEC**	European Construction Industry Federation
281	**FIM**	Facilities Information Model
282	**FM**	Facility/ies Management
283	**FMA**	Facilities Management Association
284	**FMI**	Facilities Maintenance Indexation
285	**FMP**	Forward Maintenance Plans (or programme)
286	**FOAF**	Friend of a Friend
287	**FRI**	Function Re-investment Indexation
288	**FRS**	Factory Replication
289	**FRS**	Front Running Simulation
290	**FRS**	First Run Studies
291	**FTI**	Fast Track to Innovation
292	**FTP**	File Transfer Protocol
293	**GA**	Grant Agreement
294	**GBCE**	Green Building Council España
295	**GBXML**	Green Building Extensible Modelling Language
296	**GCCB**	Government Construction Client Group
297	**GCS**	Government Construction Strategy
298	**GDL**	Geometric Description Language
299	**GDPR**	General Data Protection Regulation
300	**GEA**	Gross External Area
301	**GHG**	Greenhouse Gas
302	**GC**	General Contractor
303	**GCS**	Government Construction Strategy
304	**GHG**	Green House Gases
305	**GIA**	Gross Internal Area
306	**GIFA**	Gross Internal Floor Area
307	**GIS**	Geographical Information System
308	**GML**	Geography Markup Language
309	**GMP**	Guaranteed Maximum Price
310	**GMSD**	Generative Modular Building System Design
311	**GNSS**	Global Navigation Satellite System

312	**GPS**	Global Positioning System
313	**GRIP**	Governance for Railway Investment Projects
314	**GSA**	Government Services Administration (US)
315	**GSA**	General Services Administration
316	**GSL**	Government Soft Landings
317	**GUID**	Globally Unique Identifier
318	**GWP**	Global Warming Potential
319	**H2020**	Horizon 2020
320	**H&S**	Health and safety
321	**HA**	Highways Agency
322	**HBI**	Human Building Interfaces
323	**HCI**	Human-Computer Interaction
324	**HCOME**	Human-Centered Ontology Engineering Methodology
325	**HCONE**	Human-Centered ONtology Engineering Environment
326	**HIL**	Hardware in the Loop
327	**HMG**	Her Majesty's Government
328	**HOAI**	Honorarordnung für Architekten und Ingenieure
329	**HSE**	Health and Safety Executive
330	**HTM**	Hypertext Markup
331	**HTM**	Human Thermal Model
332	**HTMD**	Human Thermal Model Description
333	**HTML**	Hypertext Markup Language
334	**HVAC**	Heating, Ventilation and Air Conditioning
335	**IA**	Innovation Actions
336	**IaaS**	Infrastructure as a Service
337	**IAC**	Industry Advisory Council
338	**IAI**	International Alliance for Interoperability
339	**IAM**	Institute of Asset Management
340	**IAQ**	Indoor Air Quality
341	**IBACOS**	Integrated Building and Construction Solutions
342	**IBC**	International Building Code
343	**IBC**	Institute for BIM in Canada

344	**IBD**	Intelligent Building Data
345	**iBIM**	Integrated BIM
346	**ICC**	International Code Council
347	**ICD**	Integrated Cycle Design
348	**ICD**	Intelligent Community Design
349	**ICD**	Interface Control Documents
350	**ICE**	Institution of Civil Engineers and Innovative Contractor Engagement
351	**iCIM**	iCIM is a community resource monitoring and management platform that improves sustainability performance (see IESVE)
352	**ICIS**	International Construction Information Society
353	**ICL**	Intelligent Communities Lyfecicle
354	**ICONDA**	International CONstruction Database
355	**ICT**	Information and Communication Technologies
356	**ID**	Identification
357	**IDABC**	Interoperable Delivery of European eGovernment Services to public Administrations, Business and Citizens
358	**IDAE**	Instituto para la Diversificación y Ahorro de la Energía (Spain)
359	**IDD**	Integrated Design & Delivery
360	**IDM**	Information Delivery Manual
361	**IDDS**	Integrated Design & Delivery Solutions
362	**IDP**	Integrated Design Process
363	**IDP**	Intelligent Design Planning
364	**IDS**	Integrated Design Solutions
365	**IE**	Information Exchange
366	**IEEE**	Institute of Electrical and Electronics Engineers
367	**IEQ**	Indoor Environmental Quality
368	**IES**	Integrated Environmental Solutions
369	**IESVE**	IES Virtual Environment (IESVE)
370	**iESD**	Intelligent Energy System Designer
371	**ILCD**	Integrated Life Cycle Design
372	**IFC**	Industry Foundation Classes
373	**IFC**	Information For Construction
374	**IFD**	International Framework for Dictionaries

375	**IFMA**	International Facilities Management Association
376	**IFoA**	Integrated Form of Agreement
377	**IG**	Irish Grid
378	**IGES**	International Graphics Exchange Standard
379	**IGLC**	International Group of Learn Construction
380	**IIOT**	Industrial Internet of Things
381	**ILCD**	International Reference Life Cycle Data System
382	**IM**	Information Modelling
383	**IMP**	Information Management Process
384	**IMU**	Inertial Measurement Unit
385	**INE**	Instituto Nacional de Estadística (Spain)
386	**IOT**	Internet of Things
387	**IP**	Intellectual Property
388	**IPC**	Integrated Project Coordinator
389	**IPCC**	Intergovernmental Panel on Climate Change
390	**IPD**	Integrated Project Delivery
391	**IPI**	Integrated Project Insurance
392	**iPIM**	iPIM is a building portfolio and asset management tool for the visualisation of key performance indicators and data.
393	**IPLV**	Integrated Part Load Value
394	**IPMVP**	International Performance Measurement and Verification Protocol
385	**IPP**	Initial Project Proposals
396	**IPP**	Inspection Point Program
397	**IPR**	Intellectual Property Rights
398	**IR**	Information Requirements
399	**IRMP**	Integrated Risk Management Plan
400	**IRR**	Internal Rate of Return
401	**IS**	International Standard
402	**iSCAN**	Intelligent Control and Analysis
403	**ISE**	The Institution of Structural Engineers
404	**ISES**	Intelligent Services For Energy-Efficient Design and Life Cycle Simulation
405	**ISG**	Implementation Support Group (Building Smart)

406	**ISO**	International Standards Organisation
407	**IT**	Information Technology
408	**ITeC**	Institut de Tecnologia de la Construcció de Catalunya
409	**ITIL**	Information Technology Infrastructure Library
410	**ITSM**	IT Service Management
411	**IUK**	Infrastructure UK
412	**IVN**	Intelligent Virtual Network
413	**IWMS**	Integrated Workplace Management System
414	**JCT**	Joint Contract Tribunal
415	**JIB**	Joint Industry Board
416	**JIT**	Just in Time
417	**JSON**	JavaScript Object Notation
418	**JV**	Joint Venture
419	**KER**	Key Exploitable Results
420	**KET**	Key Enabling Technologies
421	**KMS**	Knowledge Management System
422	**KoM**	Kick-off Meeting
423	**KPIs**	Key Performance Indicator
424	**KRS**	Knowledge Representation Systems
425	**LADAR**	Laser Detection and Ranging
426	**LAM**	Laser Aided Modelling
427	**LAN**	Local Area Network
428	**LAS**	Look-ahead Schedule
429	**LBC**	Lean BIM Construction
430	**LBD**	Linked Building Data
431	**LC**	Lean Construction
432	**LCA**	Life Cycle Assessment
433	**LCC**	Life Cycle Contract
434	**LCC**	Life Cycle Cost
435	**LCI**	Lean Construction Institute
436	**LCI**	Life Cycle Inventory
437	**LCIA**	Life Cycle Impact Assessment

438	**LCIE**	Life Cycle Information Exchange
439	**LCR**	Life Cycle Repairs /Replacement (Renewal)
440	**LCS**	Location Coding System (London Underground)
441	**LCT**	Life Cycle Tower
442	**LD**	Linked Data
443	**LE**	Large Enterprise
444	**LEAR**	Legal Entity Appointed Representative
445	**LEED**	Leadership in Energy and Environmental Design
446	**LIDAR**	Light Detection and ranging
447	**LIPS**	Lean in Public Sector
448	**LOD**	Level of model Detail or Level of Definition
449	**LOD**	Level of Development (in US)
450	**LOD**	Linked Open Data
451	**LOI**	Level of model Information
452	**LOIN**	Level of Information Need
453	**LPD**	Lean Project Delivery
454	**LPDS**	Lean Project Delivery System
455	**LPS**	Last Planner System
456	**LPT**	Lean Production Theory
457	**LRM**	Last Responsible Moment
458	**LRM**	Linear Referencing Method
459	**LRS**	Linear Referencing System
460	**LU**	London Underground
461	**LZC**	Low to Zero Carbon
462	**M2M**	Machine-to-Machine
463	**MC**	Main Contractor
464	**MCIA**	Material Cost Impact Analysis
465	**M&E**	Mechanical and Electrical
466	**M&O**	Maintenance and Operation
467	**MEP**	Mechanical, Electrical, Plumbing
468	**MET**	Metabolic Equivalent of Task
469	**MFA**	Material Flow Analysis

470	**MFA**	Material Footprint Assessment
471	**MIDI**	Master Information Delivery Index
472	**MIDP**	Master Information Delivery Plan
473	**ML**	Machine Learning
474	**MMHW**	Method of Measurement for Highway Works (Highway Agency)
475	**MOPU**	Ministerio de Obras Públicas y Urbanismo (Spain)
476	**MP**	Management Plan
477	**MPA**	Multi-Party Agreement
478	**MPDT**	Model Production and Delivery Table
479	**MQC**	Model Quality Control
480	**MR**	Mixed Reality
481	**MRT**	Mean Radiant Temperature
482	**MSD**	Manpower Sources Diagram
483	**MSG**	Model Support Group (Building Smart)
484	**MSM**	Mirrored Spaces Model
485	**MTOE**	Million Tons of Oil Equivalent
486	**MTTR**	Mean Time to Resolution
487	**MVD**	Model View Definition
488	**N3**	Notation 3
489	**N3Logic**	Notation 3 Logic
490	**NaaS**	Native as a Service
491	**NAO**	National Audit Office
492	**NBE**	Norma Básica de Edificación (Spain)
493	**NBIMS**	National BIM Standard (US)
494	**NBS**	National Building Specification
495	**NBS**	National Bureau of Standards
496	**NC**	Numerical Control
497	**NDA**	Non-Disclosure Agreement
498	**NDEA**	Non-Domestic Energy Assessment
499	**NEC**	New Engineering Contracts
500	**NEC3**	New Engineering Contract (3rd Iteration of the NEC contract)
501	**NEEDS**	New Energy Externalities Development for Sustainability

502	**NF**	National Framework
503	**NIA**	Net Internal Area
504	**NIBS**	National Institute of Building Sciences (US)
505	**NIEM**	National Information Exchange Model
506	**NIF's**	National Interoperability Frameworks
507	**NIST**	National Institute of Standards and Technology (US)
508	**NLP**	Natural Language Processing
509	**NMS**	National Master Specification
510	**NDA**	Non-Disclosure Agreement
511	**NPC**	Net Present Cost
512	**NPV**	Net Present Value
513	**NRM**	New Rules of Measurement
514	**NS**	Net Savings
515	**NSB**	National Standards Body
516	**NST**	Negotiated Select Team
517	**NURBS**	Non-Uniform Rational B-Spline Surfaces
518	**O&M**	Operations and Maintenance
519	**OA**	Open Access
520	**OASIS**	Organisation for the Advancement of Structured Information Standards
521	**OBDA**	Ontology-Based Data Access
522	**OBS**	Organisation Breakdown Structures
523	**OCCS**	OmniClass Construction Classification System
524	**OCE**	Order of Cost Estimates
525	**OCI**	Optimised Contractor Involvement
526	**OCIP**	Owner Controller Insurance Program
527	**ODA**	Olympic Delivery Authority
528	**OEF**	Organisational Environmental Footprint
529	**OGC**	Office of Government Commerce
530	**OGC**	Open Geospatial Consortium
531	**ÖGNI**	Österreichische Gesellschaft für Nachhaltige Immobilienwirtschaft
532	**OHLE**	See OLE
533	**OIR**	Organization Information Requirement

534	**OLE**	Overhead Line Electrification
535	**OMSI**	Operations and Maintenance Support
536	**OOP**	Objective Oriented Production
537	**OPA**	Organizational Process Assets
538	**OPex**	Operating Expenses
539	**OPex**	Operational Expenditures
540	**OPS**	Outline Procurement Strategy
541	**OR**	Operational Rating
542	**ORD**	Open Research Data
543	**OS**	Ordinance Survey
544	**OWA**	Open World Assumption
545	**OWL**	Ontology Web Language
546	**PaaS**	Platform as a Service
547	**PACE**	Property Advisers to the Civil Estate
548	**PAM**	Property Asset Management
549	**PARL**	Percentage Asset Remaining Life
550	**PAS**	Publically Available Specification
551	**PCI**	Pre-Construction Information
552	**PCI**	Payment Card Industry
553	**PC Price**	Prime Cost Price
554	**PC Sum**	Prime Cost Sum
555	**PD**	Predicted Desirable
556	**PDCA**	Plan – Do – Check – Adjust
557	**PDF**	Portable Document Format
558	**PDM**	Project Delivery Manager
559	**PDP**	Project Definition Plan
560	**PDSM**	Problem Driven Scope Management
561	**PDT**	Product Data Templates
562	**PEB**	Positive Energy Block/District
563	**PEB**	Proyectos de Ejecución BIM
564	**PEF**	Product Environmental Footprint
565	**PEP**	Project Execution Plan

566	**PESTLE**	Political, Economic, Social, Technological, Legal, and Environmental analysis
567	**PFI**	Private Finance Initiative
568	**PHP**	Hypertext Pre-processor
569	**PIB**	Planned Inspection of Buildings
570	**PII**	Professional Indemnity Insurance
571	**PIM**	Project Information Model
572	**PIN**	Prior Indicative Notice
573	**PIP**	Project Implementation Plan
574	**PIX**	Project Information Exchange
575	**PIR**	Project Information Requirement
576	**PIT**	Project Implementation Team
577	**PLC**	Product Life Cycle
578	**PLM**	Product Lifecycle Management
579	**PM**	Person Month
580	**PMB**	Protocolo de Modelos BIM
581	**PMO**	Project Management Office
582	**PMO**	Product Modelling Ontology
583	**PMT**	Project Management Team
584	**PMV**	Predicted Mean Vote
585	**PO**	Policy Officer
586	**PO**	Project Officer
587	**POC**	Proof of Concept
588	**POE**	Post Occupancy Evaluation
589	**POS**	Proof of Stake
590	**POW**	Proof of Work
591	**PP**	Phases Table (CPIC Uniclass 2)
592	**PPA**	Public Purchase Agreement
593	**PPC**	Project Partnering Contracts
594	**PPC**	Percent Plan Complete
595	**PPD**	Predicted Percentage of Dissatisfied
596	**PPM**	Planned Preventive Maintenance

597	**PQQ**	Pre-Qualification Questionnaire
598	**Pr**	Products Table (CPIC Unicalss 2)
599	**PSCD**	Public Sector Construction Database
600	**PSRL**	Product Semantics Representation Language
601	**PU**	Predicted Undesirable
602	**P&ID**	Piping and Instrumentation Diagram
603	**P&CM**	Project and Construction Management
604	**PV**	Present Value
605	**PV**	Photovoltaics
606	**QA**	Quality Assurance
607	**Q&A**	Questions and Answers
608	**QL**	Quality Level
609	**QoS**	Quality of Service
610	**QS**	Quantity Surveyor
611	**QTO**	Quantity Take Off
612	**R&D**	Research and Development
613	**RACI**	Responsible, Accountable, Consulted and Informed
614	**RAG**	Red, Amber, Green
615	**RAM**	Random Access Memory
616	**RCA**	Root Cause Analysis
617	**R2RML**	RDB to RDF Mapping Language
618	**RCM**	Reliability Centred Maintenance
619	**RDF**	Resource Description Framework
620	**RFDa**	Resource Description Framework in Attributes
621	**RDFS**	RDF Schema
622	**RDS**	Room Data Sheet
623	**RDS**	Room Data Schedule
624	**RFI**	Request for Information
625	**RFID**	Radio-Frequency IDentification
626	**RFP**	Request fro Proposal
627	**RGB**	Red, Green, Blue
628	**RIA**	Regulatory Impact Assessment

629	**RIA**	Research and Innovation Actions
630	**RIAS**	Royal Incorporation of Architects in Scotland
631	**RIBA**	Royal Institute of British Architects
632	**RICS**	Royal Institute of Chartered Surveyors
633	**RIF**	Rule Interchange Format
634	**RIT**	Room Integrity Testing
635	**RMIT**	Royal Melbourne Institute of Technology
636	**ROI**	Return of Investment
637	**RPI**	Retail Price Index
638	**RSL**	Reference Service Life
639	**RST**	Rhetorical Structure Theory
640	**RTL**	Register Transfer Level
641	**RTC**	Real Time Clock
642	**RTO**	Research Technology Organization
643	**RV**	Reference View
644	**R&D**	Research & Development
645	**R&M**	Renovation & Modernization
646	**SA**	Site Area
647	**SAL**	Security Aspect Letter
648	**SaaS**	Software as a Service
649	**SAP**	Standard Assessment Procedure
650	**SAP**	Systems, Applications, Products in Data Processing
651	**SBC**	Standard Building Tribunal
652	**SBD**	Set-Based Design
653	**SBEM**	Simplified Building Energy Method
654	**SBS**	Small Business Service
655	**SCADA**	Supervisory Control And Data Acquisition
656	**SCCS**	Supply Chain Capability Summary
657	**SCPS**	Smart, Connected Product Systems
658	**SLCA**	Social Life Cycle Assessment
659	**SDD**	System Design Description
660	**SDNF**	Steel Detailing Neutral Format

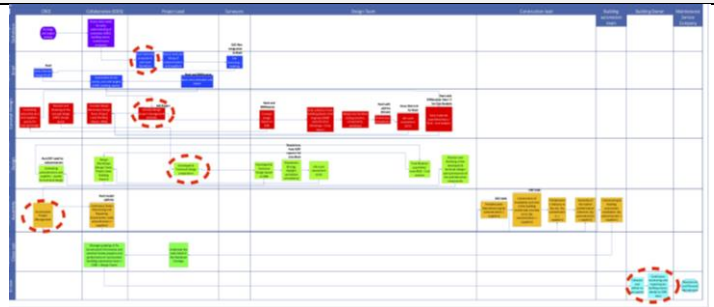
661	**SDO**	Standards Developing Organization
662	**SDS**	Space Data Sheet
663	**SDS**	Space Data Schedule
664	**SECAP**	Sustainable Energy and Climate Action Plan
665	**SETAC**	Society of Environmental Toxicology and Chemistry
666	**SGNI**	Schweizer Gesellschaft für Nachhaltige Immobilienwirtschaft
667	**SIA**	Security Industry Authority
668	**SIL**	Safety Integrity Level
669	**SIL**	Software in the Loop
670	**SIM**	Structural Information Model
671	**SIR**	Savings to Investment Ratio
672	**SKOS**	Simple Knowledge Organization System
673	**SLA**	Service Level Agreement
674	**SME**	Small and Medium Enterprises
675	**SMP**	Standard Method and Procedure
676	**SMT**	Site Management Team
677	**SOA**	Service Oriented Architectures
678	**SOAP**	Simple Object Access Protocol
679	**Sp**	Spaces Table (CPIC Uniclass 2)
680	**SPARQL**	Simple Protocol and RDF Query Language
681	**SPie**	Specifiers' Properties information exchange
682	**SPE**	Single Purpose Entity
683	**SPF**	STEP Physical File
684	**SPFF**	STEP Physical File Format (IFC)
685	**SQL**	Structured Query Language
686	**Ss**	Systems Table (CPIC Uniclass 2)
687	**SSL**	Structural Slab Level
688	**SSL**	Secure Sockets Layer
689	**SSN**	Semantic Sensor Network
690	**STEP**	STandard for Exchange of Product Model Data
691	**STL**	Standard Tessellation Language
692	**STOs**	Specific Technical Objectives

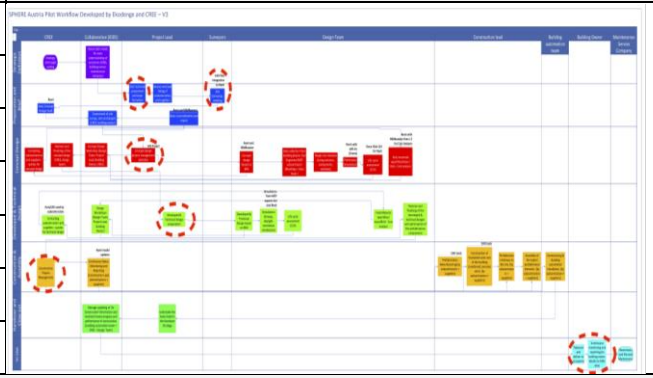
693	**SWOP**	Semantic Web-based Open engineering Platform
694	**SWRL**	Semantic Web Rule Language
695	**TA**	Technical Adviser
696	**TAI**	Teaching as Inquiring
697	**TBD**	To Be Defined
698	**TBM**	Tunnel Boring Machine
699	**TBM**	Temporary Benchmark
700	**TCQ**	Temps, Cost, Qualitat
701	**TER**	Target Emission Rate
702	**TIDP**	Task Information Delivery Plan
703	**TILT**	Transfer Implementation Leadership Team
704	**TL**	Tube Lines
705	**TLS**	Terrestrial Laser Scanner
706	**TOC**	Table of Contents
707	**TOID**	Topographic Identifier
708	**TPI**	Tender Price Index
709	**TPS**	Toyota Production System
710	**TRL**	Technological Readiness Level
711	**TVD**	Target Value Delivery
712	**TVD**	Target Value Design
713	**TVP**	Target Value Production
714	**UC**	Use Case
715	**UCD**	User Centred Design
716	**UCL**	University College London
717	**UD**	Unpredicted Desirable
718	**UK**	United Kingdom
719	**Umbel**	Upper Mapping and Binding Exchange Layer
720	**UML**	Unified Model/ling Language
721	**UNDP**	United Nations Development Programme
722	**UNEP**	United Nations Environment Programme
723	**Uniclass**	Unified Classification System
724	**UPRN**	Unique Property Reference Number

725	**URI**	Unique Resource Identifier
726	**URI**	Uniform Resource Identifiers
727	**US**	United States (of America)
728	**USACE**	United States Army Corps of Engineers
729	**USGBC**	United States Green Building Council
730	**UX**	User Experience
731	**UXB**	Unexploded Bomb
732	**UU**	Unpredicted Undesirable
733	**VCMP**	Virtual Construction Management Platform
734	**V2B**	Vehicle to Building
735	**V2G**	Vehicle to Grid
736	**VC**	Virtual Call
737	**VC**	Virtual Construction
738	**VDC**	Virtual Design and Construction
739	**VDR**	Virtual Data Room
740	**VE**	Virtual Environmental
741	**VERDE**	Valoración de Eficiencia de Referencia de Edificios
742	**VFM**	Value for Money
743	**VPN**	Virtual Private Network
744	**VR**	Virtual Reality
745	**VRML**	Virtual Reality Modelling Language
746	**VSM**	Value Stream Mapping
747	**W3C**	World Wide Web Consortium
748	**WAN**	Wide Area Network
749	**WBDG**	Whole Building Design Guide
750	**WBI**	Well Building Institute
751	**WBS**	Work Breakdown Structure
752	**WGBC**	World Green Building Council
753	**WIP**	Work-in-Process
754	**WLC**	Whole Life Costing
755	**WP**	Work Package
756	**WR**	Work Results Table (CPIC Uniclass 2)

757	**WRAP**	Waste & Resources Action Programme
758	**WS**	Work Results for Specifications (CPIC Uniclass 2)
759	**WTO**	World Trade Organization
760	**WWP**	Weekly Work Plan
761	**WWW**	World Wide Web
762	**XML**	eXtensible Markup Language
763	**X-REF**	Cross Reference
764	**XSD**	XML Schema Definition
765	**XSLT**	eXtensible Stylesheet Language Transformations
766	**XSP**	Cross Section Positions
767	**Zz**	CAD Table (CPIC Uniclass 2)

Appendix A SPHERE Module Sheet

<table>
<tr><th colspan="4">Module: I1.M1 User and Network Management</th></tr>
<tr><th>Module description:</th><th colspan="2">Used in life cycle phase:</th><th>Module use in Austria Pilot workflow:</th></tr>
<tr><td rowspan="7">Manages and assign users and roles, initiates software</td><td>Strategic definition (purple):</td><td>No</td><td rowspan="7">  </td></tr>
<tr><td>Definition and brief (Blue):</td><td>Yes</td></tr>
<tr><td>Concept Design (Red):</td><td>Yes</td></tr>
<tr><td>Dev. & Technical Design (Green):</td><td>Yes</td></tr>
<tr><td>Construction/Renovation (Yellow):</td><td>Yes</td></tr>
<tr><td>Handover & close (Dark green):</td><td>No</td></tr>
<tr><td>In Use (Turquoise):</td><td>Yes</td></tr>
<tr><th colspan="4">Sub-module Features Descriptions:</th></tr>
<tr><td colspan="2">I1.M.1.SM.1 Identify Users: (select user type from ontologies)</td><td colspan="2">I1.M.1.SM.2 Create Project & Identify Roles: (select role from predefined ontologies)</td></tr>
<tr><th>Sub-modules:</th><th>Assoc Tools:</th><th>Inputs:</th><th>Outputs:</th></tr>
<tr><td>I1.M.1.SM.1 Identify Users</td><td>Refurbify</td><td>Personal information, identification</td><td></td></tr>
<tr><td>I1.M.1.SM.2 Create Project & Identify Roles</td><td>Refurbify</td><td></td><td>Assigned roles to the created users</td></tr>
</table>

Module: I1.M2 Processes and Workflows Management			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
	Strategic definition (purple):	No	
	Definition and brief (Blue):	Yes	
	Concept Design (Red):	Yes	
	Dev. & Technical Design (Green):	Yes	
	Construction/Renovation (Yellow):	Yes	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	Yes	

Sub-module Features Descriptions:			
I1.M2.SM1 Setup and Management of Project Phases and Processes	**I1.M2.SM2 Roles and Processes Matching**	**I1.M2.SM3 Authorisation:**	**I1.M2.SM4 IDDS Guidelines, Roles, Information Sharing:**

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I1.M2.SM1 Setup and Management of Project Phases and Processes:	Refurbify, OPT, LCCCA, CMT		
I1.M2.SM2 Roles and Process Matching:	Refurbify		
I1.M2.SM3 Authorisation:	Refurbify		

Module: I1.M3 Common Data Environment Management

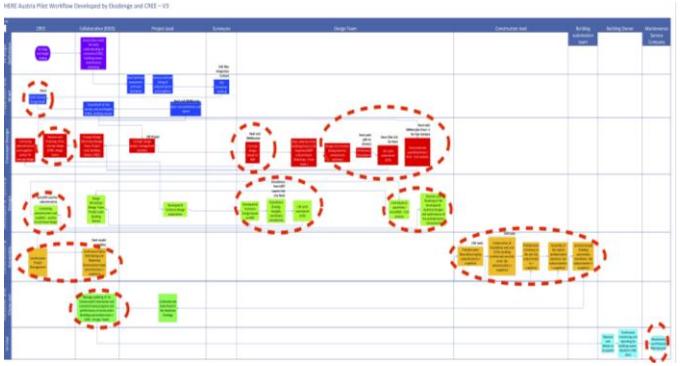
Module description:

Description of the module:
The common data environment (CDE), is the single source of information used to collect, manage and disseminate documentation, the graphical model and non-graphical data for the whole project team (i.e. all project information whether created in a BIM environment or in a conventional data format). Creating this single source of information facilitates collaboration between project team members and helps avoid duplication and mistakes.

Used in life cycle phase:

Strategic definition (purple):	No
Definition and brief (Blue):	Yes
Concept Design (Red):	Yes
Dev. & Technical Design (Green):	Yes
Construction/Renovation (Yellow):	Yes
Handover & close (Dark green):	Yes
In Use (Turquoise):	Yes

Module use in Austria Pilot workflow:



Sub-module Features Descriptions:

I1.M3.SM1 Data/Document Management:
- Add files
- Download files
- Manage document versions
- Organise documents with labels or folders
- Create relations between documents and assets
- Manage sharing of documents or specific versions of a document

I1.M3.SM 2 Connectivity to IoT and External Live Sources:
- Add new devices
- Review connectivity of existing devices
- Set, receive and action alerts (loss of heat supply, mechanical failure, security alarm etc.)
- Link device to object (IFC object, document)
- Visualise device location
- Comms failure notification

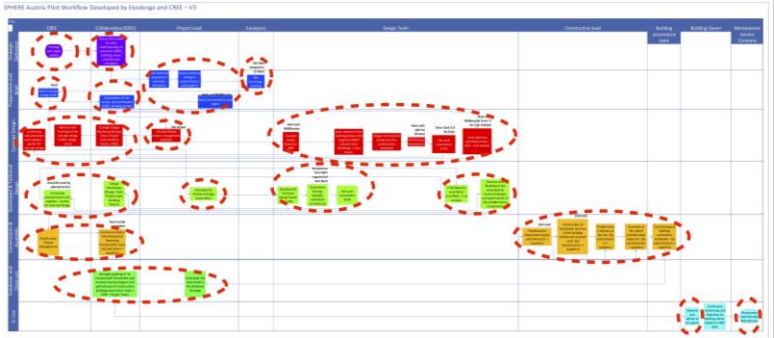
I1.M3.SM3 Exporting/Allow Access Data:
- Export data in different formats (xlsx, csv)
- Provide access to data through a web service (API)
- Data includes assets, requirements, specifications, properties etc.
- Protect data with a role-based security layer (you can only access what your role needs)

I1.M3.SM4 Dynamic Data Visualisation:
- Visualise data in dynamic tables
- Link project information (BIM data,tasks,issues) to a 3D visualisation of the BIM Model -> dynamic 3D BIM Viewer
- Provide mechanism for visualizing&analyzing large datasets from heterogeneous external source (sensor Data,simulation results, ..)

I1.M3.SM5 Reporting:
- Report data in a predefined document format
- Manage report templates
- Store reports documents on the file server
- Export Bill of Quantity from a selected data set
- Extract a Minutes of Meeting report
- Manage document reviews in a structured way

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I1.M3.SM1 Data/Document Management:	Refurbify		
I1.M3.SM 2 Connectivity to IoT and External Live Sources:	Clarity		

I1.M3.SM3 Exporting/Allow Access Data:	Clarity		
I1.M3.SM4 Dynamic Data Visualisation:	Clarity		
I1.M3.SM5 Reporting:	Clarity		

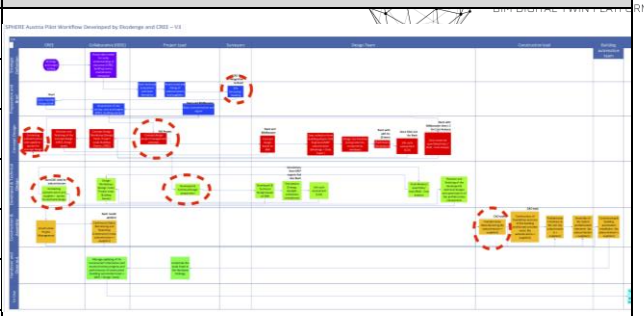
Module: I1.M4 BIM and Object Libraries			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
	Strategic definition (purple):	Yes	
	Definition and brief (Blue):	Yes	
	Concept Design (Red):	Yes	
	Dev. & Technical Design (Green):	Yes	
	Construction/Renovation (Yellow):	Yes	
	Handover & close (Dark green):	Yes	
	In Use (Turquoise):	Yes	

Sub-module Features Descriptions:				
I1.M4.SM1 BIM Execution Plan: • Project Information • Key Project Contacts • Project Goals/BIM Objectives • Evaluate Partner BIM capabilities and define roles and responsibilities • Technology Infrastructure Needs • BIM Process Design • BIM and Facility Data Requirements • Model Structure • BIM Information Exchanges • Collaboration Procedures • Model Quality Control Procedures • Project Deliverables: • Delivery Strategy/Contracts: • Project delivery • Evaluate Project success to date and revisit BEP	**I1.M4.SM2 BIM and Object Libraries:**	**I1.M4.SM3 Material Library:** • Create/Update/Delete material database entries. Each entry contains below set of information • Create/ update Life Cycle Inventory (LCI) entries.	**I1.M4.SM4 HVAC Library:** • Providing a set of components (mathematical) for the simulation of HVAC system for the development of a simulation model in EcosimPro: • Providing a set of components for the simulation of HVAC control:	**I1.M4.SM5 Thermal and Fluid Component Libraries:** • Providing a library for multicomponent fluid properties calculation to be used in HVAC components. • Providing a library with thermal models of building components and base compents for the energy flow calculations:

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I1.M4.SM1 BIM Execution Plan:			
I1.M4.SM2 BIM and Object Libraries:	OPT		

I1.M4.SM3 Material Library:	OPT		
I1.M4.SM4 HVAC Library:	EcosimPro, RobMOS		
I1.M4.SM5 Thermal and Fluid Component Libraries:	EcosimPro, RobMOS		

Module: I1.M5 Procurement and Contracting

Module description:	Used in life cycle phase:		Module use in Austria Pilot workflow:
	Strategic definition (purple):	No	
	Definition and brief (Blue):	Yes	
	Concept Design (Red):	Yes	
	Dev. & Technical Design (Green):	Yes	
	Construction/Renovation (Yellow):	Yes	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	No	

Sub-module Features Descriptions:

I1.M5.SM1 Tendering Functionalities:

Based on the previous reports(brief and strategic definition, early concept design draft, basic cost estimation reports) find a suitable design team-company-member:

- Review documents from previous similar projects
- Assess other concept designs and prioritise
- Access cost estimation tool
- Review contract templates for suitability
- Complete and issue tendering docs from suite of templates

Seeking specialists using the BIM based design needs, simulation and LCA assessment:

- Identify potential specialists
- Contact potential specialists

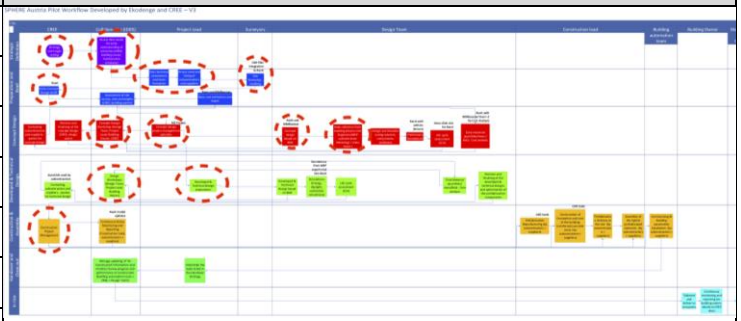
I1.M5.SM2 Smart Contracts, Block chain

If desired, use the smart contract between the parties

- Blockchain integration tbc
- Access “smart” contracts and doc via contracts module
- Digital signature
- Lock contracts within the platform and append to digital entity

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I1.M5.SM1 Tendering Functionalities:	Refubify		
I1.M5.SM2 Smart Contracts, Block chain:			

Module: I2.M1 Brief and Target Setting

Module description:	Used in life cycle phase:		Module use in Austria Pilot workflow:
Designated form including KPIs and responsibilities. Using the existing KPI databases, setting targets for the project, identifying the follow-up/monitoring need.	Strategic definition (purple):	Yes	
	Definition and brief (Blue):	Yes	
	Concept Design (Red):	Yes	
	Dev. & Technical Design (Green):	Yes	
	Construction/Renovation (Yellow):	Yes	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	No	

Sub-module Features Descriptions:

I2.M1.SM1 Brief Definition:

- Select items to be included in the project brief (selection lists)
- Generate example empty project brief with headers
- Provide deletion or addition of further items to be included in the project brief
- Enable fill-in fields to add qualitative information under project brief header
- Generate final project brief PDF
- Enable downloading and sending of project brief to other stakeholders (for example project/building owner)

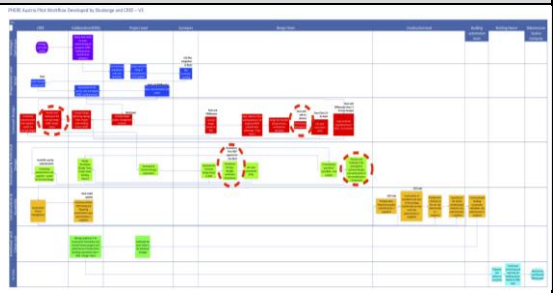
I2.M1.SM2 Target Setting & Collaborative Management:

- Load generated brief and unlock target template / environment
- Select targets and performance standards to track
- Select quantities of targets
- Set roles to targets for management
- Create collaboration groups
- Generate Target PDF
- Enable sending of project targets to relevant involved stakeholders

I2.M1.SM3 ESCO Operational & Contractual Responsibilities:

- Access energy and operational data
- Set operational responsibilities
- Set contractual responsibilities
- Create report
- Review operational responsibilities
- Review contractual responsibilities
- Export data

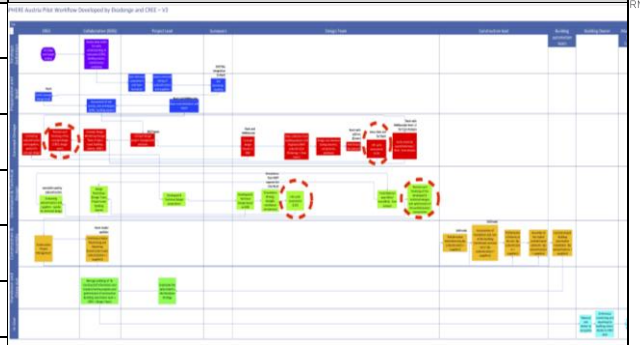
Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I2.M1.SM1 Brief Definition			
I2.M1.SM2 Target Setting & Collaborative Management			
I2.M1.SM3 ESCO Operational & Contractual Responsibilities	En-Ms		

Module: **I3.M1 Energy Modelling and Simulation**			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
Energy modelling of the asset and understanding its behaviour under certain conditions with simulations including thermal, daylight, acoustic simulations and energy assessment.	Strategic definition (purple):	No	
	Definition and brief (Blue):	No	
	Concept Design (Red):	Yes	
	Dev. & Technical Design (Green):	Yes	
	Construction/Renovation (Yellow):	No	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	No	

Sub-module Features Descriptions:						
I3.M1.SM 1 Settings and Parameters: Temperature, indoor environment quality control (comfort):	**I3.M1.SM 2 Targets and Metrics:**	**I3.M1.SM3 Heat load modelling:** • Access the IFC file from the SPHERE Database • Fill in missing data from the IFC file / additional sources • Configure the Heat Load Model with parameters • Run the Heat Load Model • Obtain results for the model and Interpret	**I3.M1.SM4 Renovation Energy Assessment:**	**I3.M1.SM5 Energy Efficiency and Supply:** • Access the project data; • Extraction of Building information from BIM model; • Access to meteorological data (related to the building's location); • Provide the energy consumption vectors (i.e. heating, cooling, lighting, DHW).	**I3.M1.SM6 Micro-services for Energy Modelling Calibration and Validation:**	**I3.M1.SM7 Human Thermal Model:**

Sub-modules:	**Assoc Tools:**	**Inputs:**	**Outputs:**
I3.M1.SM 1 Settings and parameters:	RobMOS, HTM	BIM and design parameters	Energy, thermal, acoustic model of the asset. Simulation results and predicted behaviour of the asset.
I3.M1.SM 2 Targets and Metrics:	All energy tools		
I3.M1.SM3 Heat load Modelling:	ModSCO,RobMOS, EcosimPro		
I3.M1.SM4 Renovation Energy Assessment:	ModSCO, EcosimPro		

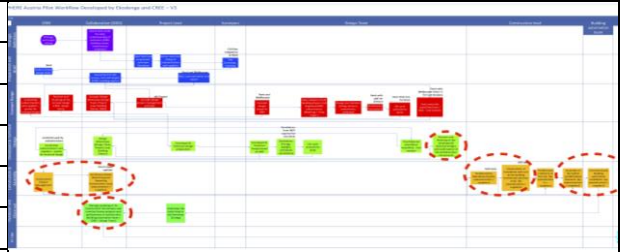
I3.M1.SM5 Energy Efficiency and Supply:	iESD_E		
I3.M1.SM6 Micro-Services for Modelling:	RobMOS		
I3.M1.SM7 Human Thermal Model:	HTM		

Module: I3.M2 Sustainability Assessment			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
The assessment capabilities, encapsulated in the digital twin platform of SPHERE, will allow the analyses of the performance within the whole life cycle of the buildings. This approach will allow the decision support to designers, construction processes as well as the occupants, including the energy consumption and waste management of the buildings as well.	Strategic definition (purple):	No	
	Definition and brief (Blue):	No	
	Concept Design (Red):	Yes	
	Dev. & Technical Design (Green):	Yes	
	Construction/Renovation (Yellow):	No	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	No	

Sub-module Features Descriptions

I3.M2.SM1 Material Flow Management:	I3.M2.SM2 Life Cycle Impact Assessment:	I3.M2.SM3 Life Cycle Costing Analyses:	I3.M2.SM4 Circularity Assessment:	I3.M2.SM5 Water Treatment Assessment:
• Access the project data • Extract material BoQ from the BIM file • Identify the scope and functional units for the analyses (in relation to the target metrics settings) • Visualise the Material flow as a whole	• Identify the reference Life Cycle Inventory • Match the flows with inventory objects • Visualise the matching of the material flows with inventory items • Allow the selection of generic flows such as Energy grid-mix, Logistics definitions (if necessary) • Allow the selection of the Impact Assessment category- ie IPCC Co_2 Eq tons, etc • Show the results of assessment • Allow benchmark/comparison of assessments - ie baseline vs proposed design, change of specific materials etc	• Identify the parameters for cost calculations • Match material flows with the known costs (external software?) • Provide the life cycle calculations	• Identify the metrics to be used for assessment • Report on these metrics	• Access the project data; • Extraction of Building information from BIM model; • Access to meteorological data (related to the building's location); • Access to user information

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I3.M2.SM1 Material Flow Management	EPESUS		
I3.M2.SM2 Life Cycle Impact Assessment:	CMT, EPESUS		
I3.M2.SM3 Life Cycle Costing Analyses:	LCCCA, EPESUS		
I3.M2.SM4 Circularity Assessment:	EPESUS		
I3.M2.SM5 Water Treatment Assessment:	iESD_W		

Module: I4.M1 Blockchain Services for the Construction Processes			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
	Strategic definition (purple):	No	
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	Concept Design (Red):	No	
	Dev. & Technical Design (Green):	Yes	
	Construction/Renovation (Yellow):	Yes	
	Handover & close (Dark green):	Yes	
	In Use (Turquoise):	No	

Sub-module Features Descriptions

I4.M1.SM1 Time Stamping/ Versioning for Digital Twin Certification:

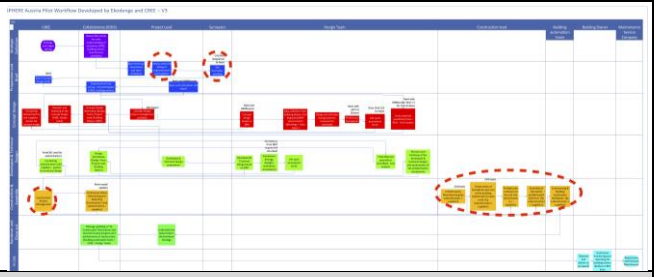
- Compilation of the below set of data for digital twin configuration
  - Responsible system user, ie. Project Configuration manager
  - Time
  - Digital Twin Standards valid at the time- achieved from the Digital Twin Management settings
  - Comments, executive summary note on the version of Digital Twin
  - Digital Twin file location (and file itself)
- All above info and only the Hash of the Digital Twin file is compiled in a an XML, JSon structure (te be defined)
- The version is digitally signed and stored for future compliance and liability validation

I4.M1.SM2 Subcontracting Management:

- Subcontracting party is defined in the platform and project
- Information on their scope, responsibilities stored in the system
- Scope carried out by the party defined in the system and referenced to Digital Twin / BIM subcomponents
- If a performance related obligation exists, that information and related obligations and liabilities are specified (I2.M1.SM3 3. ESCO operational & Contractual responsibilities)
- Periodic need for validation and bookkeeping specified.
- For the scope related obligations, Action (I4.M1.SM1 Time stamping/versioning for digital twin certification) carried out with reference to the subcontracting party
- In case of performance obligations, Action (I4.M1.SM2 Energy related account keeping) carried out with reference to the subcontracting party

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I4.M1.SM1 Time Stamping/ Versioning for Digital Twin Certification:		Monitoring data, subcontract documentation and database, progress reports, status updates	Digital Twin certification and updated certification, time stamped documents
I4.M1.SM2 Subcontracting Management:			

Module: I4.M2 Construction Operation Management

Module description:	Used in life cycle phase:		Module use in Austria Pilot workflow:
	Strategic definition (purple):	No	
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	Concept Design (Red):	No	
	Dev. & Technical Design (Green):	No	
	Construction/Renovation (Yellow):	Yes	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	No	

Sub-module Features Descriptions:

I4.M2.SM1 Site Role/Task Management:

- Sharing information in the right data format and quality
- Order based on BIM objects and BIM components
- During construction, continuous update of the BIM (Revit/ArchiCAD) model when something changes, create the *'As built' model*.
- The As Built Model should include all data from Architecture, MEP, Structure and should include all required data for the desired purpose.
- Define roles and responsibilities within the project
- Create tasks related to BIM object
- Assign tasks to the concerned team/worker/role
- Locate the task in the building
- Report the task status (Open, Done, Extended Deadline, Failed)
- Provide a communication channel concerning a task between the concerned users/roles

I4.M2.SM2 Site Surveys and Inspection:

- Sharing information in the right data format and quality
- Quality inspection of prefabrication
- Transportation inspection
- Delivery and storage on-site
- Assembly process
- Final assembly quality control

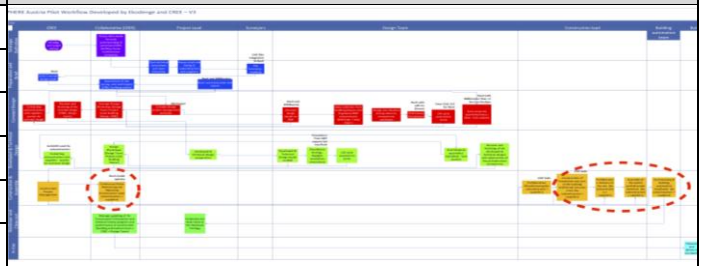
I4.M2.SM3 Clash Detection Solving and Documenting:

- Sharing information in the right data format and quality
- Identifying clashes, locating them on-site and in the model
- Give the task to the responsible person to solve it and document it

I4.M2.SM4 Progress Monitoring:

- Sharing information in the right data format and quality
- Continuous monitoring and reporting from the whole construction process.
- Handle and solve changes and delays, reporting them.

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I4.M2.SM1 Site Role/Task Management:	Refurbify	Design/BIM documents with the identified clash,	
I4.M2.SM2 Site Surveys and Inspection:	Refurbify		
I4.M2.SM3 Clash Detection Solving and Documenting:			
I4.M2.SM4 Progress Monitoring:	FLINK2GO		

Module: I4.M3 Construction Document Management			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
	Strategic definition (purple):	No	
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	Concept Design (Red):	No	
	Dev. & Technical Design (Green):	No	
	Construction/Renovation (Yellow):	Yes	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	No	

Sub-module Features Descriptions:

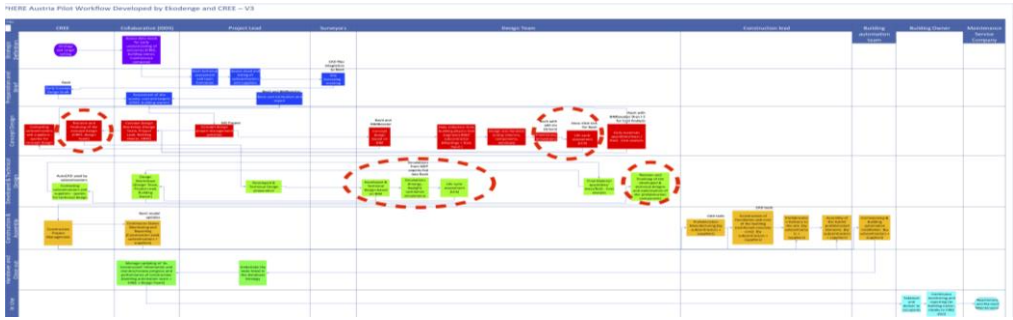
I4.M3.SM1 Design-As Built Data Compliance:

This user story is delivered by the Digital Twin Configuration management user story items

I4.M3.SM2 Improving the Process of Change Management:

- Identify change request
  - Owner
  - Description
  - Supportive documents (Basic BIM/CAD Drawings)
- Identify the approval needs
- Approve change
- Crete required set of documents (BIM/Dİgital Twin) for change specifications
- The rest of the user story is delivered by the Digital Twin Configuration management user story items

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I4.M3.SM1 Design-As Built Data Compliance			
I4.M3.SM2 Improving the Process of Change Management	Refurbify		
I4.M3.SM3 Clash Detection			

<table>
<tr><th colspan="4">Module: I4.M4 Regulatory Compliance Check</th></tr>
<tr><th>Module description:</th><th colspan="2">Used in life cycle phase:</th><th>Module use in Austria Pilot workflow:</th></tr>
<tr><td rowspan="7"></td><td>Strategic definition (purple):</td><td>No</td><td rowspan="7">  </td></tr>
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<tr><td>Concept Design (Red):</td><td>Yes</td></tr>
<tr><td>Dev. & Technical Design (Green):</td><td>Yes</td></tr>
<tr><td>Construction/Renovation (Yellow):</td><td>No</td></tr>
<tr><td>Handover & close (Dark green):</td><td>No</td></tr>
<tr><td>In Use (Turquoise):</td><td>No</td></tr>
<tr><th colspan="4">Sub-module Features Descriptions:</th></tr>
<tr><td colspan="4">I4.M4.SM1 Regulatory Compliance Check</td></tr>
<tr><th>Sub-modules:</th><th>Assoc Tools:</th><th>Inputs:</th><th>Outputs:</th></tr>
<tr><td>I4.M4.SM1 Regulatory Compliance Check</td><td>VCMP</td><td></td><td></td></tr>
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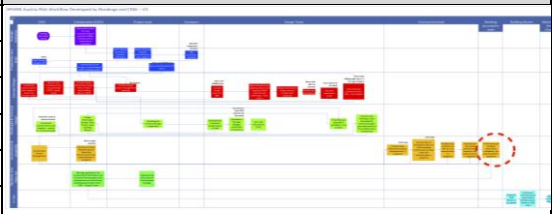
<table>
<tr><th colspan="4">Module: I4.M5 Commissioning</th></tr>
<tr><th>Module description:</th><th colspan="2">Used in life cycle phase:</th><th>Module use in Austria Pilot workflow:</th></tr>
<tr><td rowspan="8"></td><td>Strategic definition (purple):</td><td>No</td><td rowspan="8">  </td></tr>
<tr><td>Definition and brief (Blue):</td><td>No</td></tr>
<tr><td>Concept Design (Red):</td><td>No</td></tr>
<tr><td>Dev. & Technical Design (Green):</td><td>No</td></tr>
<tr><td>Construction/Renovation (Yellow):</td><td>Yes</td></tr>
<tr><td>Handover & close (Dark green):</td><td>Yes</td></tr>
<tr><td>In Use (Turquoise):</td><td>No</td></tr>
<tr><td colspan="4">Sub-module Features Descriptions:</td></tr>
<tr><td colspan="4">I4.M5.SM1 Comparison of Energy Simulation and Real Values
• BUilding Energy Consumption parameters are defined
○ Description on scope of coverage of consumption data (whole building or zones of building)
▪ In case of multiple power meters, multiple entries are needed
• Occupancy conditions
▪ User numbers
▪ Operational practices if any (natural ventilation etc.)
• Energy Consumption data is compiled,
• Manual Process:
▪ The bills are entered into the platform
• Automated process
▪ Data sources are related to the above defined building zone/parameters are defined
▪ Automated flow of data streamlined</td></tr>
<tr><th>Sub-modules:</th><th>Assoc Tools:</th><th>Inputs:</th><th>Outputs:</th></tr>
<tr><td>I4.M5.SM1 Comparison of Energy Simulation and Real Values</td><td>RobMOS, EcosimPro</td><td></td><td></td></tr>
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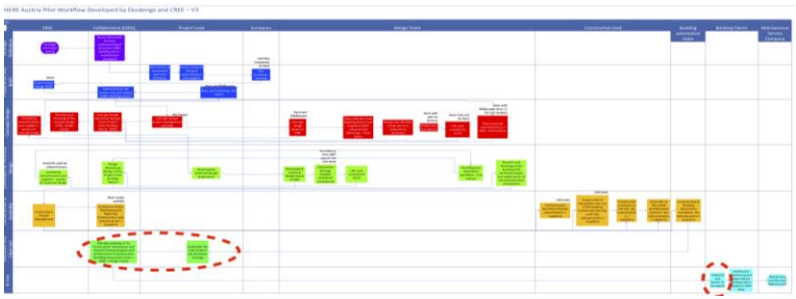
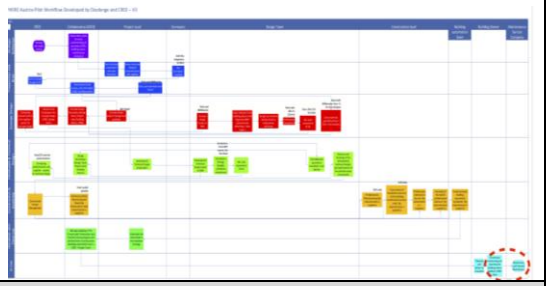
Module: **I4.M6 Handover Management Module**			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
	Strategic definition (purple):	No	
	Definition and brief (Blue):	No	
	Concept Design (Red):	No	
	Dev. & Technical Design (Green):	No	
	Construction/Renovation (Yellow):	No	
	Handover & close (Dark green):	Yes	
	In Use (Turquoise):	No	

Sub-module Features Descriptions:

I4.M6.SM1 Handover Data Management:

- Review building specific documents
- Assess for confidentiality
- Collate guarantees/contract documents
- Commence defects liability period
- Record handover acceptance
- Manage defects/handover refusal
- Collate handover information in an occupant-only environment
- Provide managed & limited access to occupant
- Link handover documents/information to the Digital Twin
- Communicate handover to project partners
- Collate O&M documents
- Collate H&S file
- Satisfy GDPR requirements

Sub-modules:	**Assoc Tools:**	**Inputs:**	**Outputs:**
I4.M6.SM1 Handover Data Management:	Refurbify		

Module: I5.M1 Facility Management			
Module description:	**Used in life cycle phase:**		**Module use in Austria Pilot workflow:**
	Strategic definition (purple):	No	
	Definition and brief (Blue):	No	
	Concept Design (Red):	No	
	Dev. & Technical Design (Green):	No	
	Construction/Renovation (Yellow):	No	
	Handover & close (Dark green):	No	
	In Use (Turquoise):	Yes	

Sub-module Features Descriptions:			
I5.M1.SM1 Organizing Maintenance Schedules:	**I5.M1.SM2 Decision Making for Refurbishment:** • Create report • Export data	**I5.M1.SM3 Building Issue Management:** • Create/report issue ○ The issue is described, located in the 2D/3D drawing and assigned to an internal and an external responsible, if exists. ○ Both responsible will be notified about the issue ○ A picture of the issue can be attached ○ The issue has a deadline, which will be used to trigger various events and to give an overview about the issue status. ○ Status Change notification for recorded defects/issues ○ From assignment to completion, sent in real time ○ A detailed history of the issue changes is saved ○ Each action is traceable • Overview of the site issues status for site managers and direct site responsible	**I5.M1.SM4 Data Analytics for Predictive Maintenance:**

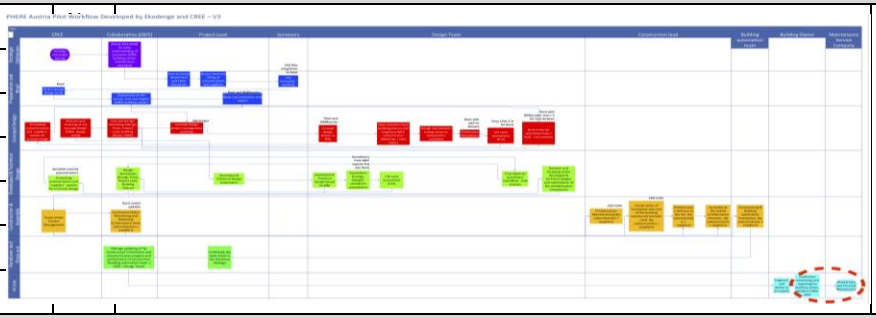
Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I5.M1.SM1 Organizing Maintenance Schedules:	LCCCA, Refurbify		
I5.M1.SM2 Decision Making for Refurbishment:	LCCCA, OPT, FRCT, ModSCO (only Passive)		
I5.M1.SM3 Building Issue Management:	Refurbify		
I5.M1.SM4 Big Data Analytics for Predictive Maintenance:	IMAN		

<table>
<tr><th colspan="7">Module: I5.M2 Energy Management and Performance Monitoring</th></tr>
<tr><th colspan="2">Module description:</th><th colspan="2">Used in life cycle phase:</th><th colspan="3">Module use in Austria Pilot workflow:</th></tr>
<tr><td colspan="2" rowspan="7"></td><td>Strategic definition (purple):</td><td>No</td><td colspan="3" rowspan="7">  </td></tr>
<tr><td>Definition and brief (Blue):</td><td>No</td></tr>
<tr><td>Concept Design (Red):</td><td>No</td></tr>
<tr><td>Dev. & Technical Design (Green):</td><td>No</td></tr>
<tr><td>Construction/Renovation (Yellow):</td><td>No</td></tr>
<tr><td>Handover & close (Dark green):</td><td>No</td></tr>
<tr><td>In Use (Turquoise):</td><td>Yes</td></tr>
<tr><th colspan="7">Sub-module Features Descriptions:</th></tr>
<tr>
<td>I5.M2.SM1 Data Acquisition and Status Reporting :
Access data
Drawings with position of installed sensors (x,z,y)
Typology of installed sensors (communication protocol, technical sheet, measured parameters, unit of measurements, …)
Declaration of conformity and take over of the whole installed system
Privacy agreements for data sharing and their correct use (between user and SPHERE consortium)
Report of the initial calibration of the data sensors and approval according to the calibration measures plan (during data acquisition in</td>
<td>I5.M2.SM2 Dynamic Env. Assessment and Communications:
Energy consumption data, compiled in I4.M5.SM1 is processed into:
Consumption of zone(s) / time period
Consumption of whole building / time period
Set points for buildings identified as alert points of medium and high consumption (KPIs</td>
<td>I5.M2.SM3 Energy Use Optimization: This part is exactly the same as I5.M2.SM4. There is not foreseen any specific module focused on the energy optimization.</td>
<td>I5.M2.SM4 Energy Generation Evaluation and Decision Support:
Access the project data;
Extraction of building information from BIM model;
Access to meteorological data (related to the building’s location);
Access to user information related to:
Technologies to be</td>
<td>I5.M2.SM5 Human Thermal Model Building Automation Control:</td>
<td>I5.M2.SM6 Energy Management ICT tool – ISO 50001 Decision:
Access current and historic energy data
Review savings
Review advice
Communicate data
Communicate recommendations
Observe results of changes mad</td>
<td>I5.M2.SM7 Reporting:
Definition of templates for reporting. (The numbers of the templates depends on the user scenario or on KPI’s?)
Export results with a simplified content (file in PDF format) or a fully set of content for professional use (file in XLS/CSV format)
Define time-lapse for automatic reporting (daily/monthly/yearly?)
Agreement for the use of the data and definition of role and scope of data use</td>
</tr>
</table>

order to assure the quality of the transmitted data) • Transmission of measured data to the platform ○ With which timestep? ○ Is there, at the demo site, a temporary storage to avoid losing information due to internet fails? • Definition of roles for the users: ○ High: professional (read, analysis, summarise) ○ Medium: project consortium (only reading and queries) ○ Low: user of the house (only reading) • Duration of stored data. The data will be erased every day/month/year	from WP2 used such as kWh/m2) • Related building project actors identified in relation to the alerts ○ Automated alarm triggers identified if any needed to a project; actor/stakeholder; Project/sub zone; KPI; Quantity; Type of alert		evaluated (e.g. envelope part, equipment, renewable energy sources); ○ Criteria for the optimization (e.g. costs, energy target, etc.); • Model Structure: ○ Consumption calculation (or access to previous energy calculation if available); ○ Load passive and active technologies databases; ○ Simulation of the passive part of the building, based on the defined criteria; ○ Simulation of the active part of the building based on the defined criteria; ○ Provide the optimal technologies			

			for passive and active technologies, as well as their impacts according to the selected criteria.			

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I5.M2.SM1 Data Acquisition and Status Reporting:	Clarity		
I5.M2.SM2 Dynamic Env. Assessment and Communications			
I5.M2.SM3 Energy Use Optimization:	ModSCO, iESD_E, RobMOS, EcosimPro		
I5.M2.SM4 Energy Generation Evaluation and Decision Support	iESD_E		
I5.M2.SM5 Human Thermal Model Building Automation Control:	HTM		
I5.M2.SM6 Energy Management ICT tool – ISO 50001 Decision:	En-MS		
I5.M2.SM7 Reporting:			

Module: I5.M3 Financial Monitoring and Accounting		
Module description:	**Used in life cycle phase:**	**Module use in Austria Pilot workflow:**
Especially during the operational life stage of the building this module undertakes the	Strategic definition (purple): Definition and brief (Blue): Concept Design (Red): Dev. & Technical Design (Green): Construction/Renovation (Yellow): Handover & close (Dark green): In Use (Turquoise):	

Sub-module Features Descriptions:

I5.M3.SM1 + SM2 Smart Contract Based Open Ledger Bookkeeping

- The specified financial valuation, timing and responsible party definition retrieved from the related project Management definition dataset
- Related approval procedure (or a single approval user role) specified to a user (can be handled in Project Management as well)
- Based on the Smart Contract liabilities, the financial debt equivalent of the scope of work is quantified, and the debtor and the recipient party addressed
- The related verified version from I4.SM1 SM retrieved
- The related financial transaction is made with evidence reference
- The open ledger of the project stores the transaction in the distributed framework

I5.M3.SM3 Evidence Recording and Tracing

- The versions stored in the project can be viewed. Related scope of the twin can be retrieved
- The related energy or similar performance stored with reference to a DT version can be retrieved
- The validation of the DT and the performance can be demanded
- The system creates stamping of the available data and compares it with the stored and signed version
  The system provides compliance of the content with the one stored at timestamp

Sub-modules:	Assoc Tools:	Inputs:	Outputs:
I5.M3.SM1 Construction Smart Contract Based Open Ledger Bookkeeping	NEW TOOL		
I5.M3.SM2 Renovation Smart Contract Based Open Ledger Bookkeeping	NEW TOOL		
I5.M3.SM3 Evidence Recording and Tracing	NEW TOOL		

Appendix B - Features of SPHERE Modules & Sub-Modules

I1.M1: User and Network Management Module

Coding	Name	Feature from User Stories	Features from software tool providers	Notes
I1.M1.SM1 NEX	Identify Users	P1. Based on the needs and strategic definition, identify the users (Aus US3) – BIM Manager (Ita US2)	F1. Add new user F2. Assign user to role F3. Provide user overview F4. Provide the ability to activate/deactivate the user F5. Relate user to person/organisation in the database	Identify sounds like an automatic process or choosing users from an existing list. If by identify we mean adding / creating new users to the application, it may be more appropriate to change the wording to add / create. Example: Create a user with design team role.
		P2. Identify the design team users (Aus US9, US19, US27) (Ita US6, US12) Assign the user (most likely to be facility manager) (Aus US36, Ita US37)		
		P3. (Temporarily) Defines maintenance service company user (Aus US38, Ita US39)		
		P4. Identify the users of the project manager and construction manager team that compete in the tender (Ita US20, US26, US34) Design team that complete tender (Ita US21)		
		P5. Identify the Stakeholders (Ita US22, US23, US25)		
I1.M1.SM2 NEX	Create Project & Identify Roles	P1. Based on the needs and strategic definition, identify the roles (Aus US3, Ita US2)	F1. Define new role F2. Assign role to user(s) F3. Manage permissions per role	What does identify role mean? Is it dynamically creating new roles and permissions according to user types or assigning different permissions to predefined roles for different user types?
		P2. Identify the design team roles (Aus US9, US19; Ita US6, US12,) Identify the construction roles (Aus US27; Ita US26) Identify the general contractor team roles (Ita US34) Assign the roles (most likely to be facility manager) (Aus US36; Ita US37)		
		P3. (Temporarily) Defines maintenance service company role (Aus US38; Ita US30)		
		P4. Tendering: Identify the roles of the project manager and construction manager team that compete in the tender (Ita US20,) design team (Ita US21)		

		P5. Identify Stakeholders (Ita US22, US23, US25,		

I1.M2: Processes and Workflow Management Module

Coding	Name	Feature from User Stories	Features from software tool providers	Notes
I1.M2.SM1 NEX	Setup and Management of Project Phases and Processes	P1. Examine the predefined phases and processes (Aus US3; Ita US2)	F1. Define project phases F2. Define relations between phases	We need to add more details to process management, what does project management mean in our application? is it changing the status of process (approve / reject), is it editing information, is it assigning user to the process or all of them?
		P2. Process management based on design, tendering and BIM documents (Aus US27; Ita US26, US28, US29, US30, US31, US32)		
I1.M2.SM2 NEX	Roles and Processes Matching	P1. Assign responsibilities to identified users and roles (Aus US3, US5, US9; Ita US2,	F1. Assign user(s) to a process/activity F2. Assign role(s) to a process/activity	
		P.4 Identifying responsibilities (Ita US3)		
		P2. Authorise the new users, if user is already authorised take no action (Aus US19; Ita US6, US12,)		
		P3. Roles and Process Matching based on design, tendering and BIM documents (Aus US27; Ita US23, US25, US26, US28, US30, US31, US32, US34,)		
I1.M2.SM3 NEX, VRM, ASC	Authorization	P1. Give authorisation to the users according to the identified roles and phases (Aus US3, US9, US19; Ita US2	F1. Allow for user creation F2. Allow secure access to platform	
		P.5 Assign users to process (Ita US6, US12		
		P2. Auhotisarion of the users for the software (Aus US27; Ita US23, US25, US26, US29, US30, US31, US32, US34)	F3. Manage access to platform tools	
		P3. Authorisation for the new user and roles (Aus US36; Ita US37)		
		P4. (Temporarily) Authorisation for platform entry with restrictions(Aus US38; Ita US39)		

I1.M3: Common Data Environment/Management Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I1.M3.SM1 NEX	Data/Document Management		F1. Add files	Again, what does management mean for our application? Adding them / removing them / changing them / grouping them / merging them / sending them? I think it would improve readability a lot if we mention what file and data is needed for these items.
			F2. Download files	
		P12. Management to the data/documents used for the selection of candidates,access to previous documentation during tendering (Ita US20, US21,	F3. Manage document versions	
		P13. Management the previous BIM data and reports (design reports, LCA,LCC),access to previous documentation (Ita US22)		
		P14. Construction companies participating in the tender able to manage the previous documentation during tendering (Ita US23)		
			F4. Organize relation between documents and assets	
			F5. Create relations between documents and assets	
			F6. Manage sharing of documents or specific version of a document	
		P1. Data/document utilised by brief and target setting (Aus US1, US2, US3; Ita US1, US2)		
		P2 access to strategic definition and survey needs data (Aus US3; Ita US2)		
		P3 Access previous findings (Aus US4, US5, US23, US27, US28, US29; Ita US3, US5, US9, US26, US27, US28)		
		P4. Access stored documents (site survey/meeting reports, assessment of the potential subcontractors, suppliers report, strategic definition documents) for early concept design draft (Aus US6, US24, US25, US26; Ita US4, US6)		
		P5 Access to stored draft early concept design report, strategic definition phase documents (Aus US7)		
		P6. Access to stored draft early concept design report and basic cost estimation report (Aus US8, US9; Ita US4)		

		P7. Access and use BIM documentation ,early concept report and BIM execution plan (Aus US10; Ita US7, US15, US16)		
		P8. Access and use concept design BIM models and previous documents(basic cost estimation, meeting outcomes, targets) (Aus US11, US12,)		
		P9. Access and use concept design, BIM and simulation documentation and LCA documentation (Aus US13, US14, US15, US16, US17; Ita US8, US9, US10, US11, US12, US13, US14, US25)		
		P.10 Concept design documentation and use the workshop outcome reports, BIM based concept design technical specifications, preliminary simulation results and LCA result reports (Aus US18, US19, US20, US21, US22; Ita US17, US18, US19)		
		P11. Access to siumulation results and built-as designed data (Aus US33; Ita US34)		
		P15. Check the construction programme and previous reports and data,access to previous documentation and BIM model (Ita US29, US30, US31, US32, US33,)		
I1.M3.SM2 VRM	Connectivity to IoT and External Live Sources	P1. Set up the connectivity of automation system with the platform (Aus US33; Ita US34)	F1. Add new devices	Is connectivity integration? If it is integration, we need to identify what kind of integration it is. Through rest API? SOAP? Importing / exporting files? Creating a scheduled task to read file from a file system?
			F2. Review connectivity of existing devices	
			F3. Set, receive and action alerts	
			F4. Link device to object	
			F5. Visualize device location	
			F6. Comms failure notification	
I1.M3.SM3 NEX	Exporting/Allow Access/Deletion of Data and Documents	P1. Export the document in desired formats (Aus US1, US5, US23, US24, US25, US9, US19) Exporting or allowing others to access selected data which are required for the survey (Aus US2)	F1. Export data in different formats (xlxs, cvs)	
		P2. Initial site assessment and parameters for BIM – if needed export the report to related parties with the desired format (Ita US3)		

		P3. Concept design management - use the module to allow access/export data with related parties (Ita US6; Ita US12)		
		P5. Access and export the BIM based concept design technical specifications, preliminary simulation results, BoQ cositings and LCA result reports and display them (Aus US15, US17, US28; Ita US10, US11, US34)		
		P6. Export the workshop outcome reports, BIM based concept design technical specifications, preliminary simulation results and LCA result reports (Aus US18)		
			F2. Provide access to data through a web service (API)	
			F3. Data includes assets, requirements, specifications, properties etc.	
		P4. Access to previous concept design documents (Aus US13) Construction companies participating in the tender access to previous BIM data and reports (design reports, LCA,LCC) (Ita US23, US25)		
		P7. Restricted access to data, only maintenance related data an d BIM for Maintenance Service Company (Aus US38; Ita US39)		
		P8. General contractor insert data and report it during starting work and provisioning of construction materials (Ita US27		
I1.M3.SM4 VRM, ASC	Dynamic Data Visualization	P1. Use dynamic table, dynamic 3D models (if needed) (Aus US22, US23, US24, US25; Ita US8, US13, US14, US15, US16)	F1. Visualize data in dynamic tables	
		P2. Previous design documents will be visualised by the team (dynamic 3D models, dynamic tables etc) (Aus US20)		
		P3. Preliminary simulation results and design documents will be displayed (dynamic tables, 3D models etc.) (Aus US21)		
		P4. Display BIM data, concept design and simulation document (Ita US34)		
		P3. Use dynamic 3D BIM viewer (if needed) (Aus US10, US12, US13, US14, US16, US17, US18, US23, US24, US25, US26; Ita US7, US8, US13 US14, US15, US16)	F2. Link project information to 3D visualization of BIM model	

			F3. Provide mechanism for visualizing, analyzing large amounts of data from heterogenous external source	
I1.M3.SM5 VRM	Reporting	P1. Report strategic brief and targets (Aus US1) Reporting functionality to export Strategic brief and send (Ita US1)	F1. Report data in a predefined document format F2. Manage report templates	
		P17 Based on the draft early concept report basic cost estimation (Ita US4)		
		P2. Report findings (Aus US2) : Assess data needs for early understanding of outcomes (CREE, building owner, maintenance company)		
		P3. Reporting functionality to export team and technical assessment info (Aus US3, Ita US2)		
		P4. Report findings (Aus US4): Assess need and listing of potential subcontractors and suppliers (Aus US27		
		P5. Reports of site surveys, inspections, targets and the meeting notes (Aus US5, US17; Ita US5)		
		P6. Create draft early concept design report and basic cost report (Aus US6, US7, US10) and strategy report (Aus US9; Ita US6, US7)		
		P7. Site survey, cost and targets report (Aus US8 Assessment of site survey, cost and targets (CREE, building owner)		
		P. Expert reports (Aus US11) Prefliminary simulations (Aus US13, Ita US8)		
		P14. Life cycle assessments (LCA) report findings (Aus US14, US22; Ita US15) LCC report findings (Ita US16)		
		P15. Early materials quantities/mass / BoQ - Cost reporting (Aus US16; Ita US9)		
		P19. Developed & Technical design management and strategy report (Aus US19; Ita US12		
		P.20 Report findings (Aus US20; Ita US13, US14,) Developed & Technical Design Design based on BIM		
		P21. Report findings (Aus US21): Simulations (energy, daylight, ventilation simulations		
		P22. Report the tendering documents and list documentation (Aus US23, Ita US20)		
		P23. Report findings from final material quantities/mass/BoQ – Cost analysis (Aus US16, Ita US17)		
		P28. Report the offers content of response to the tender (Ita US24)		

		P29. Report the anneces to the contract and certification (Ita 25)		
		P30. Report and list the construction work management document (Ita US26) work start up report (Ita US27)		
		P25. Construction process report (consturdtion of foundation and core of the building (Aus US29, Ita US28, US29, US30, US31, US32) Prefabrication delivery to site (Aus US30), Assembly of the hybrid prefabricated elevlemt (Aus US31), continuour status monitoring and reporting (Aus US32, US33; Ita US33) ,		
		P31. Commissioning report (Ita US34)	F2. Manage report templates	
		P26. Sharing of reports between parties after design workshops (Aus US15; Ita US18)	F3. Store reports documents on the file server	
			F4. Export Bill of Quantity from a selected data set	
		P16. Report the meeting notes and outcomes (Ita US3, US33)	F5. Extract a Minutes of Meeting report	
			F6. Manage document reviews in a structured way	
		P.27 Sending reports (Ita US1)		

I1M4: BIM and Objects Library Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I1.M4.SM1 IDP, TNO	BIM Execution Plan		Project Information	
			Key project contracts	
			Project goals/BIM objectives	
			Evaluate partner BIM capabilities and define roles and responsibilities	
			Technology infrastructure needs	
			BIM process design	
			BIM and facility data requirements	
			Model structure	
			BIM information exchanges	
			Collaboration procedures	
			Model quality control procedures	
			Project deliverables	
			Delivery strategy/contracts	
			Project delivery	

			Evaluate project success to date and revisit BEP	
		P1. BIM Execution plan (Aus US6, US10, US15, US18, US27, US29)		
		P2. Use BEP to determine priorities (Aus US29)		
		P3. Elaboration of a BEP to implement a BIM methodology (Ita US2)		
		P4 Check the BEP for basic cost estimation and report (Ita US3)		
		P5. Check the BEP for assessment of building survey, cost and targets (Ita US5)		
		P6. Check the BEP for the project management activities (Ita US6)		
		P7. Check the BIM execution plan for the concept design (Ita US7)		
		P8. Evaluate the BEP as a whole and revisit in concept design workshop (Ita US10, US11)		
		P9. Check the BEP for the site surveying and data collection (Ita US3)		
		P10. Check BIM execution plan during the construction project management (Ita US26, US27, US36)		
I1.M4.SM2 TNO	BIM and Objects Libraries	P1. Create BIM model (Aut US10; Ita US7)	Configuration of the parameters of the BIM Authoring tool (work units, rules and standards of dimensioning and calculation and selection and loading of libraries). General settings (project information, project location, north configuration, geographic coordinates (longitude and latitude), elevation (A.S.L.). Grid setup and structural and architectural design module. Setting the altimetry of the virtual building (elevation and height of stories/floors). Creating properties in BIM authoring tool based on construction information. Parameter settings and insertion of BIM elements (wall, slab, column, stair, etc.). Classification of BIM elements. Verification of the design choices from an architectural and	these operations are not consequential but can take place either before or after according to the way you work with your BIM authoring tool

			construction point of view (verification of the relationships and connections between the elements). Virtual building documentation e visualization. Export in various interoperability formats to start collaborative work.	
		P2. Design size iterations based on BIM (Aut US12)		
		P3. Accessing the BIM directory and all libraries to **get the parameters** for the preliminary simulations (Aut US13, U24; Ita US8)	Conversion and revision of the BIM model into a BEM model.	In the case of Italian pilot, an add-on application is activated in the BIM authoring tools to carry out the preliminary simulations. With this add-on application active it is possible to export the BIM model with all relevant information, including thermophysical value, in gbXML, PHPP, VIP Energy format.
		P4. Accessing the BIM directory and all libraries to **get the parameters** for the simulations (Aut, US21; Ita US14)	Creating properties in BIM authoring tool based on costing, structural, processing information. Export the entire model in IFC format after checking that all properties and geometry correspond to the IFC format with a specific LOD. Load IFC model in more specific simulation's software (cost, construction, structural, energy, daylight, ventilation, water reuse etc.). Control and verification of the properties and classification of the BIM model. Export of the BIM model in IFC, GbXML and spreadsheet format to load in LCA e LCC app for assessment. Creating properties in BIM authoring tool based on costing information. Export the information with interactive schedules that can be saved in format, Doc, Xls, Txt, Dwf, Pdf. If the xls format is used, interactive schedule can be loaded into spreadsheet applications and perform a final cost estimate through a collection of	Simulation apps (mainly energy) can also import the GBXML format. In the case of Italian pilot, an the gbXML format is obtained after performing the preliminary energy simulations. Calculations of final construction cost takes place through QTO (quantity takeoff) from IFC model and loaded into an 3D IFC viewer connected to an estimative metric calculation software. This app contains the database cost analysis of the works and their prices and is able to perform accounting and economic comparative tool.
		P4 Check the BIM based design, object libraries and assigned materials to get input (Aut US14, US22; Ita US15, US16, US34)		
		P14. Obtain the parameters from the BIM model (Ita US17)		

			cost data. Export the entire model in IFC format after checking that all properties correspond to the IFC format.	
		P5. BIM based design utilisation for early cost assessment (Aut US16; Ita US9)	Creating properties in BIM authoring tool based on costing information. Export the information with interactive schedules that can be saved in format, Doc, Xls, Txt, Dwf, Pdf. If the xls format is used, interactive schedule can be loaded into spreadsheet applications and perform a preliminary cost estimate through a collection of cost data. Export the entire model in IFC format after checking that all properties correspond to the IFC format.	Use an IFC viewer to extract all the information in lists and schedules directly from the model. Export the BIM Model in IFC format and load in an IFC viewer connected to an Estimative metric calculation software.
		P6. Verify the BIM based on the workshop feedbacks. If not review the design and BIM (Aut US18, U26; Ita US11, US19)	Coordinate and verify the BIM model with an external IFC viewer or the same BIM authoring tool used. in this phase it is possible to clash detection between groups of elements and set verification rules to look for possible design errors	External IFC viewer as a Solibri, Trimble Connect and Navisworks etc.
		P7. New objects will be added to the BIM library and BIM object libraries will be utilised for updating the BIM (Aut US20; Ita US13)	Acquisition of BIM objects from the different databases of manufacturers of materials and construction components to link them to the project file opened in the BIM creation tool and carry out a more detailed design.	Search and download BIM objects from different websites and then collect them in a folder to create a dedicated library. It is also possible to search BIM objects with functionality inside the BIM authoring tool used.
		P8 Access the updated data for preparing tendering documents (Aut US23)		
		P9. Export BIM data and provide it to the manufacturer (Aut US 29)		
		P10. Verify the compliance of the delivered parts with the BIM and object libraries (Aut US30)		
		P11. Updating the BIM model and material library as work progresses to produce an 'as-built' model (Aut US31, US32; Ita US33) and at the final stage (AutUS35; Ita US36)	Before (to simulate the construction process) and after during the construction phases it is possible to associate an	The update of the "as build" model takes place in base of

			exported model in IFC format to connect this model to a project management software. Based on what is built on site, the BIM model, of the previous design phases, is analysed on the basis of a WBS and progressively updated in an "as-built".	information reported by construction surveyor.
		P12. During commission and building automation installation check the updated BIM model and identify the installation location (Aut US33)		
		P13.Check the updated BIM model and identify the built elements (Ita US34)	In order to carry out the commissioning checks analyse the AS built model.	In the IFC 3D viewer, the verification rules are set to search for possible construction errors.
		P14.Update the BIM Model to the final stage (Ita US36)	Updating the BIM model with all the information of handover with the BIM authoring tool used	it is possible to create a model record that contains all the information on the building as well as the geometry of the model itself as a warranty, property and maintenance manuals, training videos, etc.
I1.M4.SM3 EKO	Material Library	P1 Using BIM object libraries to import BIM objects as the design proceed (Aus US10; Ita US7)	F1. Create/Update/Delete material database entries. Each entry contains below set of information: Material name, Description, Provider(s), Web link of product, Any reference to Life cycle inventories (Yes/N0), If yes what?, Additional documents (EPD, EU Directive related documents (Reach, etc.)), BIM Object(s) (Types of details if available), Creator of entry, Date of creation	
		P2. Accessing the BIM directory and all libraries to **get the parameters** for the preliminary simulations (Aus US13, US21, US24; Ita US8, US14)	F2. Create/ update Life Cycle Inventory (LCI) entries, including; Name of Inventory, Provider, Description, Number of objects, Web link, References to materials in the SPHERE database that are within the LCI	

		P3. Check the BIM based design, object libraries and assigned materials to get input (Aus US14, US22; Ita US15, US16) Check the updated BIM model and identify the built elements (Ita US34, US36)		
		P4. BIM based design utilisation for early cost assessment (Aus US16, Ita US9)		
		P5. Verify the BIM based on the workshop feedbacks. If not review the design and BIM (Aus US18, US26, Ita US11, US19)		
		P6. Together with object libraries, material libraries will be used to assign materials to the BIM objects and design (Aus US20; Ita US13)		
		P7. Access the updated data for preparing tendering documents (Aus US23)		
		P8. Export BIM data and provide it to the manufacturer (Aus US28)		
		P9. Obtain the parameters from the BIM model (Ita US17)		
		P10. Updating the BIM model and material library as work progresses to produce an 'As-Built' model (Ita US33)		
I1.M4.SM4 EAI	HVAC Library		F1. Providing a set of components for the simulation of HVAC system for the development of a simulation model in EcosimPro	HVAC library is a set of elements for the simulation of HVAC systems in EcosimPro. It cannot be used directly from SPHERE platform because it requires EcosimPro simulation platform to work
			F2. Proving a set of components for the simulation of HVAC control	
		P1. Using HVAC object libraries to import HVAC objects as the design proceed (Aus US10; Ita US7)	F3. HVAC libraries are simulation libraries, therefore they do not import BIM entities. However, a functionality will be provided to map IFC entities to objects in the HVAC libraries and import their parameters.	EAI will provide F3 inside EcosimPro. It is a functionality independent from HVAC module. Mapping and parameter importation is dependent of the target tool so in our opinion cannot be a generic tool.
		P2. Accessing the BIM directory and all libraries to **get the parameters** for the preliminary simulations (Aus US13, US21, US 24; Ita US8, US14)	F1. Providing a set of components for the simulation of HVAC system for the development of a simulation model in EcosimPro	F1 and F2 the elements to carry out simulations of HVAC system. F3 addresses IFC entitities mapping to HVAC object and

			F2. Proving a set of components for the simulation of HVAC control F3. Importation of HVAC equipment parameters to EcosimPro simulation tool	importation of parameters. All the functionalities are provided inside EcosimPro platform.
		P10. BIM based design utilization for early cost assessment (Ita US9)		Information from simulation can be used as input for cost assessment tools but the module do not cover cost assessment itself. DONE IN SPHERE
		P3. Check the BIM based design, object libraries and assigned materials to get input (Aus US14, US21; Ita US15, US16, US34))		THIS IS NICE TO HAVE BUT DIFFICULT
		P11. Obtain the parameters from the BIM model (Ita US17)		Not addressed within the module. To be analysed to what extend F3 can provide a limited checking DONE IN ECOSIMPRO
		P4. Early materials quantities: BIM based design utilisation for early cost assessment (Aus US16)		
		P5 Verify the BIM based on the workshop feedbacks. If not review the design and BIM (Aus US18, US26; Ita US11, US19)		
		P6. As the HVAC system being designed, HVAC objects from the libraries will be used to update BIM model (Aus US20; Ita US13)		To be analysed. To do that, it should be clearly defined what information to update and with which structure. If the scope is too wide may not be possible to do it in the framework of SPHERE project.
		P7. Access the updated data for preparing tendering documents (Aus US23)		Out of the module scope.

		P8. Commissioning and Building automation installation: check the updated BIM model and identify the installation location (Aus US33)		Should be other module the one providing this service.
		P9. Reactionary and Planned Maintenance: BIM model access to the maintenance situation (Aus US38; Ita US39)		This is not related to simulation. Other module should provide this.
		P12. Updating the BIM model and HVAC libraries as work progresses to produce an 'As built' model (Ita US33)		
		P13. Update the HVAC Library to the final stage (Ita 36)		
I1.M4.SM5 EAI	Thermal and Fluid Component Libraries		F1. Proving a library for multicomponent fluid properties calculation to be used in HVAC components	Similarly to HVAC module, this module requires simulation platform to work and it is meant to provide the fluid properties necessary for the HVAC library and elements to simulate the building.
			F2. Providing a library with thermal models of building components and base components for the energy flow calculations	
		P1. Using thermal and fluid component libraries as the concept HVAC design proceed (Aus US10; Ita US7)	F1, F2 and HVAC module.	
		P2. Accessing the BIM directory and all libraries to **get the parameters** for the preliminary simulations (Aus US13, US21, US24; Ita US8, US14)	F3. Importation of geometry, special relations, geographic information, material quantities and properties to EcosimPro simulation tool provided by a specific module in EcosimPro, not I1.M4.SM5.	Inside EcosimPro.
		P3. Check the BIM based design, object libraries and assigned materials to get input (Aus US14, US22; Ita US15, US16, US34)		Not addressed within the module. To be analysed to what extend F3 can provide a limited checking
		P4. BIM based design utilisation for early cost assessment (Aus US16; Ita US9)		Information from simulation can be used as input for cost assessment tools but the module do not cover cost assessment itself.
		P5. Verify the BIM based on the workshop feedbacks. If not review the design and BIM (Aus US18, US26; Ita US11, US19)	F1, F2 and HVAC module.	
		P6. Together with HVAC and pipe infrastructure design, this library will be used to assign materials align with the desired properties (Aus US20; Ita US13)		

		P7. Access the updated data for preparing tendering documents (Aus US23)		P9 to be analysed to what extent the BIM can be modified to introduce modifications from the simulation model
		P8. Obtain the parameters from the BIM model (Ita US17)		
		P9. Updating the BIM model and thermal and fluid component libraries as work progresses to produce an 'As built' model (Ita US33)		

I1.M5: Procurement and Contracting Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I1.M5.SM1 VRM	Tendering Functionalities		F1. Review documents from previous similar projects	
			F2. Assess other concept designs and prioritize	
			F3. Access cost estimation tool	
			F4. Review contract templates for suitability	
			F5. Complete and issue tendering docs from suite of templates	
			F6. Identify potential specialists	
			F7. Contract potential specialists	
		P1. Site Surveying: Make the contract with surveyors / auditors acc. to required procurement process and identified responsibilities (Aus US5; Ita US3)		
		P2. Concept design project management activities: Based on the previous reports(brief and strategic definition, early concept design draft, basic cost estimation reports) find a suitable design team-company-member (Aus US9; Ita US6)		Is finding a suitable design team-company-member an automatic process? Is some kind of recommender system required? What makes a design team-company member suitable?

		P3. Contracting specialist for concept design: Seeking specialists using the BIM based design needs, simulation and LCA assessment (Aus US15)		
		P4. Based on the concept design phase reports find a suitable design team-company-member (if necessary) (Aus US19; Ita US12)		
		P5. Contacting subcontractors and suppliers: Use for tendering with the tendering documentation. Find the manufacturer (Aus US23; Ita US20)		What do we mean by contacting, sending them invitation e-mail?
		P6. Starting manufacturing process (Aus US28)		
		P7. Based on the Brief , Target and Strategy find project manager and construction manager (Ita US1)		
		P8. Use for the preparation of the tender documentation for the selection of design team (Ita US21, US22)		
		P9. Use to make offers for tendering from construction companies participating in the tender (Ita US23)		
		P10. Use for comparison of the bids in the tender (Ita US24)		
		P11. Use for acceptance of the tender contract. (Ita US25)		
I1.M5.SM2 EUT	Smart Contracts; Blockchain		F1. Blockchain integration	I believe the term smart contract is misunderstood here. Smart contract is not a document, but it is a computer program that executes automatically when a condition is met. So does accessing smart contract means accessing the source code of the application within the website?
		P1. Concept design project management activities: using contracting module (Aus US9; Ita US6)	F2. Access “smart” contracts and doc via contracts module	
		P2. To be able to initiate detailed & technical design strategy and decisions: use contracting module (Aus US19; Ita US12)		
		P3. Contracting subcontractor and suppliers: is desired, use the smart contract between the parties (Aus US23; Ita US21)		
		P4. Tendering for project manager and construction manager: use contract module (Ita US20) Design team (Ita US21)		
		P5. Identification of the winner of the tender and signing of the contract (Ita US25)	F3. Digital signature	
			F4. Lock contracts within the platform and append to digital entity	

I2.M1: Brief and Target Setting Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I2.M1.SM1 EKO	Brief Definition		F1. Select items to be included in the project brief	
			F2. Generate example empty project brief with headers	
			F3. Deletion or addition of further items to be included in the project brief	
			F4. Enable fill-in fields to add qualitive information under project brief header	
			F5. Generate final project brief PDF	
			F6. Enable downloading and sending of project brief to other stakeholders	
		P1. Obtain brief template and fill in details, attach files (Aus US1; Ita US1)		
		P2. Use the filled template during the definition of the needs (Aus US2)		
I2.M1.SM2 EKO	Target Setting & Collaborative Management		F1. Load generated brief and unlock target template	
		P3. Define the needs and possible solution targets (Aus US4)	F2. Select targets and performance standards to track	
		P1. Utilisation of target setting dashboard from baseline for identifying needs when identifying overarching objective and performance criteria (Aus US1, US2; Ita US1)	F3. Select quantities of targets	
		P5. Concept design target setting (Aus US6)		
		P4. Meeting arrangement and assigning responsiblities (Aus US5; Ita US3)	F4. Set roles to targets for management	
		P10 Stakeholder cooperation management and plans (Aus US27)		
		P7. Active collaboration management among the experts (Aus US11; Ita US7) management and workshop organization (US17; Ita US10)	F5. Create collaboration groups	
		P2. Setting up the collaboration management and rules and guidelines for using it (Aus US3; Ita US2)		
		P8. Set up design team collaboration strategy ofr developed&technical design phase (Aus US19)		

		P6. Set up design team collaboration strategy (Aus US9, US10; Ita US6, US12)		
		P11. Management of executive meetings for planning verification, progress and work variants and BIM model "as built" (Ita US33)		
			F6. Generate target PDF	
		P10. Management of executive meetings between the stakeholders (Ita US26, US31)	F7. Enable sending of project targets to relevant involved stakeholders	
		P9. Worksop target settings and stakeholder involvement management (Aus US25; Ita US18)		
I2.M1.SM3 R2M	ESCO Operational & Contractual Responsibilities		F1. Create report	
			F2. Access energy and operational data	
			F3. Set operational responsibilities	
			F4. Set contractual responsibilities	
			F5. Review operational responsibilities	
			F6. Review contractual responsibilities	
			F7. Export Data	

I3.M1: Energy Modelling and Simulation Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I3.M1.SM1 TNO	Settings and Parameters: Temperature, Indoor Environment Quality Control (Comfort)	P1. Preliminary simulations: After getting the parameters input these values. Adjust the settings (Aus US13)		
		P2. Check the findings, verify the simulation findings.If not review the design (Aus US18, US26; Ita US19)		
		P3. After getting the parameters input these values. Adjust the settings (Aus US21; Ita US8, US14,)		
I3.M1.SM2 TNO	Targets and Metrics	P1. Set simulation targets based on the inputs and adjust the metrics (Aus US13, US21; Ita US8, US14)		
		P2. Check the findings, verify the simulation findings.If not review the design (Aus US18, US26; Ita US11, US19)		
I3.M1.SM3			F1. Access the IFC file from the SPHERE database	

TNO, EAI	Heat Load Modelling		F2. Fill in missing data from the IFC file/additional sources	
			F3. Configure the heat load model with parameters	
			F4. Run the heat load model	
			F5. Obtain results for the model and interpret	
			F6.	
		P1. Based on the BIM model and parameters, conduct preliminary heat load modelling (Aus US13, US21)		
		P2. Check the findings, verify the simulation findings. If not review the design (Aus US18, US26; Ita US11, US19)		The five functionalities listed cover the two requirements and also the energy assessment requirements if they are written in a generic way. Instead of heat load model, simulation model. However, not sure how TNO want to address this. Similar to first request US13, US21
		P3. Based on the BIM model and parameters, conduct preliminary heat load modelling (Ita US8, US14)		
I3.M1.SM4 TNO, EAI	Renovation Energy Assessment	P1. Based on the BIM model, objects and parameters, conduct preliminary energy assessment (Aus US13, US21)		
		P2. Check the findings, verify the simulation findings.If not review the design (Aus US18, US26; Ita US19)		
		P3. Check and verify the simulation results. If the project is not reviewed (Ita US11)		
I3.M1.SM5 EUT	Energy Efficiency and Supply		F1. Access the project data	
			F2. Extraction of building information from BIM model	
			F3. Access to meteorological data	
			F4. Provide the energy consumption vectors	
		P1. Get the results from preliminary heat load modelling and energy assessment, conduct preliminary energy efficiency simulation (Aus US13, US21)		
		P2. Check the findings, verify the simulation findings.If not review the design (Aus US18, US26; Ita US11, US19)		
I3.M1.SM6 TNO	Micro-services for Energy Modelling	P1. Use the BIMbot service for facilitate the preliminary heat and energy simulations (Aus US13, US21; Ita US8, US14)		

	Calibration and Validation	P2. Check the findings, verify the simulation findings.If not review the design (Aus US18, US26; Ita US11, US19)		
I3.M1.SM7 VTT	Human Thermal Model	P1. Use the human thermal model with the preliminary heat load modelling to obtain a concept model (Aus US13, US21; Ita US8, US14)		
		P2. Check the findings, verify the simulation findings.If not review the design (Aus US18, US26; Ita US11, US19)		

I3.M2: Sustainability Assessment

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I3.M2.SM1 EKO	Material Flow Management	P2. Check the findings, verify the sustainability assessment findings.If not review the design (Aus US18, US26; Ita US19)	F1. Access project data	
			F2. Extract material BoQ from the BIM file	
			F3. Identify the scope and functional units for the analyses	
		P1. Based on the inputs from previous tasks, form the intermediate material flow and basis of the material flow management (Aus US14)	F4. Visualize the material flows as a whole	
		P3. Based on the inputs from previous tasks, form the finalised material flow and basis of the material flow management (Aus US22; Ita US15, US16)		
I3.M2.SM2 EKO	Life Cycle Impact Assessment		F1. Identify the reference Life Cycle Inventory	
			F2. Match the flows with inventory objects	
		P1. Use the material flow and material libraries to get parameters, use them to complete the life cycle impact assessment (Aus US14, US22; Ita US15)	F3. Visualize the matching of the material flows with inventory items	
			F4. Allow the selection of generic flows such as Energy grid-mix, Logistics definitions	
			F5. Allow the selection of the Impact Assessment category	
		P2. Check the findings, verify the sustainability assessment findings.If not review the design (Aus US18, US 26; Ita US19)	F6. Show the result of assessment	
			F7. Allow benchmark/comparison of assessments	
I3.M2.SM3			F1. Identify the parameters for cost calculations	

EKO	Life Cycle Costing Analyses	P1. Use the material flow and material libraries to get parameters, use them to complete the life cycle costing analyses (Aus US14, US22; Ita US16)	F2. Match material flows with the known costs	
		P2. Check the findings, verify the sustainability assessment findings.If not review the design (Aus US18, US26; Ita US19)	F3. Provide the life cycle calculations	
I3.M2.SM4 EKO	Circularity Assessment		F1. Identify the metrics to be used for assessment	
		P2. Check the findings, verify the sustainability assessment findings.If not review the design (Aus US18, US26; Ita US19)	F2. Report on these metrics	
		P1. Utilise the LCIA and LCCA, conduct circularity assessment (Aus US14, US22; Ita US15, US16)		
I3.M2.SM5 EUT	Water Treatment Assessment		F1. Access the project data	
			F2. Extraction of building information form BIM model	
			F3. Access to meteorological data	
			F4. Access to user information	
			F5. Model structure	

I4.M1: Blockchain Services for the Construction Processes Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I4.M1.SM1 IDP	Time Stamping/Versioning for Digital Twin Certification		F1. Compilation of the below set of data for digital twin configuration F2. Hash of Digital Twin file is compiled in an XML, Json structure F3. Digital sign and store for future compliance and liability validation	Blockchain networks hash the content of blocks and store them in the header of block along with hash of the previous block automatically unless you are planning to create your own blockchain network from scratch there is no need to hash content of block again.
		P1. Update the versioning for Digital Twin certification (Aus US 26, US29, US31, US32, US33, US35; Ita US19, US20, US21, US24, US25, US27, US33, US35, US36		It is extremely important to identify what information should be stored on blockchain at an early stage. Because of high transaction costs and block size limitations it may not be feasible to store things like files in the blockchain network. (or we can hash the

				content of the document and store it)
I4.M1.SM2 EUT, VRM	Subcontracting Management		F1. Subcontracting party is defined in the platform and project	
			F2. Information on their scope, responsibilities stored in the system	
			F3. Scope carried out by the party defined in the system and referenced to Digital Twin/ BIM sub components	
			F4. If a performance related obligation exists, that information and related obligations and liabilities are specified (I2.M1.SM3)	
			F5. Periodic need for validation and bookkeeping specified	
			F6. For the scope related obligations, Action (I1.M1.SM1) carried out with reference to the subcontracting party	
			F7. In the case of performance obligations, Action (I4.M1.SM2) carried out with reference to the subcontracting party	
		P1. Subcontracting management during tendering bid review and acceptance (Ita US24, US25,		
		P2. Manage the general contractor, use this function during the roles and process matching (Ita US26. US27, US28, US29, US30, US31, US32)		

I4.M2: Construction Operation Management Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I4.M2.SM1 CREE, ASC	Site Role/Task Management		F1. Sharing information in the right data format and quality	
			F2. Order based on BIM objects and BIM components	
			F3. During construction, continuous update of the BIM (Revit/ArchiCAD) model when something changes, create the *'As built' model*.	

			F4. The As Built Model should include all data from Architecture, MEP, Structure and should include all required data for the desired purpose.	
			F5. Define roles and responsibilities within the project	
			F6. Create tasks related to BIM object	
		P2. Assign roles and tasks (Aus US27, US29, US31; Ita US27, US28, US29, US30, US31, US32)	F7. Assign tasks to the concerned team/worker/role	
		P3. assign tasks to building automation team and subcontractors for installation of building automation (Aus US33; Ita US34)		
			F8. Locate the task in the building	
			F9. Report the task status (Open, Done, Extended Deadline, Failed)	
		P3. Check the delivered prefab. Parts for the following acceptance (Aus US30)	F10. Provide a communication channel concerning a task between the concerned users/roles	
		P1. Identify the required subcontractors and suppliers for the survey and identify the survey activities and outputs (for the survey contracting) (Aus US4)		
I4.M2.SM2 CREE, ASC	Site Surveys and Inspection		F1. Sharing information in the right data format and quality	
			F2. Quality inspection of prefabrication	
			F3. Transportation inspection	
			F4. Delivery and storage on-site	
			F5. Assembly process	
			F6. Final assembly quality control	
		P1. Start the site survey and fill the audit/survey report (Aus US5; Ita US3,)		
		P2. Organize site surveys and inspection to monitor the progress (Aus US29, US31; Ita US28, US29, US30, US31, US32, US33)		Again, more detail is needed for organize, is it merging? Grouping them? Ordering them? Ignoring them in the current operation?
I4.M2.SM3 CREE, ASC			F1. Sharing information in the right data format and quality	

	Clash Detection Solving and Documenting	P1. Use it for clash detection documentation and solving (Aus US29, US31)	F2. Identifying clashes, locating them on-site and in the model	
			F3. Give the task to the responsible person to solve it and document it	
I4.M2.SM4 CREE, ASC	Progress Monitoring		F1. Sharing information in the right data format and quality	Change? Is it change in status? Change in the content? What kind of reporting is needed? Mail? SMS?
		P1. Constantly monitor the progress, reporting the change (Aus US29) Constantly monitor the progress, reporting every change (US30, US31, US32, US33, US34) (Ita US28, US29, US30, US31, US32, US33, US34, US35)	F2. Continuous monitoring and reporting from the whole construction process.	
			F3. Handle and solve changes and delays, reporting them	

I4.M3: Construction Document Management

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I4.M3.SM1 EKO	Design-As Built Data Compliance	P1. Based on monitoring activities update the design 'As built' data using the design and progress documents (Aus US29, US31, US32, US33; Ita US33, US34)	F1.	This user story is delivered by the Digital Twin Configuration management user story items
		P2. Check the as built model compliance (Ita US36)		
I4.M3.SM2 NEX, VRM	Improving the Process and Change Management	P1. Constant feedbacks (Aus US29, US30, US31, US32; Ita Us28, US29, IS30, US31, US32, US33, US34)	F1. Identify change request F2. Identify approval needs F3. Approve change F4. Create required set of documents for change specifications F5. Relate change request to requirements/objects in the database	Feedbacks in what form?

I4.M4: Regulatory Compliance Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes

I4.M4 VRM	Regulatory and Compliance Checks	P1.set value by regulations/ Check whether results are within the acceptable range determined by regulatories (Aus US13, US21; Ita US8,)		Is it automatic or manual?
		P2. Check the findings, verify the design.If not review the design (Ita US11, US19)		
		P3. Constantly check with regulatories, if not report as a feedback (Aus US14, US18, US20, US22, US26; Ita US13, US14,US35)		
		P4. Check the regulatory compliance, legal integrity, qualification, skill and required certification of the project manager and construction manager team. (Ita US20, US21, US22,)		
		P5. Check construction companies participating in the tender in the regulatory compliance, legal integrity and required certification (iso 9001, iso 14001 etc.) (Ita US23)		
		P6. Check construction companies contracting the regulatory compliance and legal integrity for contract agreement (Ita US25)		

I4.M5: Comissioning

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I4.M5.SM1 IDP, EKO	Comparison of Energy Simulation and Real Values	P1. Compare the simulation results with the real values after the installation of the automation systems, report the results (Aus US33; Ita US34)	F1. Building Energy Consumption parameters are defined: Description on scope of coverage of consumption data (whole building or zones of building) [In case of multiple power meters, multiple entries are needed] Occupancy conditions [User numbers, Operational practices if any (natural ventilation etc.)]	I think it would be helpful to identify how we are going to report the results. Is it a report? Changing the color of row that contains the

			F2. Energy Consumption data is compiled, Manual Process: [The bills are entered into the platform] Automated process: [Data sources are related to the above defined building zone/parameters are defined, Automated flow of data streamlined]	simulation to green/red?

I4:M6: Handover Management

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I4.M6.SM1 NEX, VRM	Handover Data Management		F1. Review building specific documents	
			F2. Assess for confidentiality	
			F3. Collate guarantees/contract documents	
			F4. Commence defects liability period	
			F5. Record handover acceptance	
			F6. Manage defects/handover refusal	
		P3. Hand over operational & technical info to client (Aus US36; Ita US37)	F7. Collate handover information in an occupant-only environment	
			F8. Provide managed & limited access to occupant	
			F9. Link handover documents/information to the Digital Twin	
			F10. Communicate handover to project partners	
			F11. Collate O&M documents	
			F12. Collate H&S file	
			F13. Satisfy GDPR requirements	
		P1. Complete the handover using the building automation data and the Handover strategy (Aus US34; Ita US35)		
		P2. Review the progress monitoring reports, update 'As built' information based on design as built data and submit performance reports (Aus US35; Ita US36)		

I5.M1: Facility Management Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I5.M1.SM1 IDP, EUT, VRM	Organizing Maintenance Schedules	P1. Use the acquired data from the facility and technical documents (BIM and life cycle assessment reports) determine maintenance dates (Aus US37; Ita US38))	F1. Enable user defined rules for maintenance schedules F3. Trigger warning when maintenance operation is approaching according to programmed rules	
		P2. Check the compiled reports to identify root cause and maintenenace details (Aus. 38; Ita US39)	F4. Create decision support trees based on use-case reasoning	
I5.M1.SM2 TNO	Decision Making for Refurbishment	P1. Using the maintenance and status reports, determine refurbishment requirements (Aus US37; Ita US38)	F1. Create report	
		P2. Check the compiled reports to identify root cause and maintenenace details (Aus US38; Ita US39)		
			F2. Export data	
I5.M1.SM3 VRM, ASC	Building Issue Management	P2. Check the compiled reports to identify root cause and maintenenace details (Aus. US38; Ita US39)	F1. Create/report issue	
			F2. Overview of the site issues status for site managers and direct site responsible	
		P1. Use this tool to identify and reseolve the unexpected issues (Aus US37: Ita US38)		
I5.M1.SM4 COMSA,EUT	Big Data Analytics for Predictive Maintenance	P1. Based on the previous maintenance pattern and product details, anticipate the possible maintenance dates (Aus US37; Ita US38)	F1. Feature selection: select variables affecting equipment operation F2. Estimate need for maintenance based on real operation conditions F3. Create decision support trees based on use-case reasoning (explanatory scheme) F4. Self-learning capabilities: new cases enhance the automatic decision-making process	Extension from I5.M1.SM1 (preventive and predictive maintenance). As the amount of data grows, expert knowledge (rule-based) is replaced by AI.
		P2. Check the compiled reports to identify root cause and maintenenace details (Aus US38; Ita US39)		

I5.M2: Energy Management, Performance Management

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I5.M2.SM1 ED5			F1. Access project data	
			F2. Privacy agreements for data sharing	

	Data Acquisition and Status Reporting		F3. General agreements specifying the correct use without any manomission of them	
			F4. Report of the initial calibration of the sensors and approval of a calibration plan of the sensors	
			F5. Internal general verification of the installed sensor	
			F6. Transmission of measured data to the platform	
			F7. Definition of roles for the users	
			F8. Duration of stored data	
		P1. Platform automation collects the data and transfer it for further analyses (Aus US37; Ita US38)		
I5.M2.SM2 EKO	Dynamic Env. Assessment and Communications	P1. Platform automatically decides (Aus US37; Ita US38)	F1. Energy consumption data, compiled in I4.M5.SM1 is processed into: [Consumption of zone(s) / time period, Consumption of whole building / time period]	
			F2. Set points for buildings identified as alert points of medium and high consumption (KPIs from WP2 used such as kWh/m2)	
			F3. Related building project actors identified in relation to the alerts	
			F4. Automated alarm triggers identified if any needed to a [A project, An actor/stakeholder, Project/sub zone, KPI, Quantity, Type of alert]	
I5.M2.SM3 EUT, TNO, EKO, EAI	Energy Use Optimization	P1. Using the energy simulation results conduct energy optimisation (Aus US37; Ita US38)		This part is exactly the same as **I5.M2.SM4**. There is not foreseen any specific module focused on the energy optimization.
I5.M2.SM4 EUT	Energy Generation Evaluation and Decision Support		F1. Access the project data	
			F2. Extraction of building information from BIM model	
			F3. Access to meteorological data	
			F4. Access to user information	
			F5. Model structure	
		P1. Based on the acquired data, platform automatically conducts simulation and results are utilised in decision support and other activities (Aus US37; Ita US38)		

I5.M2.SM5 VTT	Human Thermal Model Building Automation Control	P1. Based on the acquired data, platform automatically conducts simulation and results are utilised in decision support and other activities (Aus US37; Ita US38)		
I5.M2.SM6 R2M, VRM	Energy Management ICT tool – ISO 50001 Decision		F1. Access current and historic energy data F2. Review savings F3. Review advice F4. Communicate data F5. Communicate recommendations F6. Observe results of changes made	
		P1. Simultaneously with the energy simulation and optimisation, energy management tool assess the results and provides the best solutions automatically (Aus US37; Ita US38)		
I5.M2.SM7 DE5	Reporting		F1. Definition of template for reporting F2. Export results with a simplified content: PDF F3. Export results with a fully set of content: XLS/CSV F4. Define time-lapse for automatic reporting F5. Agreement for the use of data and definition of: role and scope from the user data	
		P1. Compile reports on energy management are created and delivered to the (Aus US37; Ita US38)		

I5:M3: Financial Monitoring and Account Keeping Module

Coding	Name	Feature from pilots	Features from software tool providers	Notes
I5.M3.SM1 EUT, EKO	Smart Contract Based Open Ledger Book-Keeping		F1. The specified financial valuation, timing and responsible part definition retrieved from the related project Management definition dataset F2. Related approval procedure specified to a user F3. Base on the Smart Contract liabilities, the financial debt equivalent of the scope of work is	

			quantified, and the debtor and the recipient party addressed	
			F4. The related verified version from I4.M1.SM1 retrieved	
			F5. The related financial transaction is made with evidence reference	
			F6. The open ledger of the project stores the transaction in the distributed framework	

Appendix C – SPHERE Partner Software Templates

Acronym	Tool name	Tool provider	Location	Status
iESD_E	Intelligent Energy Designer	Eurecat (Appendix C.1)	Appendix C1.1	Complete
iESD_W	Intelligent Water Designer		Appendix C1.2	Complete
iPREDICT	Predictive Maintenance Tool		Appendix C1.3	Complete
IMAN	IMAN - Computerized Maintenance management System	COMSA (Appendix C.2)	Appendix C2.1	Complete
HTM	Human Thermal Model	VTT (Appendix C.3)	Appendix C.3.1	Complete
EPESUS	EPESUS	EKO (Appendix C.4)	Appendix C4.1	Complete
CMT	Concrete Management Tool	BASF (Appendix C.5)	Appendix C5.1	Complete
OPT	Operational Planning Tool		Appendix C5.2	Complete
FRCT	Fiber Reinforced Concrete Tool		Appendix C5.3	Complete
LCCCA	Life Cycle Cost Concrete Assessment		Appendix C5.4	Complete
En-MS	Energy Management System	R2M (Appendix C.6)	Appendix C6.1	Complete
ECOSIMPRO	ECOSIMPRO	EAI (Appendix C.7)	Appendix C7.1	Complete
Refurbify	Refurbify	VRM (Appendix C.8)	Appendix C8.1	Complete
Clarity	Clarity		Appendix C8.2	Complete
ModSCO	ModSCO	NUIG (Appendix C.9)	Appendix C9.1	Complete
RobMOS	RobMOS	TNO (Appendix C.10)	Appendix C10.1	Complete
FLINK2GO	FLINK2GO	ASC (Appendix C.11)	Appendix C11.1	Complete
NEXT	NEANEX PORTAL	NEANEX (Appendix C.12)	Appendix C12.1	Complete

C.1 Eurecat iESD_E, iESD_W, iPREDICT

C1.1 Intelligent Energy Designer (iESD_E)

iESD_E	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	iESD (intelligent Energy System Designer) is a tool focused on the determination of the optimal retrofitting actions to be made on a given building, considering both technologies for the building´s cover and roof, as well as technologies for the energy production, conversion and supply. It is based on the combination of mathematical models that characterize the annual energy demand vectors of a given building (based on its characteristics) and a multiobjective optimization engine that evaluates the different available retrofitting actions for both the envelope, cover and energy equipment of the building, with objective to determine the optimal ones in terms of multi-criteria approach (e.g. energy efficiency, investment and maintenance costs, CO_2 emissions). The tool developed is at TLR 5 since has been validated in an experimental environment, but has to be tested in an operative commercial environment.
How is the software tool to be used and by whom?	It is a visible service. The life cycle stage at which it can be used is either at design or retrofitting. Due to its structure and modular operation, the tool can be used by prescribing technicians, energy services companies, maintenance companies, engineering services or architectonical bureaus as well as consultancies and the end users, focusing only on the passive part (envelop and cover), active part (energetic equipment), or in the entire chain, always to assessing the impact of targeted actions previously selected.
What does the end user get from using the software tool in terms of results?	Calculates and evaluates the energy requirements of the building (heating, cooling, DHW and lighting). Then, it studies potential passive and active solutions to be installed in the building and **analyse their impact in terms of energy, costs and sustainability**. Determine the most efficient equipment to be installed in the building, based on its demand profiles, building's conditions and the optimization criteria.

	As well as, it evaluates which renewable energy technology is the most suitable to install in the building according to its climatic condition, use and architectonic characteristics (e.g. available surface for panels).
What are the main benefits from the results provided by the software tool?	Determine the optimal passive and active technologies to be installed in the building according economical, technical, efficiency and sustainability impacts among others.
Which SPHERE sub-modules does the software relate to?	I3.M1.SM5, I5.M2.SM3 and I5.M2.SM4.
Screenshots (four)	
There are some screenshots of the provisional mockups, however the user interface is pending to be defined and validated.	
Description of BIM USE	
Does the software use data from a BIM file?	Yes, it does. The data needed from the BIM file is: the architectonical parameters (i.e. building shape, number of floors), the climatic conditions (i.e. building situation) and the building's typology (i.e. usage profile, occupation, schedule).
What type of (BIM) files does the software need / will it be built for?	IFC.
Does the software generate data that can be added to a BIM file?	No.
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	The historical energy demand (heating, cooling, DHW, lighting) vectors of the given building.
Does the software generate/provide for any specific files and formats?	No.
Service Architecture	
How would the software interface with the SPHERE platform?	At the moment there aren't linkages considered between the iESD_E tool and any other tool, only with the Sphere platform.

C1.2 Intelligent Water Designer (iESD_W)

iESD_W	Not yet available
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	The tool is focused on three main aspects related to the building and its location: to obtain the annual water demand and its quality requirements, to determine the available wastewater and rainwater per year and to recommend the most suitable water treatment technology. In order to do so, the tool will connect to the corresponding databases to obtain the required input data. The corresponding TRL for the tool is 4 since it has been validated at the laboratory scale.
How is the software tool to be used and by whom?	This tool is a visible service. The tool can be used by engineering firms, service and maintenance companies, local administration, environmental associations and building residents. The life cycle stage at which it can be used is either at design or retrofitting. This tool will automatically connect to the different databases to obtain the inputs for the models and will provide the most suitable options for the user.
What does the end user get from using the software tool in terms of results?	The output for the user will contain water availability (both greywater and rainwater), water requirements of the building (related to irrigation and toilet discharge) and a recommendation for the most suitable water treatment technology to be installed taking into account different parameters (climatic condition, use, architectonic characteristics and its water requirements). It may also determine the optimal sizing of the recommended technology.
What are the main benefits from the results provided by the software tool?	The tool will provide a recommendation of the most suitable water treatment technology to be used, both from an economical and environmental point of view, as well as the water availability and requirements for a given building.
Which SPHERE sub-modules does the software relate to?	I3.M2.SM5
Screenshots (four)	
Pending to be defined.	
Description of BIM USE	
Does the software use data from a BIM file?	Yes, it does. It needs to obtain information related to the building and its location, as well as data from climate databases to include annual water availability.
What type of (BIM) files does the software need / will it be built for?	Probably IFC or gbXML but still to be determined.
Does the software generate data that can be added to a BIM file?	No.
Description of other DATA	

What other datasets are needed from other tools or entered by the user?	Meteorological data related to average annual rainwater disposal, specific site legislation regarding quality requirements and/or allowed water usage.
Does the software generate/provide for any specific files and formats?	No.
Service Architecture	
How would the software interface with the SPHERE platform?	To be defined.

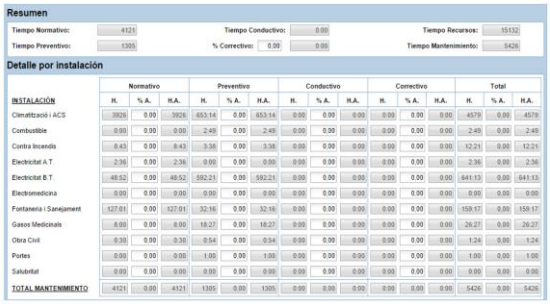
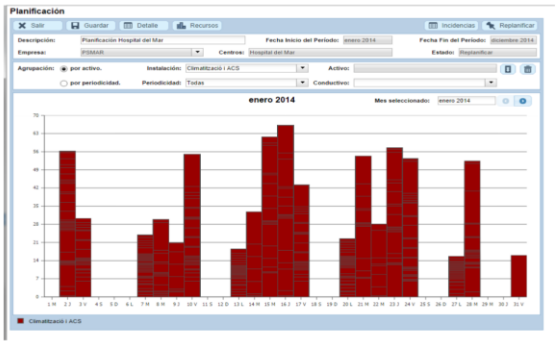
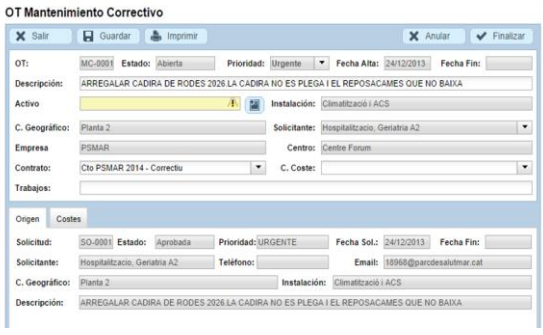
C1.3 Predictive Maintenance Tool (iPredict)

iPredict	[add Logo if any]
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	A maintenance module based on AI and machine learning which enables to minimize downtimes due to unexpected breakdowns and reduce energy waste due to malfunctioning or misuse of equipment. Initially designed for heating and air conditioning and in water heating systems; it can be extended to other equipment or building elements and target structural instability, leakage and other safety risks that may derive in unforeseen construction work and use of resources, energy among them. iPredict is a tool focused on the generation of early warnings to avoid major damage and downtimes. The machine learning engine relies of the existence of big data to extract patterns and variable dependencies to detect anomalies and trigger alerts. However, for new installations or systems where not such amount of historical data exists, or for more basic operation, the tool accepts the configuration of rules (expert knowledge) to trigger alarms whenever a configured threshold is reached. Compared to more basic tools, the rules to trigger a maintenance requests can be calculated based on real operations conditions (not calendar days but operation hours). As more data is provided to the system, the thresholds are estimated automatically based on statistics. The tool developed is at TLR 5 for domestic boiler predictive maintenance operation. .
How is the software tool to be used and by whom?	iPredict is a module. It relies on data gathered and stored by other components (request to a repository). The results of the module will be fed into a repository and send to IMAN, where the interaction will be done through a GUI. An additional GUI for system configuration and rule definition needs to be developed. The target users are mainly facility managers and technicians. Configuration of the system and rule settings will be performed by domain experts (experienced technicians, engineers).
What does the end user get from using the software tool in terms of results?	It enhances maintenance operation. The advance preventive maintenance offered enables to better adjust maintenance actions based on real operation conditions rather than periodically pre-defined actions. The predictive features enable to avoid downtimes, minimize complaints and better plan staff schedules.

What are the main benefits from the results provided by the software tool?	It eventually reduces costs and increases customers satisfaction.
Which SPHERE sub-modules does the software relate to?	I5.M1.SM1 and I5.M1.SM4.
Screenshots (four)	
Pending to be defined.	
Description of BIM USE	
Does the software use data from a BIM file?	Yes, it might. The data needed from the BIM file is: the climatic conditions (i.e. building situation), the building's typology (i.e. usage profile, occupation, schedule) and parameters of equipment (HVAC).
What type of (BIM) files does the software need / will it be built for?	IFC or gbXML.
Does the software generate data that can be added to a BIM file?	No.
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	The historical energy demand (heating, cooling, DHW, lighting), temperature, equipment set-points.
Does the software generate/provide for any specific files and formats?	No.
Service Architecture	
How would the software interface with the SPHERE platform?	To be defined. There are different options, but it is not defined yet.

C.2 COMSA - IMAN

CMMS	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	Brief description IMAN v5 is a CMMS software developed by COMSA Service to support its main activity as Facility Management and Maintenance Company. The tool has been continuously improved, adding new features, such as integration with BIM. Technological maturity level (TRL) The software meets a maximum maturity level, corresponding to a *TRL9* since it is a real system tested in an operational environment. The software and its continuous evolutions are common tools in many of the contracts managed by COMSA Service.
How is the software tool to be used and by whom?	Is it an application (hidden) or a visible service? The software represents a visible service since it is the tool used to manage and plan all maintenance and facility management operations. In a BIM environment, it can work in a hidden and accessible way directly from the model, being able to generate simple interactions with the CMMS software End users There are different types of end users. From the operator who performs the maintenance operations to be performed, the maintenance technician who is responsible for programming and managing all maintenance tasks to the end user of the facility that can generate notices for maintenance needs. Life cycle stage in which it is used The software is mainly used in the operation and maintenance phase of buildings. Although it can be used to manage work orders in all phases of the asset life cycle Usage of product It is used to plan and manage all maintenance and facility management operations, as well as a ticketing tool to manage notices sent by the end user.
What does the end user get from using the software tool in terms of results?	Format of result The result of using this tool is the monitoring, management and planning of all maintenance operations, whether corrective, preventive or predictive. Additionally, it allows to report the results of this process. In turn, it allows to have the history of maintenance operations and breakdowns of the assets. Description of results

	The results of the use of the software are diverse depending on the profile. For maintenance personnel it allows to know the planning of tasks and the notices of the activities to be carried out. On the other hand, from the client's point of view, he can check the progress of the work and obtain a periodic report.
What are the main benefits from the results provided by the software tool?	Performance benefits It is a software developed with total customer orientation, so COMSA Service adapts the performance of the tool to the real needs of the client (servers, users, roles, etc.). It is possible, in cases where the client requests it, to adapt the installation and the performance of the tool to its own on-premise servers. Cost/financial There is no license cost for the software beyond the cost of cloud servers.
Which SPHERE sub-modules does the software relate to?	I5.M1.SM1 I5.M1.SM3 I5.M1.SM4 (the hard link)
Screenshots (four)	
	
	
Description of BIM USE	
Does the software use data from a BIM file?	Yes Brief description of data needed The software needs the input of the inventory data (detailed) and the information associated with it (datasheets, installation manual, user manual, certificates, commissioning sheets, etc.). Additionally, the linking of assets to physical spaces

	allows to optimize the routes of maintenance activities.
What type of (BIM) files does the software need / will it be built for?	IFC? gbXML? Through a middleware working as a viewer of the BIM model, IMAN software can communicate, via API, with any BIM format, native (.rvt) or open (.ifc). Other – COBie The entry of data from previous phases of the facility lifecycle is expected to be done through a COBie format. This is usually one of the main pain points for the use of this type of software. The software is prepared for direct data loading through a COBie datasheet. The system automatically interprets the files in COBie format and loads the inventory items and their characteristics, significantly reducing the resources required for this phase.
Does the software generate data that can be added to a BIM file?	Yes Description of data Yes, but in no case is the software expected to generate data that modifies the geometric component of the native BIM file. The tool allows the edition of the data and metadata of families, systems or spaces. Additionally, if any parameter of the equipment is modified, this information reverts bi-directionally between both systems.
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	Description of other data requirements When using custom assets (those who are not present in the application database), the user is required to upload an Excel file containing the asset data to be imported. Those new assets will be merged with the current ones already on the application. Additionally, the data referring to the performance of the assets from the IoT platform and interpreted by the iPredict platform generate actions to create work orders in the asset in question.
Does the software generate/provide for any specific files and formats?	Description of files generated? Specific reports are generated in PDF format.
Service Architecture	
How would the software interface with the SPHERE platform?	API The application has a REST API serving JSON files through HTTPS protocol. Manual use with data files Certain files (such as .csv, .xls, .txt, etc) could be parsed into the app with no hassle. Description of the process

	The API service callings between the platform and the application is preferred when available, adapting authentication procedures as needed.

C.3 VTT - HTM

C3.1 Human Thermal Model (HTM)

Human Thermal Model	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	Human Thermal Model software enables demand-based and individual control methodology of thermal indoor environment. It provides autonomous definition of individual temperature set-point values for occupants, and these individual thermal preferences can further been fine-tuned by feedback related to thermal experiences. In addition, HTM software enables to monitor how different types of fictional people experience measured indoor thermal environment. Technological maturity level (TRL): TRL 7/9
How is the software tool to be used and by whom?	HTM will be used to control individual thermal indoor environment and monitor how different types of fictional people experience measured indoor thermal environment. From technical point of view, HTM control solution need to be properly integrated into building automation system and its operation can be monitored by facility managers. From utilization point of view, this technology is used by occupants - simply by giving feedback of how they have experienced the thermal conditions.
What does the end user get from using the software tool in terms of results?	End users will have pleasant thermal conditions, controlled according to their individual expectations. In addition, building facility managers will get information on which spaces and at what times there have been challenges in studied person type thermal comfort.
What are the main benefits from the results provided by the software tool?	HTM control technology will improve occupants' thermal satisfaction and energy efficiency of buildings (by avoiding unnecessary heating and cooling). In addition, by HTM monitoring, building facility managers will improve the quality of service by finding thermal comfort problems more easily.
Which SPHERE sub-modules does the software relate to?	I3.M1.SM7 Human Thermal Model I5.M2.SM5 Human Thermal Model Building Automation Control
Screenshots (four)	

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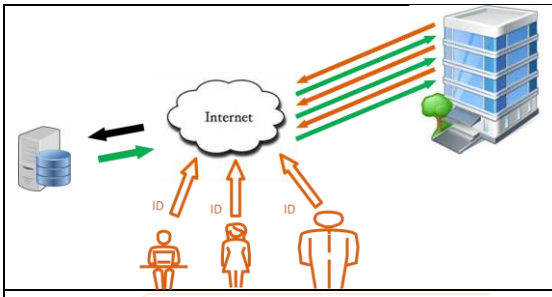
<td> 
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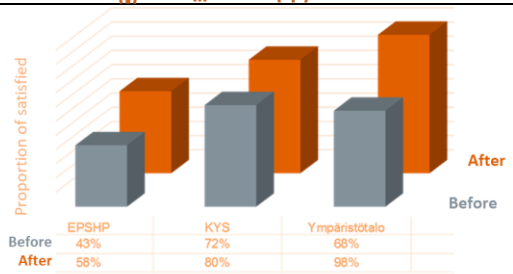
<td> 
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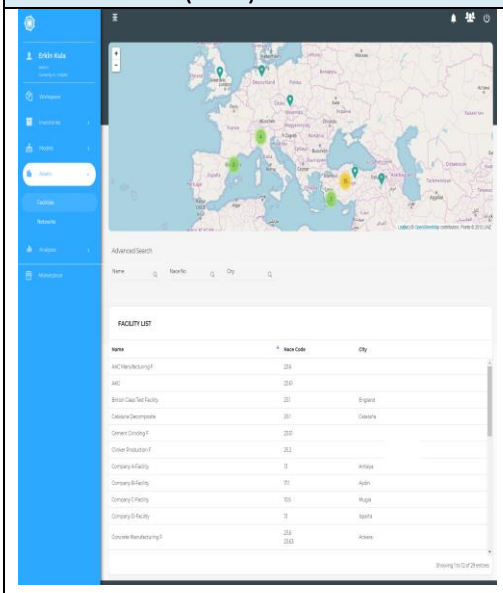
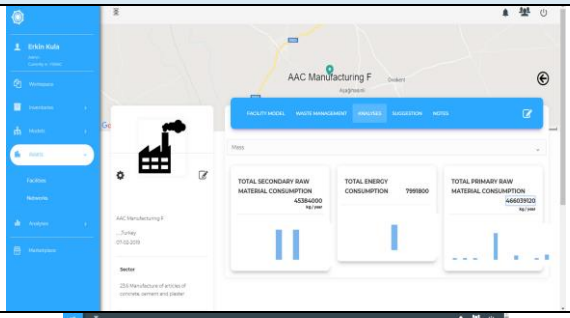
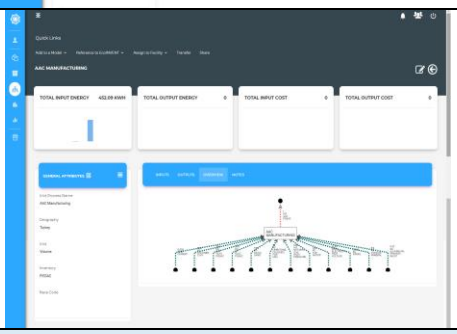
</tr>
<tr><td colspan="2">Description of BIM USE</td></tr>
<tr><td>Does the software use data from a BIM file?</td><td>Optional feature. Not in basic setup but the BIM data can be used if also studied space related surface temperatures are measured.</td></tr>
<tr><td>What type of (BIM) files does the software need / will it be built for?</td><td>Optional feature. Architectural BIM models (including ifcSpace and related geometry) can be used via BIM Model server API or manually by BIM files.</td></tr>
<tr><td>Does the software generate data that can be added to a BIM file?</td><td>No, only manufacturer-specific BIM content extension can be implemented as optional.</td></tr>
<tr><td colspan="2">Description of other DATA</td></tr>
<tr><td>What other datasets are needed from other tools or entered by the user?</td><td>Datasets needed for HTM service internal configuration:
Occupant data (real or fictional person id, gender, age, BMI, fitness, clothing, activity)
Space data (space id, space indoor air temperature measurement point id, space indoor air humidity measurement point id, optional space surface temperature measure points’ ids, optional space surfaces’ geometries)
Datasets needed from other tools when calling HTM REST API (space id, real or fictional person id, optional start time, optional end time) or SPHERE measurements based HTM REST API (temperature sensor value, relative humidity sensor value, real or fictional person id).</td></tr>
</table>

Does the software generate/provide for any specific files and formats?	The result data (time stamped thermal sensation and optionally also room controller's or radiator thermostat's setpoint) can be read online via REST APIs. Results as Excel files can be download manually if needed.
Service Architecture	
How would the software interface with the SPHERE platform?	Cloud based with REST API.

C.4 EKO - CEAT

C4.1 Circular Environmental Assessment Toolbox (CEAT)

CEAT (formerly EPESUS)	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	The CEAT toolbox purpose is for life cycle analyses based on BIM data files, so as to rapidly allow for the generation of environmental and circularity footprints of buildings. It includes: 1) Life Cycle Assessment (LCA) to assess the environmental impacts of buildings and to generate different scenarios depending on building materials used. 2) Life Cycle Costing (LCC), to create combined environmental impact and cost scenarios. 3) Circular economy assessment scenarios on the re-use and recycling potential of buildings. The purpose is to calculate key performance indicators, to increase resource efficiency in production processes, and to adapt to the continuously renewed environmental legislation. The Technological maturity level (TRL) is at TRL 5 for the entire building life cycle (TRL 6 for the construction materials cycle).
How is the software tool to be used and by whom?	The tool serves currently to support design assessments for design/architects, and construction/renovation companies to provide for an as built overview of the environmental/cost/circularity footprint, and for LEED/BREEAM assessors as a calculation tool.
What does the end user get from using the software tool in terms of results?	After the updating of the tool the user will obtain an materials and environmental footprint of the desired renovation or new build building compliant with ISO 14040 LCA and EN 15978:2011 (environmental performance of buildings) with related KPIs, and a life cycle costing in line with ISO 15686-5:2017, and can also obtain insights in the circularity status of

	the building and renovation/construction processes in terms of recycling and re-use
What are the main benefits from the results provided by the software tool?	Utilisation in improving building design for higher environmental and circular standards , lower cost BREAM and WELL certification, improved insights in circularity for deconstruction of buildings.
Which SPHERE sub-modules does the software relate to?	I3.M1.SM2 Targets and Metrics I3.M2.SM1 Material Flow Management I3.M2.SM2 Life Cycle Impact Assessment I3.M2.SM4 Circularity Assessment
Screenshots (four)	
	 
Description of BIM USE	
Does the software use data from a BIM file?	Yes the version to be provided for the SPHERE project will utilise building elements and related information from BIM files.
What type of (BIM) files does the software need / will it be built for?	The developments will be built for IFC files
Does the software generate data that can be added to a BIM file?	Yes the materials footprints information will be calculated from volumes of elements, and can potentially be added to the IFC
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	The tool will use standardised typologies of buildings with life cycle inventory data on materials, so as to fill in any gaps from the IFC file if types of materials information is missing. It will be linked to existing life cycle inventory databases. The tool will also utilise a technology dataset for construction and deconstruction processes for calculating energy and carbon emissions, and to ascertain the recycling and re-use potential of building materials.

Does the software generate/provide for any specific files and formats?	Standard formats will be used based on XML/JSON formats, and a .csv format.
Service Architecture	
How would the software interface with the SPHERE platform?	Cloud based with an API

C.5 BASF – CMT, OPT, FRCT, LCCCA

C5.1 Concrete Management Tool (CMT)

Concrete Manager Tool (CMT)	Logo if available
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	Assessment of concrete mixture sustainability. The Technological maturity level (TRL) is 8.
How is the software tool to be used and by whom?	The users are AEC community & Concrete producers and it is used during renovation and construction works https://gabi-envision.basf.com/Envision/
What does the end user get from using the software tool in terms of results?	Assess and reports most of the economic and environmental indicators detailed in EN 15804. Assess the environmental footprint of ready-mixed and precast concrete based on EN 15804. Allows quick calculations of environmental indicators and cost impacts for real concrete mix designs. Allows direct comparison of different scenarios and varying production installation and concrete disposal situations. Delivers a comprehensive report for concrete EPDs, and input for green building rating schemes (BREEAM, LEED, DGNB, HQE). Provides related production data (energy, water consumption), material cost, transport, data for installation and use, recycling and disposal for concrete management.
What are the main benefits from the results provided by the software tool?	Several different concrete mix-designs can be compared simultaneously, allowing the comprehensive analysis of “what if” scenarios and finding environmentally preferable and cost effective.
Which SPHERE sub-modules does the software relate to?	I3.M2.SM2
Screenshots (four)	

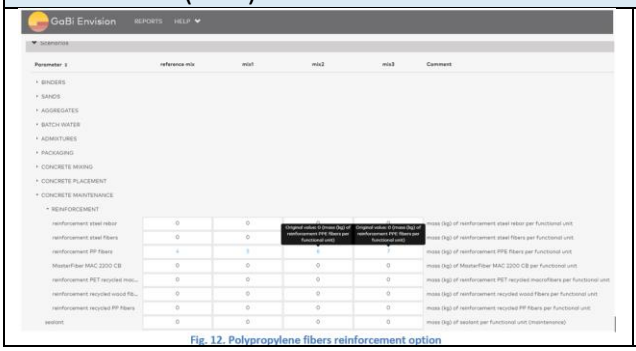
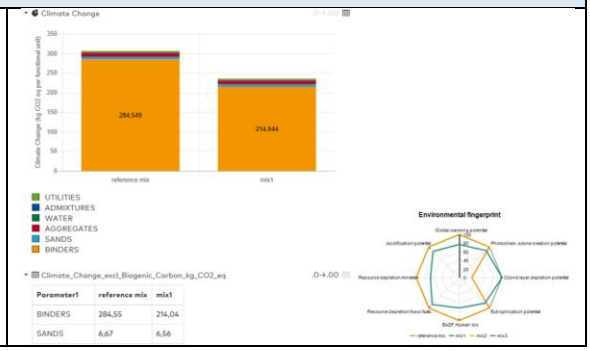
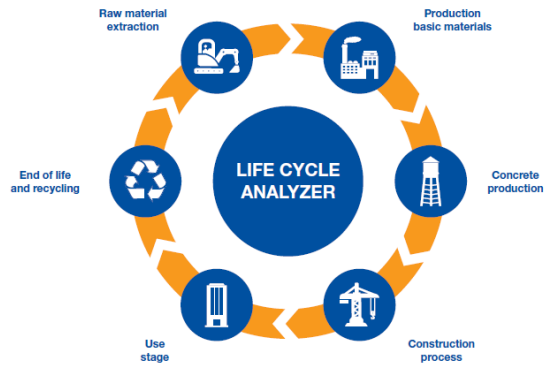
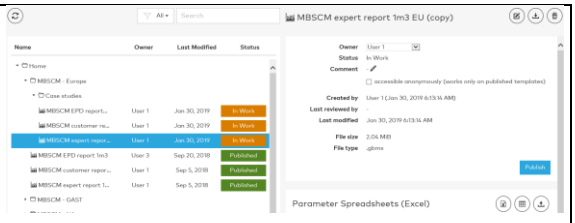


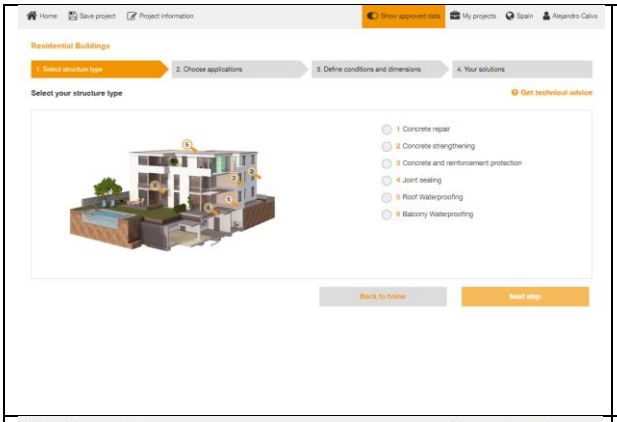
Fig. 12. Polypropylene fibers reinforcement option

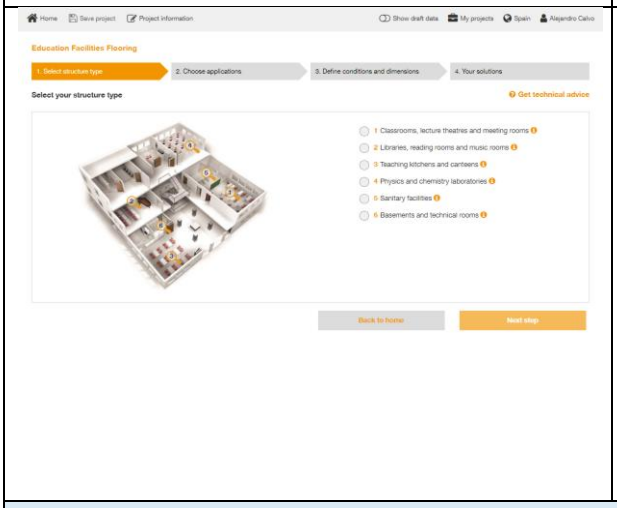


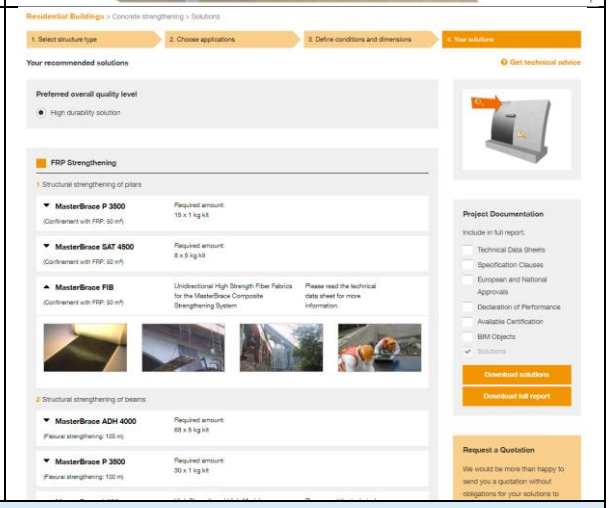
	
Description of BIM USE	
Does the software use data from a BIM file?	Not currently
What type of (BIM) files does the software need / will it be built for?	None
Does the software generate data that can be added to a BIM file?	Probably; environmental indicators to be included in BIM elements.
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	Data input may also be uploaded from the Excel file *input_template_MBSCM.xlsx*
Does the software generate/provide for any specific files and formats?	Results may be viewed online as diagrams & tables or as a report. Reports may be exported as PDF or RTF (rich text format, compatible with MS Word).
Service Architecture	
How would the software interface with the SPHERE platform?	Online link: https://gabi-envision.basf.com/Envision/

C5.2 Online Planning Tool (OPT)

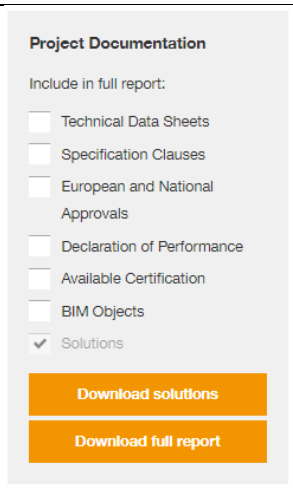
Operational Planning Tool	Logo if available
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	Develop an On-line planning tool (OPT) to select the best repair/coating solution for a specific situation in the building, considering sustainability, durability and long- term performance of the structure. Will be linked externally and will be online. TRL to be updated
How is the software tool to be used and by whom?	The tool will be used by construction managers, architects and engineers, contractors and maintenance service companies, in the concept design and technical design phase, as well as during construction and assembly and in-use.
What does the end user get from using the software tool in terms of results?	Prevents information overload, provides specific BIM objects for repair/coating solutions. Provides changing project requirements and provides crucial information along each step of the project planning process, offering additional details about the selected products.
What are the main benefits from the results provided by the software tool?	As a **construction manager** it will help me to request product and application pricing information. As an **architect and engineer, as well as contractor and maintenance service company** it will help me to find the right solutions for my projects in a safe, fast and efficient way, and download the relevant BIM objects directly without the need to surf through several databases. As a **contractor** it will help me to compare different solutions for my projects. Request product and application pricing information, and adjust to changing project requirements and provides crucial information along each step of the project-planning process, and additional details about the products selected.
Which SPHERE sub-modules does the software relate to?	I1.M2.SM1; I1.M4.SM2; I1.M4.SM3; I5.M1.SM2
Screenshots (four)	





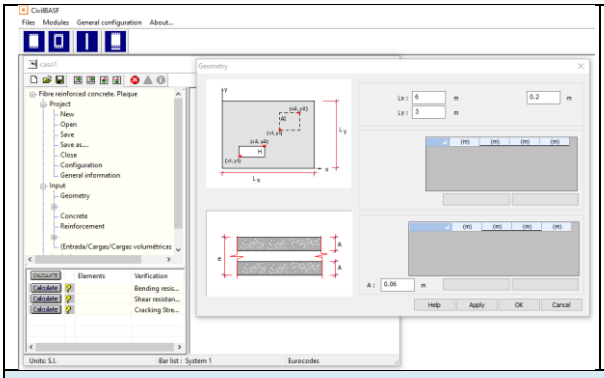
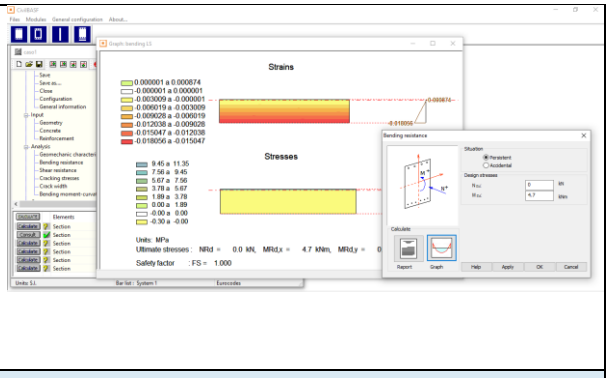


Description of BIM USE	
Does the software use data from a BIM file?	No
What type of (BIM) files does the software need / will it be built for?	No BIM needs
Does the software generate data that can be added to a BIM file?	Yes, BIM models (construction products)
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	To be evaluated

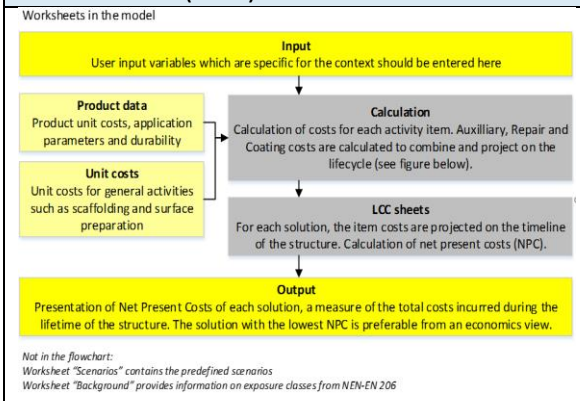
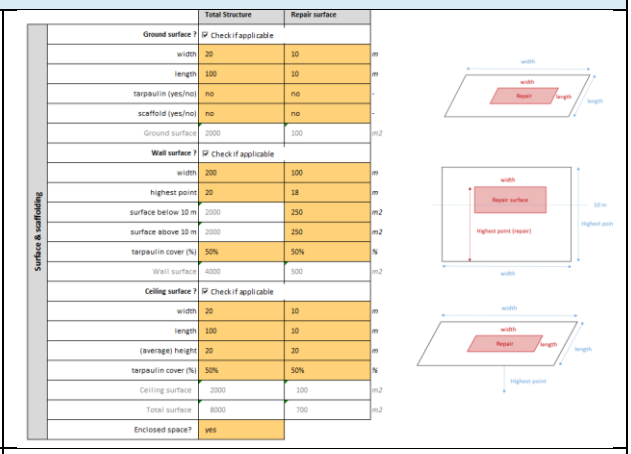
Does the software generate/provide for any specific files and formats?	
Service Architecture	
How would the software interface with the SPHERE platform?	The OPT will be linked to SPHERE platform as an external tool to be used on-line. https://www.online-planning.construction.basf.com/

C5.3 Fiber Reinforced Concrete Tool (FRCT)

Fiber Reinforced Concrete Tool (FRCT)	Logo if available
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	The main goal is the partial or full replacement of steel rebar in precast concrete elements and concrete slabs-on ground by using polypropylene fibers. TRL level to be provided.
How is the software tool to be used and by whom?	The tool is intended for architects, engineers, BIM managers, construction managers and contractors during the concept design and construction assembly phase
What does the end user get from using the software tool in terms of results?	Provides a constitutive model that enables to develop a computer aided tool for Nonlinear Fibre Reinforced Concrete Designs. Allows for developing new designs for FRC precast façade panels and slabs, in which the traditional steel reinforcement is totally or partially replaced.
What are the main benefits from the results provided by the software tool?	As an **architect and engineer** it will help me to carry out structural checking of specific concrete elements , using polypropylene fibers (more sustainable materials) to replace traditional reinforcement. As a **BIM Manager** it will help me to refine my BIM models in the BIM Building Design. As a **Construction Manager** or **Contractor** it will help me to evaluate the total replacement or partial replacement of steel reinforcement in façade panels and slabs -> cost benefits, sustainability impact.
Which SPHERE sub-modules does the software relate to?	I5.M1.SM2
Screenshots (four)	

	
Description of BIM USE	
Does the software use data from a BIM file?	No,
What type of (BIM) files does the software need / will it be built for?	No needs
Does the software generate data that can be added to a BIM file?	Yes, it does.
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	The user enters manually the shape of the concrete element (i.e. precast panel)
Does the software generate/provide for any specific files and formats?	ifc files
Service Architecture	
How would the software interface with the SPHERE platform?	To be discussed: linked to SPHERE platform as an external tool or integrated in the platform.

C5.4 Life Cycle Cost Concrete Assessment (LCCCA)

Life Cycle Cost Concrete Assessment (LCCCA)	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	Tool (excel file) to compare and find a proper solution to protect and repair reinforced concrete structures on the basis of life cycle costs Technological maturity level (TRL)
How is the software tool to be used and by whom?	The tool is intended for construction managers, architects and engineers, and contractors during the Strategic Definition and Design Phase
What does the end user get from using the software tool in terms of results?	Compare different solutions of repair and coating on the basis of Life Cycle Costs (LCC) and Life Cycle Environment Assessments (LCA). This model is used to compare BASF solutions of repair and coating on the basis of Life Cycle Costs (LCC)
What are the main benefits from the results provided by the software tool?	As a **Construction Manager, Architect or Engineer or Contractor** I will obtain a solid economic foundation to select the best repair/coating solution for a specific situation. In addition, the service life of a product determines the interval for re-application and thus greatly influences lifecycle costs. By protecting the initial repair with a coating which is re-applied as specified, initial costs may be higher but service life of the repair may greatly increase. Thus, the application of coating determines the costs for re-application and may decrease Life Cycle Costs
Which SPHERE sub-modules does the software relate to?	I3.M2.SM3; I5.M1.SM1; I5.M1.SM2
Screenshots (four)	
	
Description of BIM USE	
Does the software use data from a BIM file?	No
What type of (BIM) files does the software need / will it be built for?	No needs
Does the software generate data that can be added to a BIM file?	No

Description of other DATA	
What other datasets are needed from other tools or entered by the user?	No need
Does the software generate/provide for any specific files and formats?	In sheet "Output" the results are shown, as the calculated Life Cycle Costs of each solution. This is a measure of the total costs incurred during the lifetime of the structure. The solution with the lowest LCC should be selected from an economic point of view.
Service Architecture	
How would the software interface with the SPHERE platform?	We should try to link excel file to BIM software (i.e. Revit)

C.6 R2M – En-MS

C6.1 Energy Management System (En-MS)

Energy Management System (En-MS)	Not yet Available
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	Tool including energy audit workflows, providing a energy planning process, objectives & targets that can be tracked, and supporting the Energy Review identifying the energy sources and related significant energy uses together with estimation of possible improvement opportunities. Technological maturity level (TRL) still to be defined
How is the software tool to be used and by whom?	Visible service for Design Team, Building Automation Team, MEP Engineer, Building Facility Manager, Tenant. To be used in Strategic Definition and in-use phaseas part of implementing an Energy Management system (ISO 50001) in the building
What does the end user get from using the software tool in terms of results?	EnMs web platform/application - to be agreed with VRM. For implementation of energy Management system
What are the main benefits from the results provided by the software tool?	Improvement of energy efficiency in the building – improvement of quality in the management of the building. Economic savings from energy efficiency improvement.
Which SPHERE sub-modules does the software relate to?	I2.M1.SM3 I5.M2.SM6
Screenshots (four)	
Not yet available	
Description of BIM USE	
Does the software use data from a BIM file?	To be studied Data needed related to energy consumption, building physics data and data related to KPIs
What type of (BIM) files does the software need / will it be built for?	To be studied
Does the software generate data that can be added to a BIM file?	To be studied
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	Energy consumption data, KPI, building physics data, data from energy audit, target and objectives
Does the software generate/provide for any specific files and formats?	To be studied
Service Architecture	
How would the software interface with the SPHERE platform?	Cloud based API

C.7 EAI - ECOSIMPRO

C7.1 ECOSIMPRO

EcosimPro	EcosimPro Modelling and Simulation Software
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	EcosimPro is a first class modelling and simulation tool for modeling 0D or 1D multidisciplinary continuous-discrete systems and any kind of system based on differential-algebraic equations (DAE) and discrete events. EcosimPro has been designed to carry out steady state and transient studies, as an optimization and design tool that helps the engineer to improve any kind of system modeled with equations (0D and 1D). It also provides a highly intuitive graphics environment that facilitates its use in creating physical models based on schematic views. Within SPHERE platform it will be used to model and simulate the building and its HVAC system including control to support energy assessment, design verification, and optimization of the operation. The technological maturity level of the simulation platform is TRL9, having being used in aerospace and energy areas for many years.
How is the software tool to be used and by whom?	EcosimPro is a desktop software tool including a result visualization module (EcosimPro monitor). The user can perform different simulation analysis, post process the results and export them in different ways. It is also possible to generate standalone applications from simulation models generated with EcosimPro if necessary. The tool provides interfaces with FMI, OPC UA and Matlab/Simulink for cosimulation and SIL and HIL applications. End users will be engineers responsible for the HVAC design, the building automation team, facility managers and maintenance companies. Given its generalist approach can be used from design phase to operation for different purposes. In the design phase, it will be used by HVAC engineers to analyse the design alternatives and control strategies to optimize the performance. Building automation teams may use the simulation models for the virtual commissioning of the system. During operation phase, facility managers and maintenance companies can use the model generated to analyse the baseline operation, evaluate alternatives and detect problems comparing simulation results with measured data from sensors.
What does the end user get from using the software tool in terms of results?	EcosimPro can store result files in different formats like ASCII, csv and hdf5. For standalone applications, the results can be obtained by executing the standalone application step by step. The results provided include physical variables like pressure, temperature, massflow, heat flows and other relevant variables.

What are the main benefits from the results provided by the software tool?	Allowing the functional assessment of the HVAC system for different purposes: design analysis, performance optimization, detection of malfunctions, etc.
Which SPHERE sub-modules does the software relate to?	I1.M4.SM4: HVAC Library I1.M4.SM5: Thermal and fluid component libraries I3.M1.SM3: Heat load modelling I3.M1.SM4: Renovation energy assessment I4.M5.SM1: Comparison of energy simulation values and real values I5.M2.SM3 Energy use optimization

Screenshots (four)

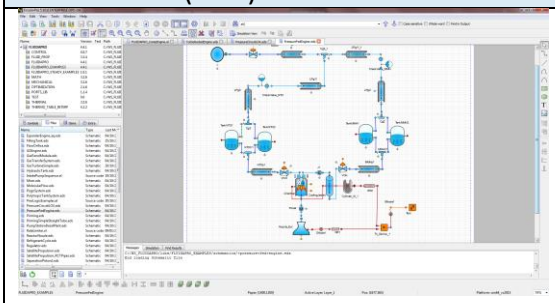


Figure 42 EcosimPro GUI for schematic diagram edition

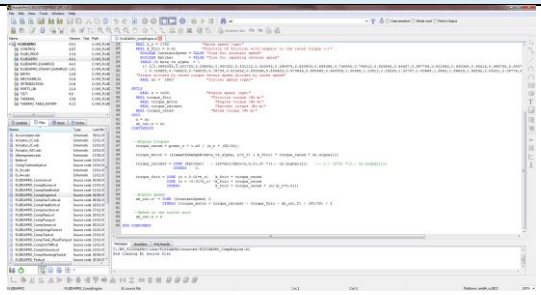


Figure 43 *EcosimPro development environment*

Figure 44 EcosimPro tool for results visualization

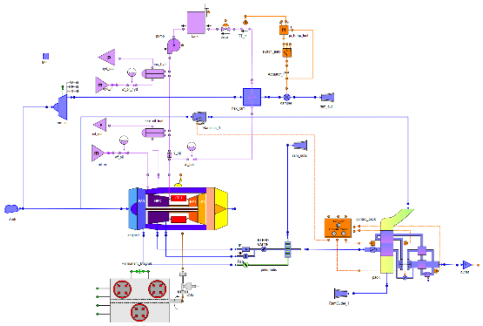


Figure 45 Example of EcosimPro model of engine and aircraft systems

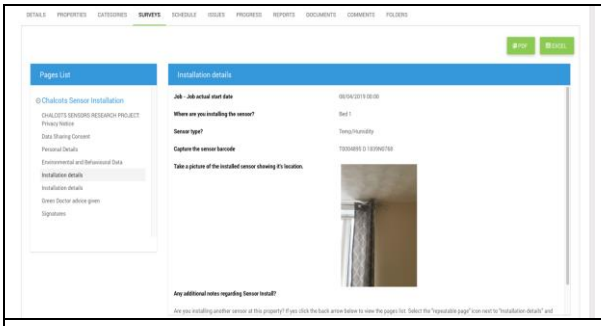
Description of BIM USE	
Does the software use data from a BIM file?	Yes, If the scope of the model includes the building it is required to import the building geometric information and its parameters. Similarly, it is also necessary to incorporate the information related with the equipment used for the HVAC system.
What type of (BIM) files does the software need / will it be built for?	IFC
Does the software generate data that can be added to a BIM file?	No.
Description of other DATA	

What other datasets are needed from other tools or entered by the user?	Other files used are: weather files (TMY), files related with information not included in IFC, e.g. those related with assets (to be defined) or heat load data from other software tools.
Does the software generate/provide for any specific files and formats?	The software can provide simulation results in different formats (ASCII, csv, hdf5)
Service Architecture	
How would the software interface with the SPHERE platform?	API for data importation and results exportation

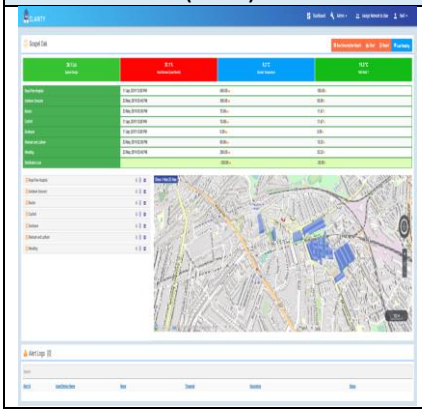
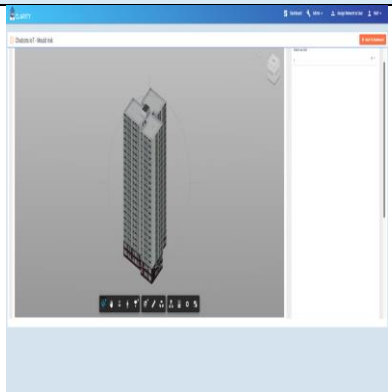
C.8 VRM – Refurbify & Clarity

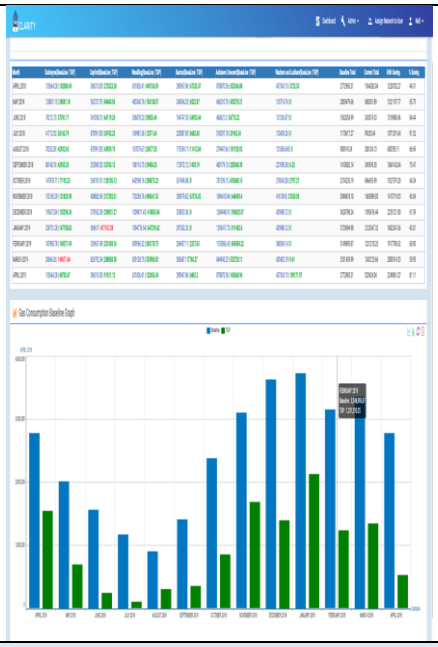
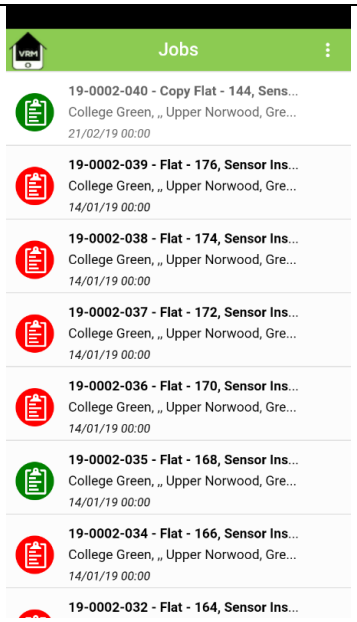
C8.1 Refurbify + VCMP

Refurbify + VCMP	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	VRM Refurbify is a cloud-based refurbishment platform enabling large housing stockowners and their supply chain to manage all refurbishment, repair and maintenance activities seamlessly in the cloud. The technological maturity level of the platform is TRL7-9 depending on the application. Refurbify also has a sub-module called the VCMP (Virtual Construction Management Platform) that is used for the same process during the construction phase
How is the software tool to be used and by whom?	It is a service with an interface that is used by Social Landlords, Construction Bodies, and Regulatory Bodies, and used during the renovation phase and for handover, as well as in the in-use phase for maintenance.
What does the end user get from using the software tool in terms of results?	The user is provided with i) Integrated tendering solution. Allows tenderers to grant access to potential contractors to review available data in detail. Access to BIM models where available, ii) Platform designed with intuitive, visually-focussed and configurable KPIs. Minimal training should be required, iii) Auto-generate alerts and graphics for end-user/stakeholders/residents allowing at-a-glance information on energy saved and/or consumed, iv) Reduced snags as desktop approvals happen in real-time or near-time. Payment approvals are linked to agreed and approved work items with required digital evidence. Less reasons not to pay. Client can have visibility through main contractor down to sub-contractor level.
What are the main benefits from the results provided by the software tool?	The main benefits are an efficient and timely communication and information flow between different parties working on a renovation both between off-site and on-site personnel, resulting in large cost savings over standard non-streamlined approaches.
Which SPHERE sub-modules does the software relate to?	I1.M1.SM1;I1.M1.SM2;I1.M2.SM1;I1.M2.SM2;I1.M2.SM3; I1.M3.SM1; I1M5.SM1; I4.M1S.SM2; I4.M2.SM1;I4.M2.SM2 I4.M6.SM1;I5.M1.SM1;I5.M1.SM3
Screenshots (four)	

	
Description of BIM USE	
Does the software use data from a BIM file?	Yes it utilises BIM with an integrated BIM viewer for understanding specific building elements within renovation process needs
What type of (BIM) files does the software need / will it be built for?	Can work with both IFC and gbXML
Does the software generate data that can be added to a BIM file?	No
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	Renovation Documents, Photo's, task listings
Does the software generate/provide for any specific files and formats?	No specific files, all done via interfaces
Service Architecture	
How would the software interface with the SPHERE platform?	- Data Inputs: • Encrypted JSON payload • REST API for Refurbify <> Clarity interface. FTPS • CSV/flat file • external API (Environmental data) - Data outputs: • FTPS transfer to client • CSV/flat file. - Database and repository specific information • Database type: MySQL • Size: Variable (consistently large dataset) • Location: AWS

C8.2 Clarity

Clarity	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	VRM Clarity is a networked Asset Hub, taking data from assets, BMS, sensors, onsite workers, residents and back-office staff to provide an objective view of assets through configurable Dashboards. The technological maturity level of the platform is TRL 7-9
How is the software tool to be used and by whom?	It is a visible service for Construction companies, renovation companies, Facility Managers, Building Owners and it is used in the in-use cycle of the product.
What does the end user get from using the software tool in terms of results?	The end users obtains visibility of the internal performance of the building in a wide range of areas, including energy, ventilation, and indoor environmental quality, that can be integrated with a Building Maintenance System.
What are the main benefits from the results provided by the software tool?	The software provides savings up to 30%-40% due to lower energy and maintenance cost, reduction of OPEX by changing from reactive to proactive maintenance, reduction in CAPEX due to extended asset life of HVAC equipment.
Which SPHERE sub-modules does the software relate to?	I1.M3.SM2; I1.M3.SM3; I1.M3.SM4; I1.M3.SM5
Screenshots (four)	
	

	
Description of BIM USE	
Does the software use data from a BIM file?	Yes, for locating/placement of sensors within a property within a BIM viewer
What type of (BIM) files does the software need / will it be built for?	IFC
Does the software generate data that can be added to a BIM file?	Yes sensor elements
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	None
Does the software generate/provide for any specific files and formats?	Yes time-series data associated with sensors.
Service Architecture	
How would the software interface with the SPHERE platform?	Cloud based API

C.9 NUIG - ModSCO

C9.1 ModSCO

ModSCO	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	ModSCO is the acronym for Model-Supported Control. This is a web application currently in development within the IRUSE group at the NUIG. ModSCO uses Reduced Order Grey Box Models (ROM) developed with MODELICA ® language. It offers standardized Performance Assessment Methods in order to analyse and optimize building performances by: applying control settings, testing envelope retrofit packages and evaluating the savings by using a novel IPMVP method. The technological maturity level is 4.
How is the software tool to be used and by whom?	It is a visible service for MEP engineers, Maintenance Service Companies, Certified Measurement and Verification Professiona and Building Facility Managers, to be used in Preparation and brief, Concept design, In-use phase Used to develop quick model of a building and have a quick evaluation of the performance. Generate energy conservation opportunity Correct operation of HVAC systems, monitor energy conservation opportunities, correct operation of HVAC systems. Analyse ideal (generated by the ROM) vs actual performance of a building following the M&V protocol. Optimize the HVAC setting by comparing the real data with the baseline model (generated by the ROM) Apply building retrofitting scenarios (envelope)
What does the end user get from using the software tool in terms of results?	ModSCO is based on a Python code. It gives as result .csv files and related graph. Mainly Gas and electricity consumption of the building/room. Other output could be taken from the Modelica model such as cooling and heating pick of energy, average temperature of the building.
What are the main benefits from the results provided by the software tool?	ModSCO simplify the building energy simulation by giving an easy to setup interface, a fast to run simulation and accurate results that can support impact evaluation of environmental and energy retrofit scenarios using a limited information and uncertain data.
Which SPHERE sub-modules does the software relate to?	*I3.M1.SM3, I3.M1.SM4, I5.M2.SM3*
Screenshots (four)	

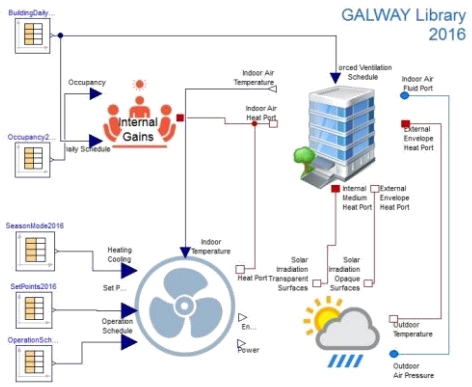


Figure 46 - Modelica Model

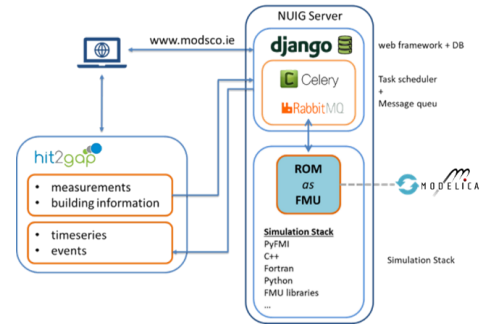


Figure 47 - ModSCO application architecture

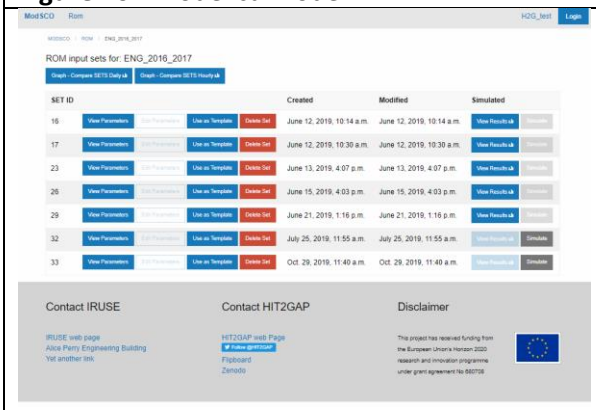


Figure 48 - ModSCO web user interface

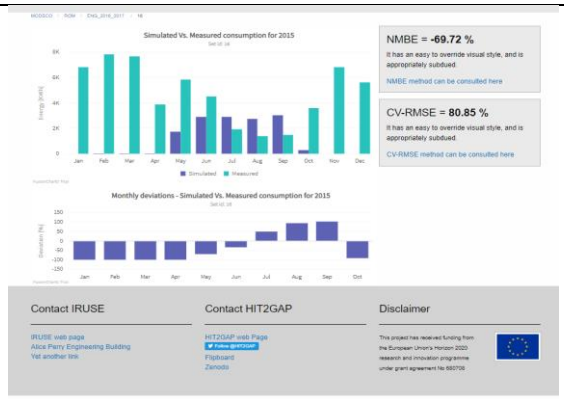


Figure 49 - ModSCO Results example

Description of BIM USE	
Does the software use data from a BIM file?	Not yet. The BIM data could speed up the parameter's insertion. All the building envelope characteristics are needed, they will simplify the resistances and capacitances calculation.
What type of (BIM) files does the software need / will it be built for?	IFC
Does the software generate data that can be added to a BIM file?	No.
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	The data needed is the building latitude (**Latitude**), the building total volume [m^3] (**Volume**), the windows surfaces for each direction [m^2] (e.g. **AWin$_{xxx}$**) the g total value of the windows for each direction (e.g. **GtotW$_{xxxx}$**) the ratio between a building element surface and the total building surface (e.g. **Ratio_$_x$**) the resistances and capacitances, automatically calculated with the buildings specs(e.g. **C$_{xxx}$**, **R$_{xxxx}$**) infiltration rate (**L_RATE**) Weater file(**WeaFile**)

Ground Temperature (**GroundT**)
maximum people, lighting and equipment heat gain (e.g. **MLoad$_{xxx}$**)
standby value of equipment heat gain (**SBLoad**)
Maximum HVAC cooling and heating power(**MCoolP, MHeatP**)
the stand-by consumption of the HVAC(**SBHC**)
thermostat hysteresis range(**Trange**)
people to switch off/of control (**P$_{_SWITCH}$**)
Finally the Alpha parameters that are used in the calibration process (thay start with a value equal to one)

In the following Table the full list of ROM parameters is provided.

Table 39- ROM Parameters

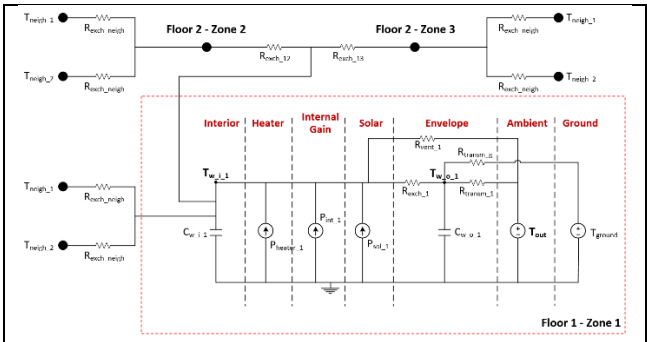
	Value	Unit		Value	Unit
Latitude	41.4776	-	**R_M**	1.17E-04	K/W
Volume	13547	m^3	**C_M**	2.52E+09	J/K
$AWin_{South}$	255.75	m^2	**R_{GF_IS}**	6.57E-05	K/W
$AWin_{North}$	237.51	m^2	**R_{GF}**	2.83E-04	K/W
$AWin_{West}$	60.9	m^2	**R_{GF_ES}**	2.02E-05	K/W
$AWin_{Est}$	54.81	m^2	**C_{GF}**	1.51E+09	J/K
$AWin_{Roof}$	0		**L$_{_RATE}$**	3	Kg/s
$GtotW_{South}$	0.75	-	**WeaFile**	SanCugat	-
$GtotW_{North}$	0.75	-	**GroundT**	20	°C
$GtotW_{West}$	0.75	-	**$MLoad_{Peo}$**	32756	W
$GtotW_{Est}$	0.75	-	**$MLoad_{Lig}$**	42280	W
$GtotW_{Roof}$	0	-	**$MLoad_{Eqi}$**	6724	W
Ratio$_{_m}$	0.381	-	**SBLoad**	0	W
Ratio$_{_wall}$	0.424	-	**$Alpha_{Lig}$**	1	-
Ratio$_{_win}$	0.046	-	**$Alpha_{Eqi}$**	1	-
Ratio$_{_gf}$	0.149	-	**MCoolP**	XX	W
R_{WALL_IS}	2.31E-05	K/W	**MHeatP**	345000	W
R_{WALL}	1.02E-03	K/W	**SBHC**	10000	W
R_{WALL_ES}	7.10E-06	K/W	**Trange**	1	°C
C_{WALL}	1.18E+09	J/K	**P$_{_SWITCH}$**	FALSE	-
R_{WIN_IS}	2.13E-04	K/W	**$Alpha_{Peo}$**	1	-
R_{WIN}	6.33E-04	K/W	**$Alpha_{Heat}$**	1	-
R_{WIN_ES}	6.56E-05	K/W	**$Alpha_{Cool}$**	1	-
R_{M_IS}	2.56E-05	K/W			

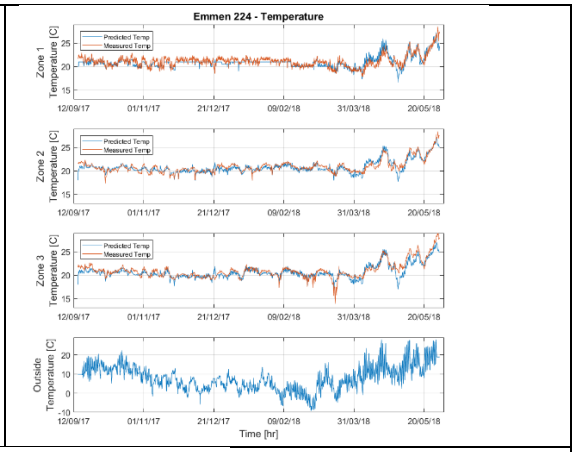
Does the software generate/provide for any specific files and formats?	The script is developed by using Python. Several kinds of files can be generated. At the moment they are mainly .csv
Service Architecture	
How would the software interface with the SPHERE platform?	Cloud based interface API

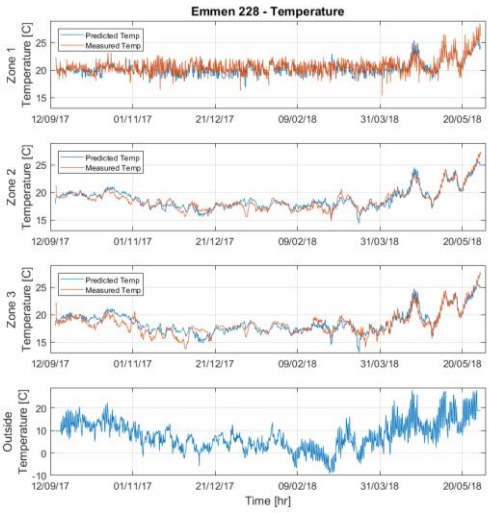
C.10 TNO - RobMOS

C10.1 RobMOS

ROBMOS	
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	The goal of this tool is to better predict energy demand and IEQ (thermal comfort) of dwellings. The tools is able to continuously calibrate its models with real data reducing the gap between predicted energy demand and monitored energy demand. The tTechnological maturity level (TRL): TRL: 6
How is the software tool to be used and by whom?	It is a service for project engineer responsible for calculating energy performance and IEQ in the design phase, and the project engineer responsible for checking performance contracts energy and IEQ in the use phase. In the design phase, the tool reads in the gbXML file of the dwelling, and compiles this to a building energy demand model and building thermal model, additional data is provided regarding lacking building data (for example airtightness) and installation information (system performance, buffers, type of systems). After specifying a climate scenario and occupant use scenario, a simulation can be started. KPIs can be derived from the simulation outputs. In the use phase the model is calibrated with real monitoring data and the performance can be compared with the performance according to the design.
What does the end user get from using the software tool in terms of results?	The user obtains time series (vectors) of simulation outputs. Single values (scalars) of KPIs on energy and thermal comfort. Time series of temperatures per zone. Time series of heating cooling power. KPIs of energy performance and thermal comfort. Prediction and comparison with energy use according to design with calibrated models of the real dwellings.
What are the main benefits from the results provided by the software tool?	Performance benefits include at an early stage of the buildings life cycle, estimations of the future energy performance and thermal comfort can be calculated. During the operational stage of the life cycle, the performance of the building can be compared with the simulated performance. In case of (significant) deviations, a trigger signal can be sent to either tenant or building manager. The cost/financial benefits include that the tool allows design optimizations, preventing the need to compensate for design mistakes during the building phase. Furthermore, tenants and maintenance companies or ESCO's can be informed in case of errors in HVAC installations, HVAC usage or building envelope.
Which SPHERE sub-modules does the software relate to?	Sub-module or modules listing I1.M4: BIM and objects libraries module I3.M1: Energy modelling and simulation module. I4.M5: Commissioning I5.M2: Energy management and performance monitoring
Screenshots (four)	







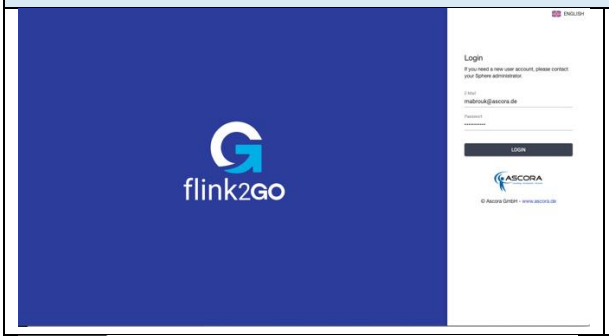
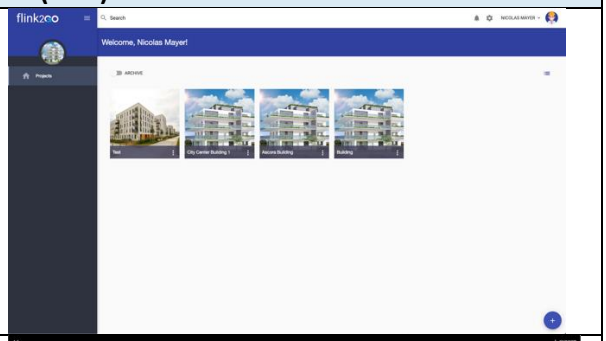
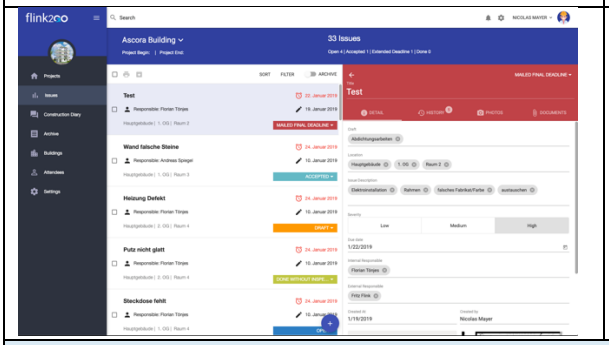
Description of BIM USE	
Does the software use data from a BIM file?	Yes, data requirements include: Description of building (preferably gbXML model) Dimensions and construction parameters (mass, Rc, U, airtightness): roof, façade, windows, blinds, walls, and floor Location / orientation of building Building structure: zones, special orientation (heated, not heated) Heating / cooling system / ventilation system (type, efficiency, performances, capacity). Other relevant systems
What type of (BIM) files does the software need / will it be built for?	The software uses gbXML file formats and is used for calibrating: Monitoring data (preferably 15 minutes – hour values), ontology Project HayStack: Temperatures (living room, bedroom). Energy usage (separate domestic hot water, heating/cooling, appliances, auxiliary energy, PV). Weather data (from nearby weather station). Occupancy data (presence #, schedule, preferable window use) Thermostat values, ventilation control (setpoints)
Does the software generate data that can be added to a BIM file?	No

Description of other DATA	
What other datasets are needed from other tools or entered by the user?	gbXML description of dwelling additional building information not in IFC Models of HVAC components Climate models (design phase) User scenarios (design phase) Monitoring data see above (use phase)
Does the software generate/provide for any specific files and formats?	Simulation results are stored as CSV files.
Service Architecture	
How would the software interface with the SPHERE platform?	Preferably via an API. Also files exchange can be managed via an API. At this stage, however, it is still difficult to know what information will be present in the SPHERE platform. Manual use with data files The tool can also operate without the SPHERE platform.

C.11 ASC – FLINK2GO

C11.1 FLINK2GO

Flink2Go	flink2GO
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	Brief description Flink2Go is a B2B product resulting from the research project ACCEPT. It's a cloud based platrom which brings paperless solutions to the construction site enabling reporting issues and assigning tasks with a construction diary and defects management, supporting the Building Information Model (BIM) and keeping records for proving correct accounting. Fine grained user roles and usage rights can be set for users of the tool. Technological maturity level (TRL) - TRL 6
How is the software tool to be used and by whom?	Is it an application (hidden) or a visible service? Visible Service: Flink2Go is a cloud based platform with an interface End users: Project Managers, Architects, Construction Managers, Construction sub-contractors, building owners, surveyor, tenants and maintenance facility companies. Life cycle stage in which it is used: Preparation and brief, Design phase, Construction and assembly, In-use Phase Usage of product: Project Managers can use the tool to add the project team and define their roles and responsibilities, and by having an overview on the overall status of the project. (Delayed tasks, urgent issues). Surveyors can upload any observed/collected information which may be relevant to the project to the platform (walkover survey outcome), initiate detailed site surveys focusing on specific issues, and save all the obtained information of the survey on the platform and shared among the concerned parties. Architects can Upload detailed iterations of the building drawings to the platform and receive feedback and identify any instructions required by the client/building owner. Building owners can preview the drawings and send feedback. Construction Leads can create tasks/issues, schedule them, assign them to the internal/external responsible and mark their location in the building (on the 2D drawing or the 3D model where available), and initiate approval directly on the Sphere platform to report/validate the subcontractors work. Maintenance Service companies can manage the building issues created by the tenants and assign them to the responsible Maintenance Service Company
What does the end user get from using the software tool in terms of results?	The user will mainly profit from the simplicity of issue reporting/ task assignment, as Flink2Go will allow a direct communication between the on-site operatives and the backend office. This will reduce the time needed to get approval from the decision makers. The user will also gain more time with tailor-made text modules and intelligently pre-

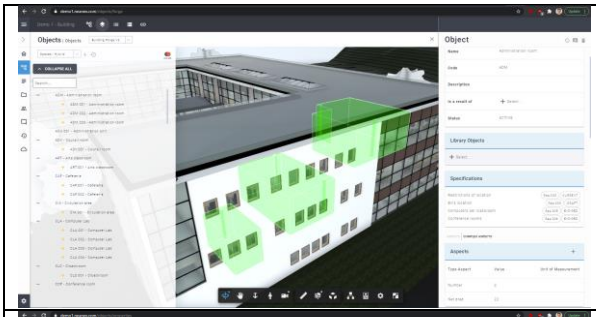
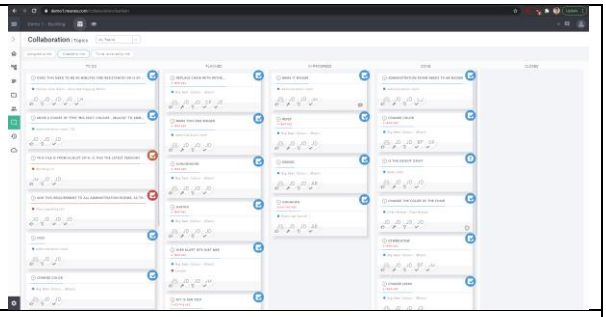
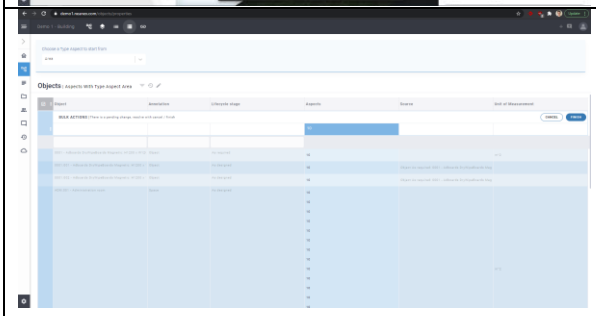
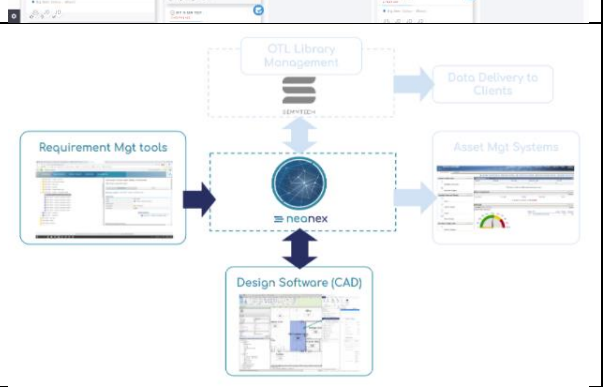
	filled entries which reflect how the platform has been designed to be super user friendly with no training required.
What are the main benefits from the results provided by the software tool?	-Saving time in defects/issues reporting and recording between the front and back office => Time saving in communication => Efficiency and cost saving. -Error reduction in logging -Automation of documentation
Which SPHERE sub-modules does the software relate to?	I1.M1.SM2 Create Project & Identify Roles I1.M2.SM2 Roles and Processes Matching I1.M2.SM3 Authorisation I1.M3.SM4 Dynamic Data Visualisation I4.M2.SM1 Site Role/Task Management I4.M2.SM2 Site Surveys and Inspection I4.M2.SM4 Progress Monitoring I5.M1.SM3 Building Issue Management
Screenshots (four)	
	
	
Description of BIM USE	
Does the software use data from a BIM file?	Yes - Using BIM data to visualize the geometry and attach task/issues to correspondent BIM element
What type of (BIM) files does the software need / will it be built for?	IFC
Does the software generate data that can be added to a BIM file?	No
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	Description of other data requirements: Project and Team information Sub-Contractors Information Photos

	2D plans (if no BIM data avaialble)
Does the software generate/provide for any specific files and formats?	Description of files generated? Reports (inspection, survey, issues) in a PDF format. Annotated 2D plans in a PDF format
Service Architecture	
How would the software interface with the SPHERE platform?	- Data Inputs: IFC REST API CSV (Project settings import) - Data outputs: CSV REST API - Database: MongoDB database hosted on Hetzner

C.12 NEXT – Neanex Portal

C12.1 Neanex Portal

Neanex Portal	neanex think as many - work as one
Software Overview	
What is the purpose of the software tool within the context of the SPHERE platform?	The Neanex Portal will function as an asset register, managing the static & geometric data on a project basis. Because of its graph database structure, all tools can request very specific data for their needs. On the other hand, data can be enriched in the Neanex Portal by the different SPHERE tools, preparing the project data for handover to other parties compliant to certain standards (eg. COBie, NLSfB, ...).
How is the software tool to be used and by whom?	The Neanex Methodology envisages the entire project - the project team and stakeholders - during the entire life-cycle of a construction project. Typical customers include public and private owner-operators, architectural and engineering firms, contractors, project developers, etc…
What does the end user get from using the software tool in terms of results?	Smart and contextual data. All project members can easily share and access asset information in the context they require, so that it is specific and relevant for their tasks and interests.
What are the main benefits from the results provided by the software tool?	The Neanex Portal solves the top three pains in the construction industry: - Data loss: the collaboration between different parties and the handovers in between create a lot of duplicate or corrupt data. - Costs: the inefficient, manual (re)gathering of data, the errors as a result of corrupt data. - Integrations: no interoperability between different tools of a construction project, no common data.
Which SPHERE sub-modules does the software relate to?	I1.M1.SM1 Identify Users I1.M1.SM2 Create Project & Identify Roles I1.M2.SM1 Setup and Management of Project Phases and Processes I1.M2.SM2 Roles and Processes Matching I1.M2.SM3 Authorisation I1.M3.SM1 Data/Document Management I1.M3.SM3 Exporting/Allow Access/Deletion of Data and Documents I1.M3.SM4 Dynamic Data Visualisation I4.M2.SM4 Progress Monitoring I5.M1.SM3 Building Issue Management
Screenshots (four)	

Description of BIM USE	
Does the software use data from a BIM file?	Yes, geometric data is imported and related to asset data. Other BIM data can be interpreted and enriched through our own plugin: Neanex Connector.
What type of (BIM) files does the software need / will it be built for?	.rvt, .nwd, .ifc Note that a lot of file types can be aggregated in Navisworks (.nwd) and imported through there.
Does the software generate data that can be added to a BIM file?	It can, BIM files can be enriched with data coming from the Portal.
Description of other DATA	
What other datasets are needed from other tools or entered by the user?	Nothing, the Neanex Portal is a standalone application. It only requires asset information coming from the project.
Does the software generate/provide for any specific files and formats?	The Neanex Portal can provide exports of data on demand. Usually this is through an API via JSON format.
Service Architecture	
How would the software interface with the SPHERE platform?	- Data Inputs: 4. .rvt, .nwd, .ifc for geometric data 5. REST API 6. csv/json - Data outputs: ● REST API ● csv/json