INTERMODEL EU

Simulation using Building Information Modelling Methodology of Multimodal, Multipurpose and Multiproduct Freight Railway Terminal Infrastructures

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D4.1 – BIM Execution Plan Guideline

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Executive Summary

As part of Work Package 4 focused on BIM modelling, the current document serves for developing the BIM execution plan. The purpose of the BIM execution plan regarding the scope of the research project is mainly strategic.

The document needs to set the starting point for BIM modelling focused on particular innovations and to record the BIM process workflow to deliver capital information for the designated goals of the project pilots.

In all the workflow needs to comply with BIM development according to the following criteria:

- ✓ Information Management Strategy
- ✓ BIM modelling Strategy and Standards
- ✓ Standard Classification or Coding Systems
- ✓ Performance Objectives
- ✓ Stakeholders needs and requirements from the BIM process
- ✓ BIM Exploitation Strategies

Since the overall development of innovations is still under research, so will this document adapt to the particular BIM workflow needs that will be defined in several stages of the current research project. In any case the tools depicted in the following plan will serve as a record of proposed and definitive project recording and workflow mapping.

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1. Introduction

1.1 Scope

The **INTERMODEL EU project** aims at establishing a methodology for multimodal freight terminals which allows taking the most of the BIM tool and its capacity for providing multi-dimensional models. Thus, one of the tasks included within the project, is to develop four BIM models of different multimodal railway terminals.

Before working on the dimensional models it is necessary to describe the process used to complete these models up to the 7th Dimension. Therefore, the **aim of this deliverable** is developing a method to create a BIM Execution Plan in the early stages of the proposed pilot cases which are: La Spezia Seaport Terminal; Melzo Inland Terminal; virtual seaport terminal and inland terminal.

This **BIM Execution Plan** will serve to define the scope of BIM implementation, describes the team characteristics needed to achieve the modelling, the process impacts of using BIM, contract recommendations for BIM implementation, and the appropriate level of modelling of the different elements and categories of the terminals to better optimize the dedicated resources.

This deliverable includes an identification of BIM methods and implementation strategies organized by project phase – planning, design, construction and operation – and strategies for adopting these methods as well as a set of guidelines and best practices for BIM implementation at various stages in the project.

The BIM Execution Plan will be integrated into the Planning Environment Architecture; therefore, its scope will be limited only to develop procedure to meet the needs of planning the implementation of BIM throughout the project lifecycle, being tested afterwards through its use of the proposed pilot case evaluation along the subsequent tasks included in WP4.

1.2 Audience

The intended audience of this document is any actor involved in activities related to intermodal freight terminals, both seaport and inland, such as public administrations, private terminal operators, logistics companies, shippers and rail operators.

The BIM execution plan will allow to any actor involved in the making decision process to understand how to proceed when introducing changes in the models through the model and analyse their impact on the terminal performance, according to the relevant KPIs included in the dashboard.

1.3 Definitions / Glossary

In the current section a short description of main terms used in the manuscript are described, that is:

BIM - Building Information Model. Shared digital representation of physical and functional characteristics of any built object, including buildings, bridges and traffic networks. The acronym is also used to define management and Building Information Modelling in general, referring to using model-based applications. (ISO 12911)

BIM 7th dimension – Facility Management Applications. Where a model is created by the designer and updated throughout the construction phase, it will have the capacity to become an as-built model, which also can be turned over to the owner. The model will be able to contain all of the specifications, operation and maintenance (O&M) manuals and warranty information, useful for future maintenance.

BIM 8th dimension – Operational simulation. Simulation of the operational running of the infrastructure (e.g. the movement of cargo, the design's adequacy to an efficient logistics supply chain, detection of bottlenecks). BIM model will result in an integral control platform.

BIM Execution Plan – Plan prepared by the suppliers to explain how the information modelling aspects of a project will be carried out. It Include for example plans for the structure, management and exchange of information with applications used within the project.

CityGML – City Geography Mark-up Language. A common information model for the representation of 3D urban objects. The format defines classes and relations for the most relevant topographic objects in cities and regional models with respect to their geometrical, topological, semantic and appearance properties.

Geographic Information System – Information system dealing with information concerning phenomena associated with location, relative to the Earth. GIS is a broad term, referring to a number of different technologies, processes, and methods.

Industry Foundation Classes – An international, open specification for data exchange and sharing for architecture, engineering and construction of buildings and bridges. Two alternative exchange formats are provided for IFC, ISO 10303-21 standard (IFC Part-21 format), and XML (ifcXML). IFC is maintained and developed by *buildingSMART*.

InfraBIM – A specific acronym for information that is focused to the infrastructure information model and related structures and environment information, without e.g. buildings.

InfraGML – Infra Geography Mark-up Language. A standard for land and infrastructure information that intends to bring closer GIS and BIM curriculums.

Inframodel – A Finnish national detailed definition for the utilisation of LandXML in data exchange for infrastructures and asset data. The specification builds upon the international LandXML specification, and provides useful extensions such as national classification.

Key Performance Indicator - Indicator that tells you what to do to increase performance dramatically. They represent a set of measures focusing on those aspects of organizational performance that are the most critical for the current and future success of the organization. The KPI will be calculated on the results of the simulation model.

LandXML – A non-proprietary XML-based format containing civil engineering and survey measurement data commonly used in the land development and transportation industries. Since autumn 2012, the maintenance and development have been shared by OGC and *buildingSMART*.

Life Cycle - Consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal.

Open format – A neutral and open specification that is not controlled by a single vendor or group of vendors. Large building and infrastructure owners usually demand the use of open formats.

railML – A logical object model to standardise the representation of railway infrastructure-related data. Used together with railML, to supplement the data exchange schema.

1.4 Abbreviations

The abbreviations used in the present document are:

BEP: BIM Execution Plan

BIM: Building Information Modelling

GIS: Geographical Information System

IFC: Industry Foundation Classes

KPI: Key Performance Indicator

1.5 Structure

The present document is organized as follows:

- **Introduction:** contains an overview of this document, providing its Scope, Audience, and Structure.

- **Project information**: Project scope and stakeholders.
- **BIM goals and uses**: defines the potential value of BIM on the project through goals for BIM implementation related to each phase of a project lifecycle, and identifies the BIM uses for each objective.
- **BIM process and strategies**: includes BIM modelling needs, BIM uses and specific purposes of the project scope.
- **BIM exchange protocols**: presents a method for defining information exchanges between project processes for the successful BIM implementation.
- **Project resources and IT requirements**: presents criteria for the selection of project team members and determines the requirements for hardware, software licenses if any, networks and modelling content for the project.

2. Project Information

2.1 Project Description and Scope

For the purpose of the research and innovation project the proposed projects will be a total of four pilot BIM models of Seaport and Inland terminals:

Such models will be the following:

1. Existing Seaport Terminal of La Spezia.
2. Existing Inland Terminal of Melzo.
3. Virtual Seaport Terminal.
4. Virtual Inland Terminal.

These models will serve the purpose of validating the effectiveness of the integrated planning environment and decision support tool developed in WP2 which is deeply related to a planning project phase.

Also the models will serve as pilots for innovations proposed in WP3 to assess their impact on the indicators and proposals for 7d maintenance strategies in WP4.

Then the models will also serve to portray a strategy for continuing a standard BIM process from Design to Construction and finally Maintenance and Operation.

Since the goal of a complete BIM process is the ultimate materialization of an actual project the BIM strategy will mainly focus on the BIM processes that add to the operational and asset management values.

2.2 BIM Personnel

BIM personnel requirements for modelling terminals will be divided into two main phases. One phase will focus on BIM personnel needs for design disciplines and taking into account available BIM solutions for developing such models. This will serve as baseline for the abovementioned innovations and processes.

For implementations derived from WP2 developments a specific BIM strategy will be described to achieve integration with the proposed platform and assuring the overall goals for planning environment workflows are met.

The Team used for developing the necessary BIM models will be the usual profiles for BIM project development.

- BIM coordinator/manager – Is the focal point for all BIM model integration and coordination between each of the lead BIM modellers. This position requires model integration expertise for coordination and communication purposes between the design teams.

- Lead BIM modellers -A design Lead per specific design discipline will be the owner of the model. Criteria will be to gather disciplines into Civil and Architecture related and go into further segmentation as needed for the project's development.

After modelling is concluded and the integration between the innovation tasks from other work packages has been tested any additional and specific personnel needs will be considered and recorded.

3. BIM Goals and Objectives

3.1 Project BIM objectives

The BIM execution plan needs to support achieving the INTERMODEL EU project goals abovementioned.

The BIM objectives have been defined according to the following building lifecycle from project to implementation:

1. Planning
   - ✓ Interactive and visual terminal
   - ✓ KPI's

   Planning phase usually corresponds to an alternative analysis, and all the information derived from this study will be included in the integrated planning environment architecture, providing an interactive and visual terminal, and at the same time, a dashboard with a list of KPIs allowing the decision making in a prompt phase.

2. Design
   - ✓ Design analysis and quality
   - ✓ KPI's

   When a single terminal design has been chosen, the layout is further developed and it the model will be obtained in more detail and simulations will require more input data providing more accurate patterns and results.

   More interaction with the ICT environment prototype is expected, and the outcome expected will be a design quality analysis and a KPIs dashboard for the assessment.

3. Construction
   - ✓ Constructability analysis
   - ✓ Efficient construction
   - ✓ KPI's

When going deeper in details of a certain area within the terminal, BIM will provide a constructability analysis, how efficient the construction is in terms of timing and again a KPIs dashboard for the subsequent decision making process.

4. Maintenance
   - ✓ Efficient maintenance
   - ✓ KPI's

   Once constructed, during the operation phase, efficient maintenance will be a key issue to assess through the model and again a KPIs dashboard will allow decision making on the most appropriate patterns.

Table 1. BIM goals throughout the project lifecycle

Planning	Design	Construction	Maintenance
Interactive and visual terminal planning	Design analysis, quality	Constructability analysis	Efficient maintenance
KPI's	KPI's	Efficient construction	KPI's
		KPI's	

Despite the specific objectives related to the goals of INTERMODEL EU project, the ever-growing benefits of BIM for infrastructure and building projects should be tangible through design process impacts.

Since overall project effectiveness depends greatly on the performance of all the involved stakeholders, the process impacts from a user point of view are of capital relevance.

BIM project implementation can greatly enhance the integration of the following stakeholders related to any infrastructure/building process:

- Owner
- Final Users
- Project Managers
- Engineers
- Contractors

Although this categorization is generic and applicable to most cases, there is place for most of the stakeholders that will participate in Intermodal Terminal project.

The immediate benefits can be shortlisted to the following aspects:

- Increased collaboration

    - Multidisciplinary project coordination
    - Sharing model with all stakeholders
- Increased understanding
    - Visualization for presentations, decision making and marketing
    - Less resistance, better solutions
- Decreased risks and conflicts
    - Detect and manage risks virtually earlier
    - Remove conflicts between disciplines
- Decreased costs and time usage
    - 5-15% construction cost reduction

Faster production and information access

There are also impacts related to each project phase that can be accounted for, mostly in the added value for money concept considering BIM implementation costs.

Input/Planning:

- Easily identify existing situation risks
- Identify additional surveying needs more quickly, thus expediting surveying saving time and money

Design:

- Multidisciplinary coordination
- Optimized Change management
- Constructability assessment
- Quality and risk management control and mapping
- Optimize design solutions
- Real time quantity takeoff
- Efficient communication

Construction:

- Minimize construction site risks
- Optimize construction process and logistics
- Traffic and work safety planning
- Automated machine guidance

- Efficient communication

Handover:

- Model based quality inspections
- Guarantee issue management
- Collect As-Built data before covering structures
- As-Built model for maintenance

Maintenance:

- Training of maintenance and operations personnel
- Interactive 6D-maintenance database and service manuals
- As-Built model as input data for future additional designs and constructions

Overall the above described benefits among many others related to overall project costs saving though BIM implementation are increasingly determining the way BIM is being required for projects worldwide.

In any case, from the contractual point of view, it is the Owner or employer who sets the requirements for actual BIM implementation. From an engineering point of view, BIM methodology can be implemented without altering the contractual outcome unless the employer requires additional deliverables or indicators that can only be achieved through BIM technology. Any contract recommendation for BIM implementation is usually part of pre-contractual discussion between employer/owner and project management and is generally done according to industry standards.

It is part of any BIM execution plan to cover the owner's specific requirements by using the employer's information requirements document (EIR) and by defining the main resources for any implementation plan:

- People
- Technology
- Processes

These subjects are all more than covered in detail by any standard BIM execution plan, such as the ones consulted for developing the specific one for this project.

3.1.1 BIM uses checklist

In order to define the information required in each defined phase when modelling, a brainstorming was conducted among partners involved in Task 4.1 'BIM Execution Plan'.

What was expected was to relate the different project phases abovementioned to:

- The information required,

- the BIM tools used,
- and the expected outputs from the simulation engine

In order to comply with the goals pursued in each of the phases.

The table below shows the type of information, uses and calculation needs for each project phase.

Table 2. Information requirements and BIM tools for each defined phase

	Plan	Design	Construct	Maintenance
Goals / Outputs	• Interactive and visual terminal planning • KPI's	• Design analysis, quality • KPI's	• Constructability analysis, • Efficient construction • KPI's	• Efficient maintenance • KPI's
BIM Tools / Uses	Layout sketching tool for Explorer • Draw areas and networks • Define element attributes • Import layout DWG/DGN and convert to elements	• Design coordination • Clash detection • Compare to plan layout and requirements	• Quantity takeoff • Edit model attributes (manufacturer, materials, type coding, etc.)	• Read maintenance objects from BIM model • Maintenance task planning and programming tools • Export to COBIE
Model	Simple layout model (basically 2D but raised into 3D for better visualization) Model hierarchy (main element, sub element, etc.) Existing & Plan Object types • Area topology • Network topology • Static elements • Access point areas Object attributes • Name & GUID • Type / usage • Capacity attributes (volume, number of elements, lanes, vehicles per hour, etc.) • Relation links to other objects (access points) • Visual representation (3d-block, cranes, unloading / loading machinery, gates, etc.) • Requirements, risks, notes	3D Design model • Structures as BIM objects based on design standards and regulation • Disciplines • Existing • Sea bed • Surfaces, buildings, utilities, etc. • Design • Roads • Rails • Structures (bridges, wall, etc.) • Traffic guidance • Landscaping • Utility networks • Buildings • Terminal elements (storages, etc.) OpenBIM standards • IFC, LandXML	5D Constructible model • Construction phases • Rework on design BIM model to adjust real constructible elements (manufacturer, materials, type coding etc) • Quantities from model • Construction method → resources → cost & schedule of construction • Collect maintenance information • Construction safety (safety zones, barriers, etc.) • Temporary constructions (storages, temporary roads, etc.)	6D Maintenance model • Maintenance planning programming (tasks, scheduling) attached to BIM objects • Service information like service manuals etc connected to model
Simulation engine	• Read model elements as input for simulation • Create simulated dynamic objects into Explorer (containers, trains, vehicles, cranes, etc.) • Visualize results in model (volumes, bottlenecks, etc.) • CAPEX, OPEX estimates	• Energy simulations	• Construction time CO2 emission simulation • 5D simulation • Model based cost calculation	• Maintenance task optimization • Material durability / lifecycle costs

3.1.2 Material lifecycle assessment

As part of the requirements for lifecycle assessment of constructive materials, it will be up to BASF to provide information on material maintenance and decay. In this specific case, it will be done by defining the parameters that need to be included as well as any strategies for applying this information for calculating maintenance costs or the impact of using additives to enhance product lifecycle span.

Since BASF is currently developing its line of products for BIM project development, the criteria for initial implementation will be the same.
This is currently being done by the creation of material libraries and material assets.
Although each design platform will have their own development of material libraries, the baseline library will be the Autodesk Material libraries used for Revit.

In this case, materials are treated as a separate library from objects and include a wide number of properties and customization options under the following criteria:

The properties that define a material are organized into assets. Assets are groups of properties that control certain characteristics or behaviors of an object.
Autodesk Revit uses the following asset types to define materials:

- Graphics (Revit only) - These properties control how the material looks in non-rendered views.
- Appearance - These properties control how the material looks in rendered views, Realistic views, or Ray Trace views.
- Physical - These properties are used for structural analysis.
- Thermal (Revit only) - These properties are used for energy analysis.

Each asset will be used for several project developments, from the most straightforward related to appearance, to structural or thermal analysis done be the use of physical or thermal assets.
Additional parameters may include any identity properties that can include manufacturing data or even warranty considerations.

4. BIM Process and Strategy

The purpose of the BIM process is to capture all BIM modelling needs aligned with overall BIM objectives, BIM uses and specific purposes of the project scope.

The steps of the BIM process described will assure specific innovations using the model as core environment and to set the baseline modelling strategies so future terminal models can engage a standard and achievable BIM process and implementation.

4.1 Project BIM Standards

Project BIM standards will consider the possibility of complying with established processes and standard records inside the EU. This will be assessed during model development and will eventually derive in a specific model workflow that will either be predefined by a certain Standard or will suggest some variations to adapt to the current project objectives. In any case BIM standards focus mainly on BIM process Workflows and naming agreements for better collaboration in design phases. The need to comply with a certain standard, if determined will be recorded through a BIM Standards Record. As a new practice and given the nature of the implementation such record will include information of the local demands for project standards and the main reasons that require models to comply with certain BIM standards.

4.1.1 BIM Standards Record

A table will be used for recording applicable BIM standard specification. This is suitable in the cases where actual BIM standards are not required or specified but there is a need for recording some existing specification as a reference. Additionally, any other actual requirements will be indicated (mandatory, suggested, regulatory.).

Table 3. Record table for illustrative purposes

BIM STANDARS RECORD		
Document number	**Title/description**	**Compliance**
PAS 1192-2:2013	Specification for information management for the capital/delivery phase of construction projects using building information modelling	Mandatory
PAS 1192-3:2014	Specification for information management for the operational phase of assets using building information modelling	Requirement

4.2 Collaboration and Communication

Collaboration and communication procedures are determined by the needs of the project development team. This is done by determining a common communication platform for the project design team leaders to interchange information for coordination purposes. The platform also servers to record all communication procedures. Additionally this platform can serve as means for data interchange between disciplines.

As in any communication platform what the BIM Execution Plan needs to define are the principal roles and hierarchy of participants and assign the role of coordination, usually reserved for management profiles.

For the purpose of this project the communication platform will merely designate BIM model leaders by discipline who specifically need to deliver information for purposes contained in the scope of the development project. Coordination will be done by the designated BIM Manager.

4.3 Survey Strategy and Legacy Data Management

Input data required and a wide variety of formats will feed the system, which will be compatible with the following:

- Topographic base map (CAD, GIS, Raster)
- Topographical surface model (DTM, LIDAR)
- Layout (CAD plans, points cloud)

- Environmental information (CAD format, GIS)
- Hydrology study (CAD format, GIS)
- Geotechnical study (CAD format, GIS)
- Railway network (Istram, CAD format, GIS)
- Road network (Istram, CAD format, GIS)

4.3.1 Input Data Mapping Record

For this purpose, an input mapping table will be generated for recording input data formats. Element types for modelling existing conditions will be the same used for modelling of new project elements. For each element type the available information format and original element type will be specified. This implies that an existing element could have several source formats thus the need for additional columns. The initial table will be as follows:

Table 4. Input data mapping record

Model Categories / Surver & Legacy Data Mapping							
Category	**Elements**	**Format**	**Type**	**Format**	**Type**	**Format**	**Type**
1.Earth Works	Terrain Surfaces						
	Gradings						
	Trenches						
2. Railway	Rail Bed						
	Balast						
	Rail and sleepers						
	OH/ Gauges						
2. Road	Road Pavements						
	Kerbs, gutters						
3. Civil Works	Retaining Walls						
	Birgde Piers and Abutments						
	Bridge Decks						
4. Site Design	Pavements						
	Landscaping						
	Urban utilities						
5. Utilities	Site Utilities						
6. Foundations	Slabs on Grade						
	Foundations						
7. Structures	Columns						
	Beam						
	Walls						
8. Architecture	Partitions						
	Cladding						
	Ceilings						
	Roofing						
9. MEP/FP/SEC	Mechanical Systems						
	Electrical Systems						
	Plumbing Systems						
	Fire Protection						
	Security Systems						
10. Specialized Equipment	Equipment						

4.4 Modelling Standards and Methodologies

Modelling strategies are the core for BIM implementation and development. It is directly related to BIM modelling, specific project requirements and contractual deliverables. Although usually related to procurement and contracting, project deliverables can vary according to established BIM goals and uses.

Delivery requirements are usually established by the following records:

- ✓ Employers Information Requirements
- ✓ Mandatory Requirements
- ✓ Project team scope of services related to Industry Standards (In some cases established and regulated by Practice guilds)
- ✓ Classification standards related to production, cost and tasking
- ✓ Project Scope

All of these requirements along with any identifiable assessments for infrastructure projects in the same impact level will also vary depending on actual project phasing.

For mapping BIM process flow, BIM deliverables will be related to specific document o requirement need needs from actual project phasing elements.

Such documents will indicate in any case:

- ✓ Stage (F.E. Strategy, Briefing, Design, Handover)
- ✓ Documentation (F.E. Justification, Cost Estimate, Environmental Assessment, Technical Design)
- ✓ BIM deliverable (F.E.3D survey, Zoning Models, Structural Elements Model, Simulation Model, Road design Model)
- ✓ BIM development level (to be revised)

This method will serve useful since in some cases a certain BIM deliverable will be used for documenting several documents in different design stages. This is also useful for mapping actual BIM uses specific to the innovation project at hand where BIM modelling will be used for exploiting information for calibrating purposes and some innovation experiments.

As for element classification, the initial intent would be to use a standard classification system from the start, including the existing facility analysis. Nevertheless, and due to innovation purposes, the actual categorization might be adapted to the actual functional purposes of infrastructure assets. In any case, the relevant classification guidelines would include:

- ✓ Industry Standard Element Classification
- ✓ Design Discipline
- ✓ Design Platform

- ✓ Functional Classification

Priority of the classification criteria will be defined according to project development.

At this level, it is relevant to identify the possible design platform according to the type of elements that will be modelled. It is necessary since the selection of the tools will be part of WP2 coordination for integration purposes. On the other hand, platform selection criteria will initially be aligned with current BIM software development, mainly available commercial solutions that are available and used with reasonable results for Design Authoring and Construction.

Additionally to platform a minimum selection of attributes per element type needed in each project phase, starting with the baseline model actual definition. This will be recorded per item classification type and will vary according to actual research needs.

Table 5. Elements classification record table to be defined according to proposed platforms for their design

Model Categories / BIM design-modelling phase					
MODEL / SW			Attributes / Parameters		
Category	Elements	Platforms/ Design	Design	Construction	Asset
1.Earth Works	Terrain Surfaces	ISTRAM / ALLPLAN / CIVIL 3D			
	Gradings	ISTRAM / ALLPLAN / CIVIL 3D			
	Trenches	ISTRAM / CIVIL 3D			
2. Railway	Rail Bed	ISTRAM / ALLPLAN / CIVIL 3D			
	Balast	ISTRAM / ALLPLAN / CIVIL 3D			
	Rail and sleepers	ISTRAM			
	OH/ Gauges	ISTRAM			
2. Road	Road Pavements	ISTRAM / ALLPLAN / CIVIL 3D			
	Kerbs, gutters	ISTRAM / ALLPLAN / CIVIL 3D			
3. Civil Works	Retaining Walls	ISTRAM / ALLPLAN / CIVIL 3D / REVIT			
	Birgde Piers and Abutments	ISTRAM / ALLPLAN / REVIT			
	Bridge Decks	ISTRAM / ALLPLAN / REVIT			
4. Site Design	Pavements	ISTRAM / ALLPLAN / CIVIL 3D / REVIT			
	Landscaping	ISTRAM / ALLPLAN / CIVIL 3D / REVIT			
	Urban utilities	ISTRAM / ALLPLAN / CIVIL 3D / REVIT			
5. Utilities	Site Utilities	ISTRAM / CIVIL 3D / ALLPLAN / REVIT			
6. Foundations	Slabs on Grade	ALLPLAN / REVIT / TEKLA			
	Foundations	ALLPLAN / REVIT / TEKLA			
7. Structures	Columns	ALLPLAN / REVIT / TEKLA			
	Beam	ALLPLAN / REVIT / TEKLA			
	Walls	ALLPLAN / REVIT / TEKLA			
8. Architecture	Partitions	ALLPLAN / REVIT			
	Cladding	ALLPLAN / REVIT			
	Ceilings	ALLPLAN / REVIT			
	Roofing	ALLPLAN / REVIT			
9. MEP/FP/SEC	Mechanical Systems	REVIT MEP			
	Electrical Systems	REVIT MEP			
	Plumbing Systems	REVIT MEP			
	Fire Protection	REVIT MEP			
	Security Systems	REVIT MEP			
10. Specialized Equipment	Equipment	REVIT MEP			

From the functional Classification point of view, the research is aligned with specific configuration needs related to intermodal terminals, so it will be necessary to consider some specific area classification or coding for easy comprehension. This will be similar to the classification standards for elements types and industry class. In most cases area or zoning classification inside design platform is depicted as en attribute or parameter belonging to the modelled element.

The proposal of having a specific classification system will be studied for project development since the actual structure that will come from data requirements as

attributes from the model is easily identifiable with such a matrix. This can also help identify the nature of the modelling and simulation entities that will be handled.

Also attribute classification for early planning stages will be classified according to the nature of the information it will contain. The initial proposal is to consider the following:

- ✓ Physical or geometrical (Surface, Length, Width, Height, Material)
- ✓ Operational (Related to terminal processes)
- ✓ Simulation specific requirements (Any additional information required to perform simulation scenarios)
- ✓ Design Criteria (additional design constraints to be captured as data)

Table 6. Elements to be defined according to different functional areas within an intermodal terminal

Element Categorization / Planning Interface						
Category	**Element**	**Bim object type**	**Attributes**	**Attributes**	**Atributes**	**Attributes**
1. Waterside Area	a.Berth	Area	Physical	Operational	Simulation Specific	Design Criteria
	b.Apron	Network				
	c.Navigation Area	Area				
2. Quayside Transport	a.Vehicle Access Area	Area				
	b.Handling System	Area				
3. Stacking area	a.Piles of Containers	Area				
	b.Bulk Stacking	Area				
	c.Warehousing	Area				
	d.Access Gates	Area				
4. Unloading Areas	a.Vehicle Unloading Areas	Access point				
	b.Train Unloading Areas	Access point				
5. Internal Transport Area	a.Railway	Network				
	b.Road	Network				
6. Gates and Connections	a.Truck Gates	Access point				
	b.Rail Gates	Access point				
	c.Weighing	Access point				
	d.Scanners and detection	Access point				
7. Auxiliary Buildings	a.Buildings/Spaces	Area				
8. Utilities	a.Utilities	Area/Network				
9, External Transport	a.Railway	Network				
	b.Road	Network				

The purpose will be to record the BIM modelling process considering the abovementioned criteria and with the flexibility of integrating new processes from the actual scope of the research project but also to integrate any innovations from the global BIM development environment which is currently underway.

The final BIM workflow will be depicted using process mapping with the BIM deliverable as core entity.

4.5 BIM Data Requirements

The information required must be defined previously, to make sure that BIM model needs are covered, and throughout the duration of the project, the timing of its delivery should be specified.

The table below shows data requirements related to each phase defined and level. Level of detail of the information increases as the project progresses:

Table 7. Data requirements according to each phase

	Plan	Design	Construct	Maintenance
Geometry	2D/3D layout topology model	3D BIM objects	5D BIM objects Final elements + temporary elements	6D BIM objects As-built model
Information	Type classification, physical attributes, operational attributes, simulation attributes Requirements, risks	Dimensions, volumes, materials, quality, design parameters, specifications / requirements, IoT sensors	Materials, manufacturers Construction method	Installation date Maintenance dates Maintenance tasks Service documentation

4.6 Calculation Methodologies

Initial calculation methodology will depend on element type classification, as depicted in the previous tables since the actual calculation methods may vary from one design platform to the other. In any case the standardization of calculation standards assures most platform already comply with most industry needs.

What will be studied is the actual calculation methodologies needed for the projects innovation purposes and the actual integration with industry standards. This will also be done through recording methods and process mapping.

5. BIM Exchange Protocols

Data exchange protocol will initially establish the use of open BIM formats for data exchanges from the baseline model (basic design) to construction and asset management. Data exchanges for planning tool integration will be studied under WP2 scope and integrated in the BIM process.

- IFC
- LandXML
- GML
- City GML
- RailML
- Raster
- DTM
- LIDAR

Metadata structure for each file will be analysed for standardization purposes and integration of open formats for simulation and asset management databases. In any case open BIM formats are most likely to be overly accepted as standard interchange formats between several asset management platforms.

6. Project Resources and IT Requirements

6.1 Hardware/Infrastructure Requirements

Specific hardware needs usually vary depending on design platform selection, the size and scope of the project, the number of handled models and any additional storage access needs, whether it is server or cloud based.

In this case, IT resources needed for terminal modelling tasks will be recorded and compared for estimating overall IT needs for future implementations.

6.2 Software Requirements

This shortlist will initially capture available design platforms for modelling. Some additional software may be needed to handle input data, specification document and survey data.

This is the initial list of considered modelling platforms:

- ✓ Autodesk Infraworks
- ✓ Viasys Explorer
- ✓ Autodesk Autocad
- ✓ Autodesk Civil 3D
- ✓ Istram Ispol
- ✓ Revit Architecture/ Structures/ MEP
- ✓ Allplan architecture, Engineering and Terrain modules
- ✓ Tekla Structures

6.3 BIM Content

Any BIM content development libraries will be recorded and verified for overall process compliance. The actual nature of BIM libraries will vary from one platform to the other so it is suggested that a reasonable standardization is defined for the selected platforms. BIM content will also vary depending on specific local or regulatory requirements.

7. Conclusions

The purpose of this document is to develop a BIM execution plan for integrating BIM methods into decision-making environments and implementing objective innovations for improving terminal design processes. Such Integration and innovations are clearly defined in the scope of other work packages and in WP4.

The main objectives will be coherent with the agreement requirements in defining the needs for BIM modelling and BIM integration.

The first outcome will be inside WP4. The BEP document will set the guidelines for activities done in tasks 4.2, 4.3 and 4.4 which will be the modelling of the cases defined for testing in other work packages.

WP2 and BIM integration into a decision-making platform are one of the main objectives for BIM modelling. In this case the partners from other work packages will act as owner/employer by preparing information requirements and other BIM modelling needs for their specific task.

This can already be seen in this document under Data requirements and modelling strategies.

Some area and discipline categories, as well as modelling element types have been initially listed in accordance with the criteria defined on WP2 and WP5.

Some additional requirements will be included according to the actual needs included in other work packages during project development. This is due to the innovative nature of other work packages in determining information needs from BIM modelling that is not currently a standard practice.

References

BIM Project Execution Planning Guide. Version 2.0 (draft - April 16, 2010). Computer Integrated Construction Research Program, Pennsylvania State University.

Sireeni, J. (2015). Viasys VDC BIM Guide. Version 1.0.

PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling.

PAS 1192-3:2014 Specification for information management for the operational phase of assets using building information modelling.