

xPPM-neo

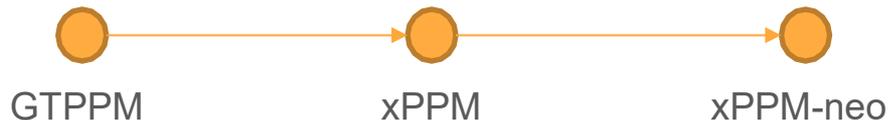
User's Manual
(Alpha Release)

2021. 7. 20



A brief history of xPPM-neo

- xPPM-neo is a free IDM authoring software.
- xPPM-neo supports ISO 29481-3 IDM schema (in DIS).
- The current version is the alpha release.
- It is a successor of the eXtended Process to Product Modeling (xPPM) tool.
- xPPM was developed to support ISO 29481-1 from 2006 to 2012 as a successor of the Georgia Tech Process to Product Modeling (GTPPM) tool.
- GTPPM was developed in the early 2000s as a software engineering tool to efficiently develop a standard data model for the precast concrete industry as part of the Precast Concrete Software Consortium (PCSC) project.



Major Features of xPPM-Neo

- Smart (Standard-enabled **M**achine-**A**pplicable, **R**eadable, and **T**ransferrable) links between information requirements and data schema elements
 - smart links among IDM components
 - smart links between IDM components and MVD elements
 - smart links between IDM components and bSDD concepts
 - smart links between informal business rules and formal constraints
- Application examples
 - Automated derivation of an MVD from an IDM specification
 - Management of the relationships between building code and regulations and formal rule sets
 - Automated generation of BEP chapters or EIRs from an IDM document

Developers



Ghang Lee, Jeaun Jung, Jungdae Kim, and
Seungwoo Son



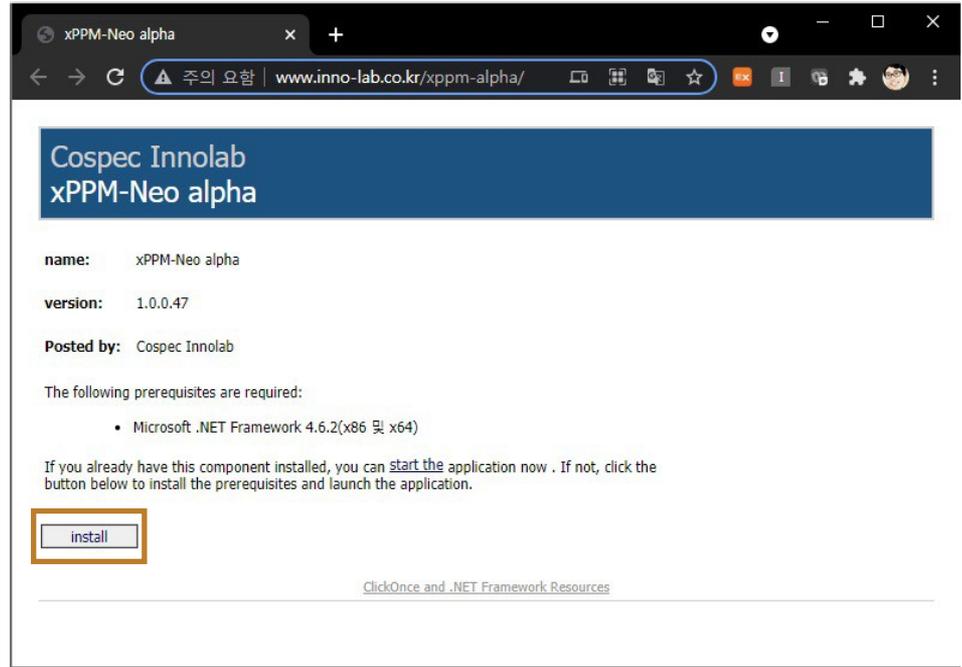
Gutaek Kim, Eunhee Kang, Kyoungjun Kang,
and Elena Gerasimenko

Table of Contents

1. Download the Installation File
2. Installation
3. Sign Up and Log In
4. Create a New IDM Document
5. Specify a Use Case
6. Specify a Use Case—
Additional Information
7. Specify a Business Context
8. Specify Exchange
Requirements
9. Specify Examples
10. Specify Constraints
11. Link an Information Unit and
an External Element
12. Link an Information Unit to IFC
Elements via bSDD
13. Create an MVD from an IDM
Document
14. Link an ER to an MVD
15. Export the IDM Specification as
an IDM xml File
16. Bug Report

Download the Installation File

- <http://www.inno-lab.co.kr/xppm-alpha>
- Click “Install” button



Installation

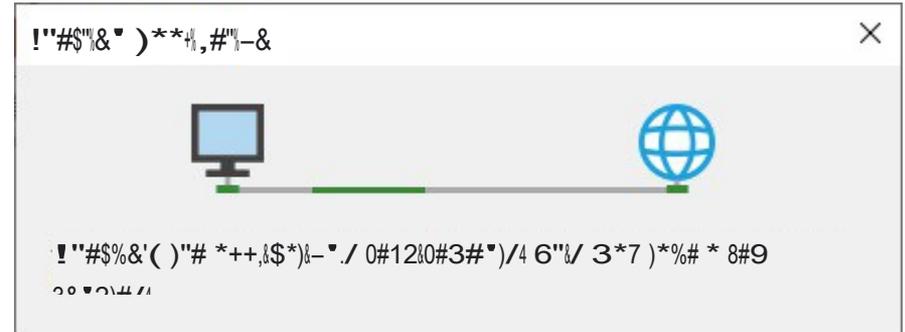
- Execute installation file (.exe)



- Start xPPM-Neo



- Application is automatically updated upon startup



Sign Up and Log In

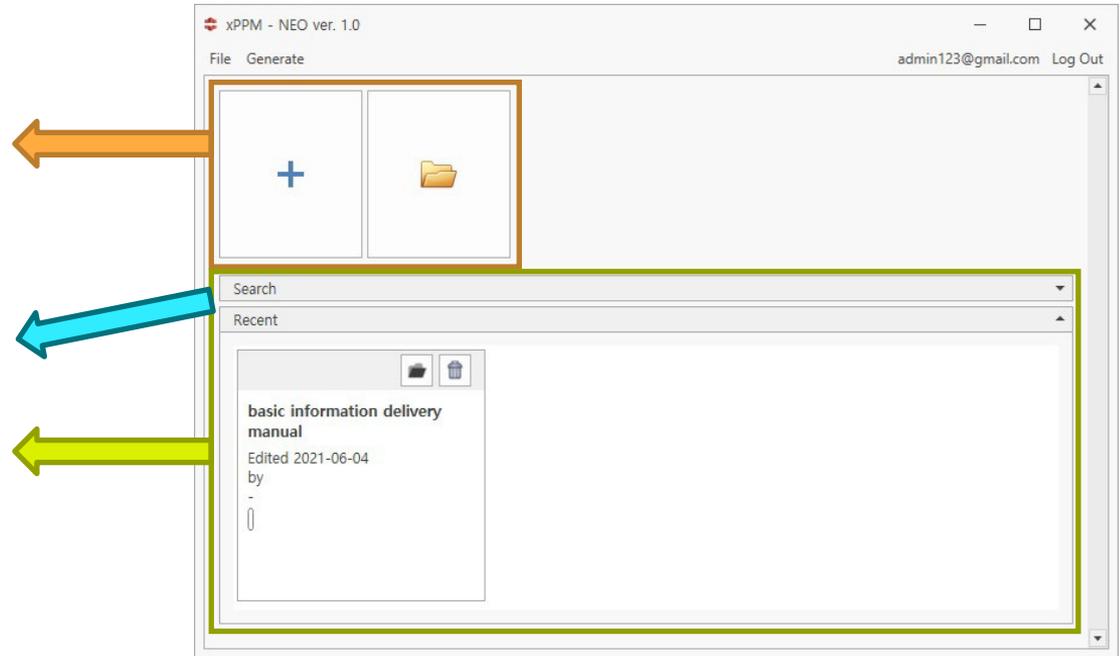
- Sign up for an account

* After signing up, **please contact us to start the approval process.**

The image displays two screenshots of a web application interface. The left screenshot shows a 'Log In' form with fields for 'E-mail' (containing 'youremail@mail.co.kr') and 'Password' (masked with dots). A 'Remember My Login' checkbox is checked. A 'Log In' button is present. A 'Sign up' button is highlighted with a brown box, and an orange arrow points from it to the right. The right screenshot shows a 'Sign up' form with fields for 'First name', 'Middle name', 'Last name', 'Email', 'Password', and 'Confirm your password'. It also includes dropdown menus for 'Language', 'Country', 'What organization do you belong to?', 'What is your role in your Organization?', and 'Which one of the following best describes your company?'. 'Register' and 'Cancel' buttons are at the bottom.

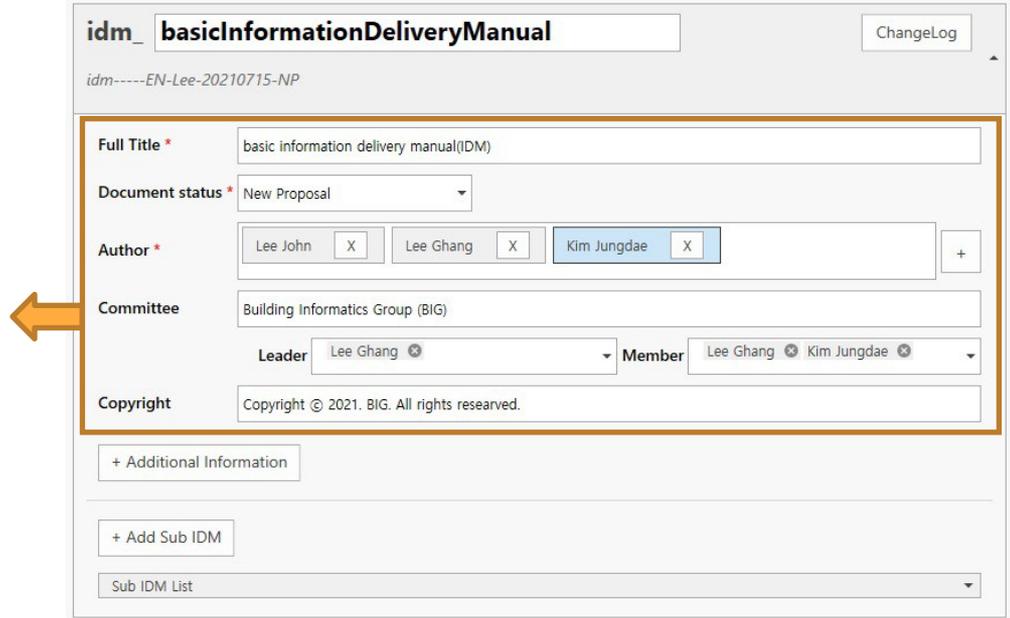
Create a New IDM Document

- Click “+” to create a new file or click the folder icon to browse and open existing IDM projects
- Search an IDM project using key attributes
- Open an existing file



Create a New IDM Document

- Specify the basic IDM information



The screenshot shows a web form for creating a new IDM document. The form is titled "idm_ basicInformationDeliveryManual" and includes a "ChangeLog" button. Below the title, the identifier "idm-----EN-Lee-20210715-NP" is displayed. The main form area is divided into several sections, with the top section highlighted by a blue border and an orange arrow pointing to it from the left. This highlighted section contains the following fields:

- Full Title ***: basic information delivery manual(IDM)
- Document status ***: New Proposal (dropdown menu)
- Author ***: Lee John (X), Lee Ghang (X), Kim Jungdae (X) (with a "+" button to add more authors)
- Committee**: Building Informatics Group (BIG)
- Leader**: Lee Ghang (X) (dropdown menu)
- Member**: Lee Ghang (X), Kim Jungdae (X) (dropdown menu)
- Copyright**: Copyright © 2021. BIG. All rights reserved.

Below the highlighted section, there are three more sections:

- + Additional Information**: A button to expand this section.
- + Add Sub IDM**: A button to add sub-IDs.
- Sub IDM List**: A dropdown menu to view the list of sub-IDs.

Create a New IDM Document

- Select and add “Additional Information” to an IDM specification

The screenshot displays the 'Create a New IDM Document' interface. The main form is titled 'idm_ basicInformationDelive' and includes a 'ChangeLog' button. Below the title, the document ID 'idm-----EN-Lee-20210715-NP' is shown. The form contains several fields: 'Full Title *' (basic information delivery manual(IDM)), 'Document status *' (New Proposal), 'Author *' (Lee John, Lee Ghang, Kim Jun), 'Committee' (Building Informatics Group (BIG)), 'Leader' (Lee Ghang), 'Member' (Lee Ghang, Kim Jungdae), and 'Copyright' (Copyright © 2021, BIG. All rights reserved.). A yellow arrow points to the '+ Additional Information' button at the bottom of the form. To the right, a panel titled 'Additional Information' is open, showing a list of checkboxes: 'Subtitle', 'Local Code', 'Local Standard Status', 'Version', and 'Publisher'. The 'Apply' and 'Close' buttons are at the bottom of this panel.

Specify a Use Case

- Specify the basic information
- Select **Use Classification** (optional) and **Use**. You can also create your own "(information) use" category. A recommended form is "Verb+Noun", e.g., EstimateCost

uc_ **basicInformationDeliveryManual** ChangeLog

uc-MI-Inception -Demolition-ABW-EN-Lee-20210715-NP Open UC

Same as the IDM basic information

Use *

Target Project Phases

+ Add Target Pr

Use Classification: **bSI BIM Use cases** Use Add Classification

Target Phase N	Name	Version	Publication Year	Information Required
Inception	bSI BIM Use cases	4-1	2019	<input checked="" type="checkbox"/>

English

Country OK Cancel

Language * Edit

Region * Edit

Summary * Edit

Aim and Scope * Edit

- Manufacturers Information
- Communication move/add/change management
- Construction System Design
- Cost analysis / Estimation
- Design Authoring and Briefing
- Design Reviews
- Design to Maintain Analysis
- Digital Fabrication
- Digital Layout - BIM 2 Field
- Disaster Planning / Emergency Preparedness
- Electrical Analysis
- Energy Analysis
- Existing Conditions Modeling
- Field & Material tracking
- FM Documentation
- Laser Scanning
- Lighting Analysis
- Maintenance & Repair Information
- Manufacturers Information

Specify a Use Case

- Define the target project phases for each IDM specification as well as the outcomes and information requirements at the end of each target project phase

uc_ **basicInformationDeliveryManual** ChangeLog

uc-MI----EN-Lee-20210715-NP Open UC

Same as the IDM basic information

Use * Use Classification: bSI BIM Use cases Use Manufacturers Information

Target Project Phases * + Add Target Project Phase All project phases

Target Phase Name	Outcome Description	Information Requirement Descri...	Exchange Requirement
Inception	Edit		x
Brief			x
Design			x
Production			x
Maintenance			x
Demolition			x

Language * English

Region * User-Defined

Summary * Edit

Specify a Use Case

- Define outcomes and information requirements with graphic examples

The screenshot shows a software interface for specifying a use case. The main window is titled "uc_ basicInformationDeliveryManual" and contains several sections:

- ChangeLog** and **Open UC** buttons.
- A dropdown menu with the option **Same as the IDM basic information**.
- Use *** section with **Use Classification:** bSI BIM Use cases and **Use:** Manufacturers Information.
- Target Project Phases *** section with a table:

Target Phase Name	Outcome Description	Information Requirement Descri...	Exchange Requirement
Inception			X
Brief			X
Design			
Production			
Maintenance			
Demolition			

An **Edit** button is visible next to the **Outcome Description** column for the **Inception** phase. An orange arrow points from the **Edit** button to the **Outcome Description** column header.

Below the table, there are sections for **Language *** (English), **Region *** (User-Defined), and **Summary *** (Edit).

An **Outcome Description** window is open, showing a rich text editor with a ribbon (Home, Insert, Page Layout, References, Mail Merge, View, Review) and a large text area for editing the outcome description. The window has **OK** and **Cancel** buttons at the bottom.

Specify a Use Case

- Information requirements can be linked to a list of exchange requirements (ERs)

uc_ **basicInformationDeliveryManual** ChangeLog

uc-MI----EN-Lee-20210715-NP Open UC

Same as the IDM basic information

Use * Use Classification: bSI BIM Use cases Use: Manufacturers Information

Target Project Phases * + Add Target Project Phase All project phases

Target Phase Name	Outcome Description	Information Requirement Descri...	Exchange Requirement
Inception			x
Brief			x
Design			x
Maintenance			x
Demolition			x

Language * English

Region * User-Defined

Summary * Edit

An orange arrow points from the 'Exchange Requirement' column of the table to the text on the left.

Specify a Use Case—Additional Information

- Define business rules

The screenshot displays a software interface for managing business rules. At the top, a header bar contains a '+ Add Business Rule' button. Below this is a table with columns for 'Rule ID', 'Rule Name', and 'Proposition'. The table is currently empty. To the right of the table, a detailed view of a business rule is shown. This view includes a search bar, a 'BusinessRule' title with a close button, and a '+ Business Rule' button. The rule details are as follows:

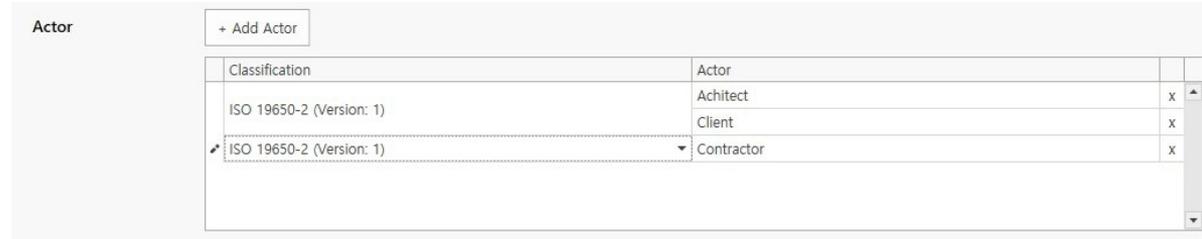
- Rule ID: 3dc79fdd-4fb4-4e35-a02f-328fff5a9a01
- Rule Name: Rule 01
- Proposition: [Empty field]
- References: [Empty field]

The 'References' field contains a list of two items:

1. For every small site within a establish the two sets of coo parameters. But after that, n
2. If the overall site is small, th local coordinate systems wit To apply the principles there defined for the overall site b the two points for a smaller both the overall local coordi coordinate system of the smc

Specify a Use Case—Additional Information

- Define the actors or roles associated with data exchange specified in an IDM document
- Actors may be defined based on a standard actor classification



The screenshot shows a software interface for defining actors. It features a header 'Actor' and a '+ Add Actor' button. Below is a table with columns for 'Classification', 'Actor', and a checkbox. The table contains three rows: 'Achitect', 'Client', and 'Contractor', all associated with the classification 'ISO 19650-2 (Version: 1)'. The 'Contractor' row is selected, indicated by a checkmark in the checkbox column.

Classification	Actor	
ISO 19650-2 (Version: 1)	Achitect	<input type="checkbox"/>
ISO 19650-2 (Version: 1)	Client	<input type="checkbox"/>
<input checked="" type="checkbox"/> ISO 19650-2 (Version: 1)	Contractor	<input type="checkbox"/>

Specify a Business Context

- Define the business context
- The data exchange process may be specified using a **process map** (an activity-oriented representation) or an **interaction map** (an actor-oriented representation)

The screenshot displays a software interface for defining business context. It is divided into two main sections: 'pm' (Process Map) and 'IM' (Interaction Map).

pm Section:

- Header: 'pm_ shortTitle' with a 'ChangeLog' button.
- Sub-header: 'pm-MI-Inception - Demolition-ABW-EN-Lee-20210715-' with 'Open PM' and 'Delete PM' buttons.
- Option: A checkbox labeled 'Same as the IDM basic information'.
- Section: 'PM Diagram *' with 'Import diagram' and 'Add new' buttons.
- Button: '+ Add Sub PM'.
- Field: 'Sub ProcessMap List' with a dropdown arrow.

IM Section:

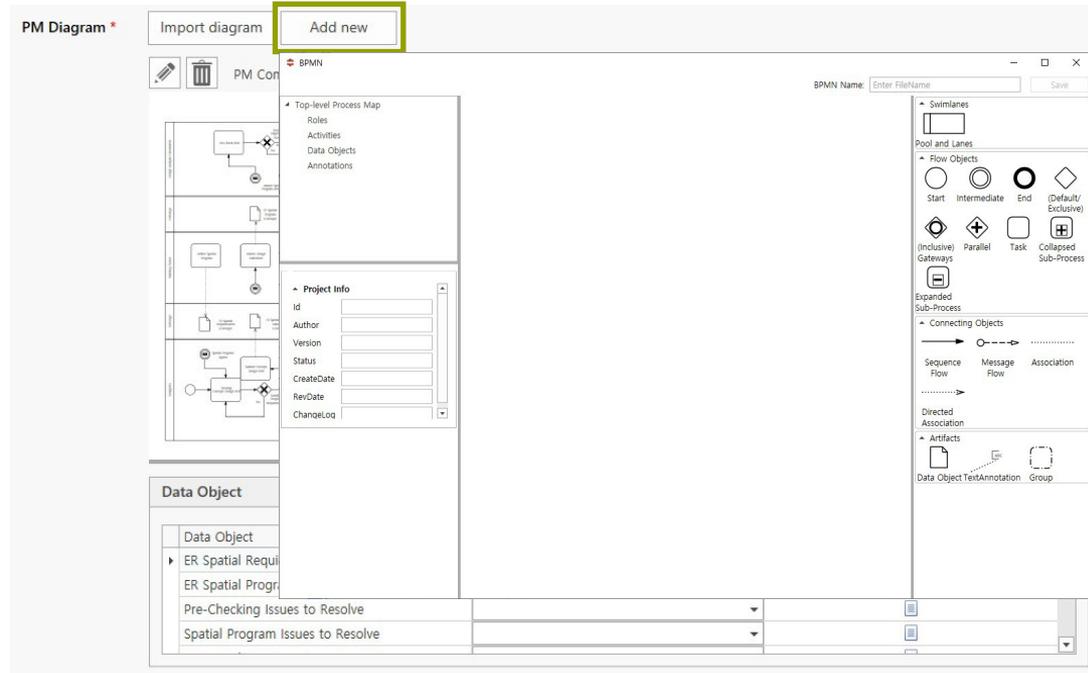
- Header: 'IM_ shortTitle' with a 'Delete IM' button.
- Button: '+ Import diagram'.
- Field: 'Notation' with an input box.
- Section: 'Description' with an 'Edit' button.
- Field: A large text area for the description.

Bottom Bar:

- Buttons: '+ PM', '+ IM', and '+ ER'. The '+ PM' and '+ IM' buttons are highlighted with a blue border.

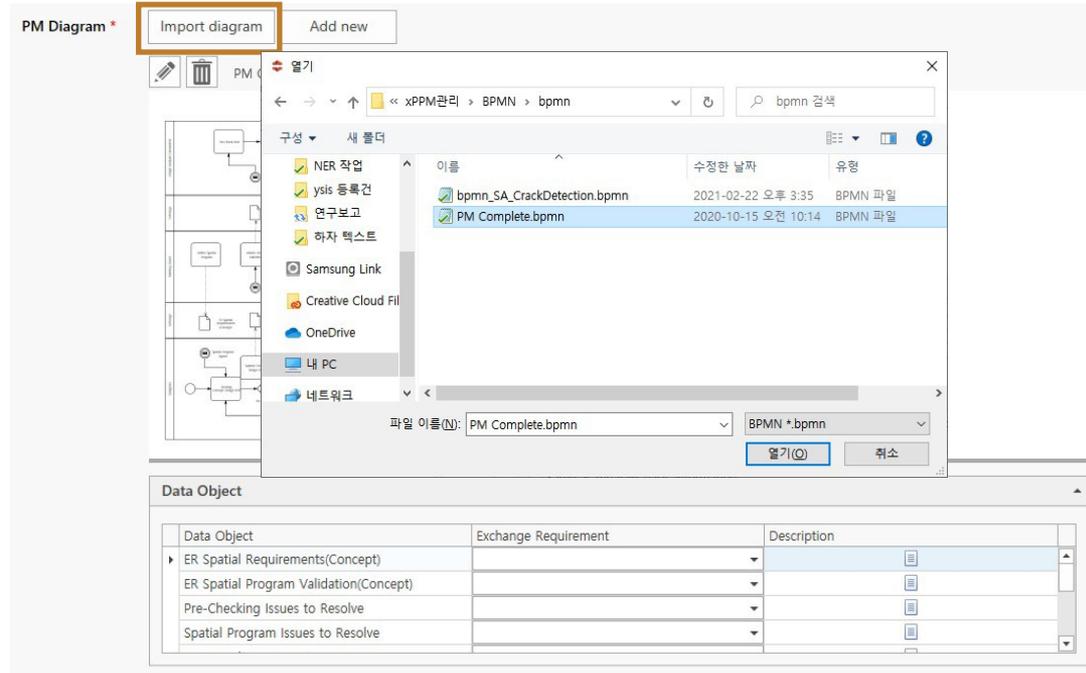
Specify a Business Context

- A process map uses business process map notation (BPMN)
- A process map may be defined by **creating a new diagram** using a **BPMN editor**



Specify a Business Context

- An existing *.bpmn file can be imported, and the process map can be edited



The screenshot shows a software interface for managing Business Process Model and Notation (BPMN) diagrams. The main window is titled "PM Diagram" and has an "Import diagram" button highlighted with an orange box. A file explorer window is open, showing a directory structure with "PM Complete.bpmn" selected. Below the file explorer, a "Data Object" table is visible, listing various data objects and their descriptions.

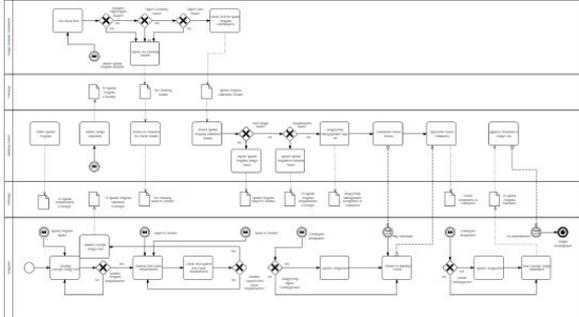
Data Object	Exchange Requirement	Description
ER Spatial Requirements(Concept)		
ER Spatial Program Validation(Concept)		
Pre-Checking Issues to Resolve		
Spatial Program Issues to Resolve		

Specify a Business Context

- **Data objects** in a process map can be associated with ERs

PM Diagram * Import diagram Add new

PM Complete

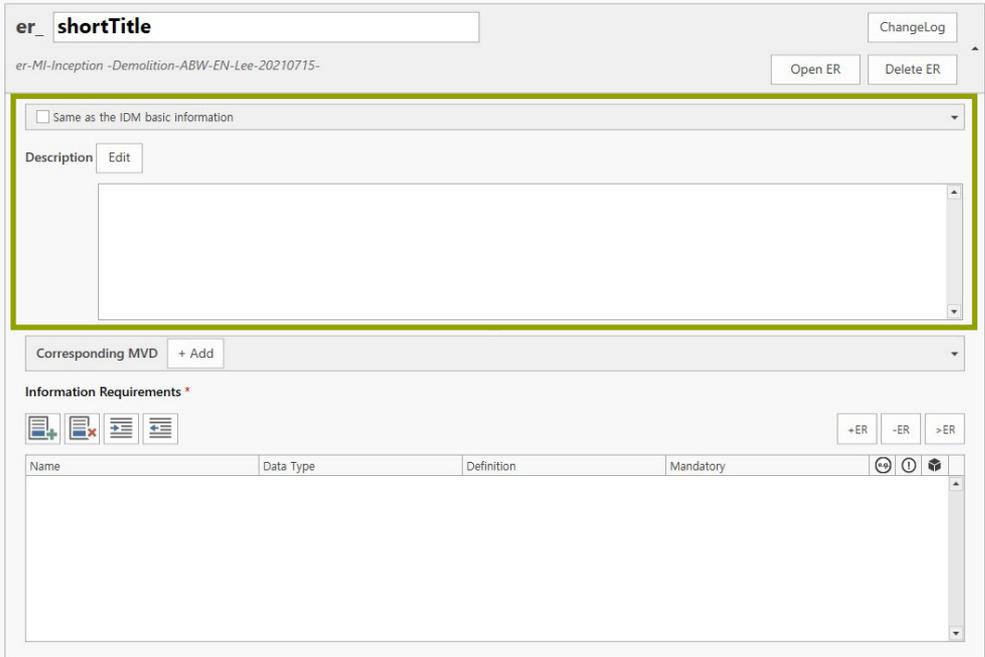


Data Object

Data Object	Exchange Requirement	Description
ER Spatial Requirements(Concept)		
ER Spatial Program Validation(Concept)		
Pre-Checking Issues to Resolve		
Spatial Program Issues to Resolve		

Specify Exchange Requirements

- Add basic information and a description about an ER



er_ ChangeLog

er-MI-Inception -Demolition-ABW-EN-Lee-20210715- Open ER Delete ER

Same as the IDM basic information

Description Edit

Corresponding MVD + Add

Information Requirements *

+ER -ER >ER

Name	Data Type	Definition	Mandatory	

Specify Exchange Requirements

- **Information units** can be added or removed using the buttons with “+” and “x” (pictured below)
- A **hierarchy between information units** can be defined using the indentation buttons (with left and right arrows), pictured below

er_ ChangeLog

er-MI-Inception -Demolition-ABW-EN-Lee-20210715- Open ER Delete ER

Same as the IDM basic information

Description Edit

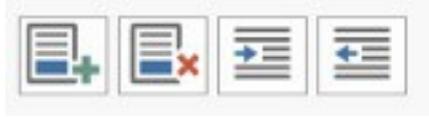
Corresponding MVD + Add

Information Requirements *

+ER -ER >ER

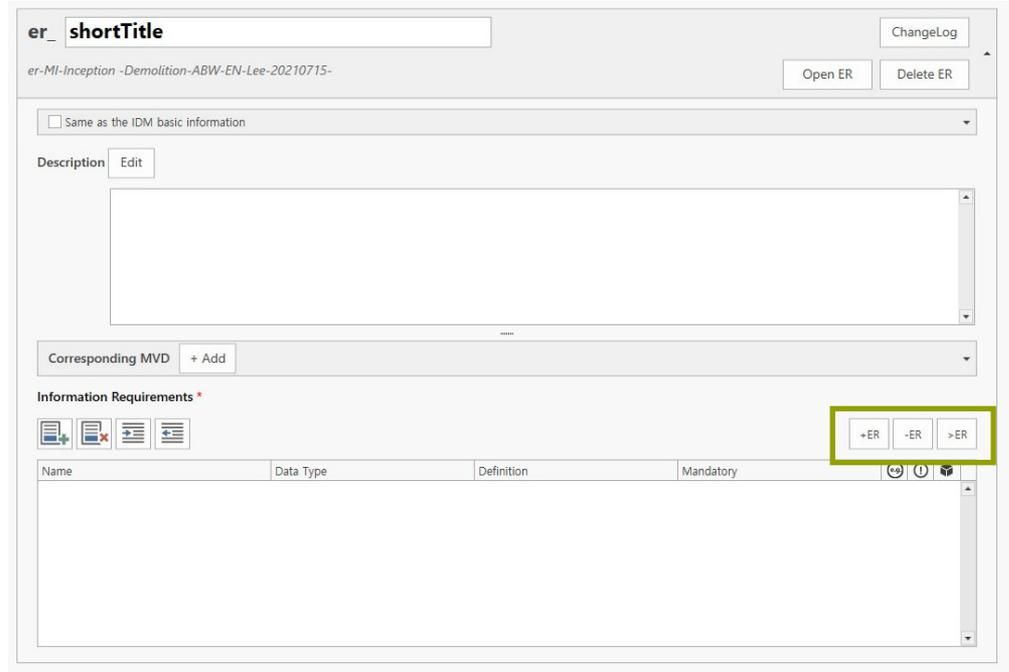
Name	Data Type	Definition	Mandatory
------	-----------	------------	-----------

Specify Exchange Requirements



Specify Exchange Requirements

- Existing ERs can be added as **sub-ERs** or removed using the “+ER” and “-ER” buttons, respectively
- The “>ER” button turns a list of selected information units into a **new ER**

A screenshot of a software interface for specifying Exchange Requirements. At the top, there is a text input field with "er_ shortTitle" and a "ChangeLog" button. Below this is a breadcrumb path "er-MI-Inception -Demolition-ABW-EN-Lee-20210715-" and "Open ER" and "Delete ER" buttons. A checkbox labeled "Same as the IDM basic information" is present. A "Description" section has an "Edit" button and a large text area. Below that is a "Corresponding MVD" section with a "+ Add" button. The "Information Requirements" section features a toolbar with icons for adding, deleting, and moving items, and a table with columns for Name, Data Type, Definition, and Mandatory. The "+ER", "-ER", and ">ER" buttons from the previous image are highlighted with a green box in the top right corner of this section.

Specify Exchange Requirements

- Double-click an information unit to input detailed information such as **examples**, **constraints**, and **associated external elements**

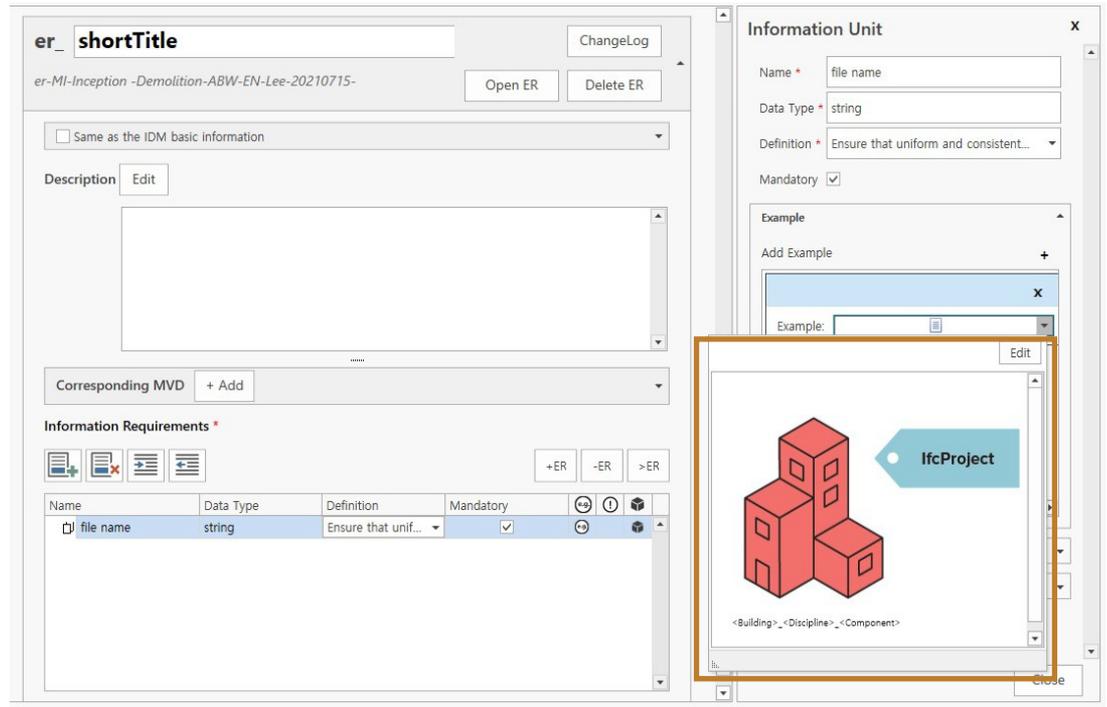
The screenshot displays the 'er_ shortTitle' window. At the top, there is a 'ChangeLog' button and a title bar. Below the title, there are 'Open ER' and 'Delete ER' buttons. A checkbox labeled 'Same as the IDM basic information' is present. A 'Description' field with an 'Edit' button is shown. Below this is a large text area. A 'Corresponding MVD' field with an '+ Add' button is also visible. The 'Information Requirements *' section contains a table with the following data:

Name	Data Type	Definition	Mandatory
file name	string	Ensure that unif...	<input checked="" type="checkbox"/>

The 'Information Unit' dialog is open on the right, showing fields for 'Name *' (file name), 'Data Type *' (string), and 'Definition *' (Ensure that uniform and consistent...). A 'Mandatory' checkbox is checked. Below these fields are tabs for 'Example', 'Constraints', and 'External Element'. A 'Close' button is at the bottom right of the dialog.

Specify Examples

- Images can be added through the editor to provide **graphic examples** of an information unit



The screenshot displays a software interface for defining an Information Unit. The main window, titled "er_ shortTitle", shows a form with a "ChangeLog" button, "Open ER", and "Delete ER" buttons. Below the form is a "Description" field with an "Edit" button. A "Corresponding MVD" dropdown menu is set to "+ Add". The "Information Requirements" section includes a table with the following data:

Name	Data Type	Definition	Mandatory	Info	Help	Icon
file name	string	Ensure that unif...	<input checked="" type="checkbox"/>	?	?	?

The "Information Unit" window is open, showing the "Name" field set to "file name", "Data Type" set to "string", and "Definition" set to "Ensure that uniform and consistent...". The "Mandatory" checkbox is checked. The "Example" section is active, showing an "Add Example" button and a list of examples. One example is highlighted, showing a graphic of three red 3D building blocks and a blue arrow pointing to them with the text "IfcProject". The graphic is labeled with the IFC class name "<Building>._<Discipline>._<Component>".

Specify Constraints

- A **constraint** can be associated with a **business rule**

The screenshot displays a software interface for configuring an Information Unit. The main window shows the 'er_ shortTitle' configuration page. Below the description field, there is a section for 'Information Requirements' which contains a table with the following data:

Name	Data Type	Definition	Mandatory
file name	string	Ensure that unif...	<input checked="" type="checkbox"/>

To the right, a pop-up window titled 'Information Unit' is open, showing the 'Constraints' section. This section is highlighted with a red box and contains a table with the following data:

Associated Business Rule:	Rule ID	Rule N...	Propos...
Description:	26b2d...	Rule 01	

Link an Information Unit and an External Element

- An information unit can be associated with one or more specific elements of an external schema such as IFC 4.0 or bSDD

The screenshot displays two windows from a software application. The main window on the left is titled "er_ shortTitle" and shows the configuration for an information unit. It includes a description field, a "Corresponding MVD" dropdown, and a table of "Information Requirements". The table has the following data:

Name	Data Type	Definition	Mandatory
file name	string	Ensure that unif...	<input checked="" type="checkbox"/>

The right window is titled "Information Unit" and shows the configuration for the "file name" information unit. It includes fields for Name, Data Type, Definition, and Mandatory. The "External Element" section is highlighted with an orange border and shows a search for "bSDD" with the following results:

Basis	Element	Description
bSDD	bSDD	IFC 4.0 cityGML

Link an Information Unit to IFC Elements via bSDD

- Select “bSDD” as the basis of an external element
- Click the magnifier icon

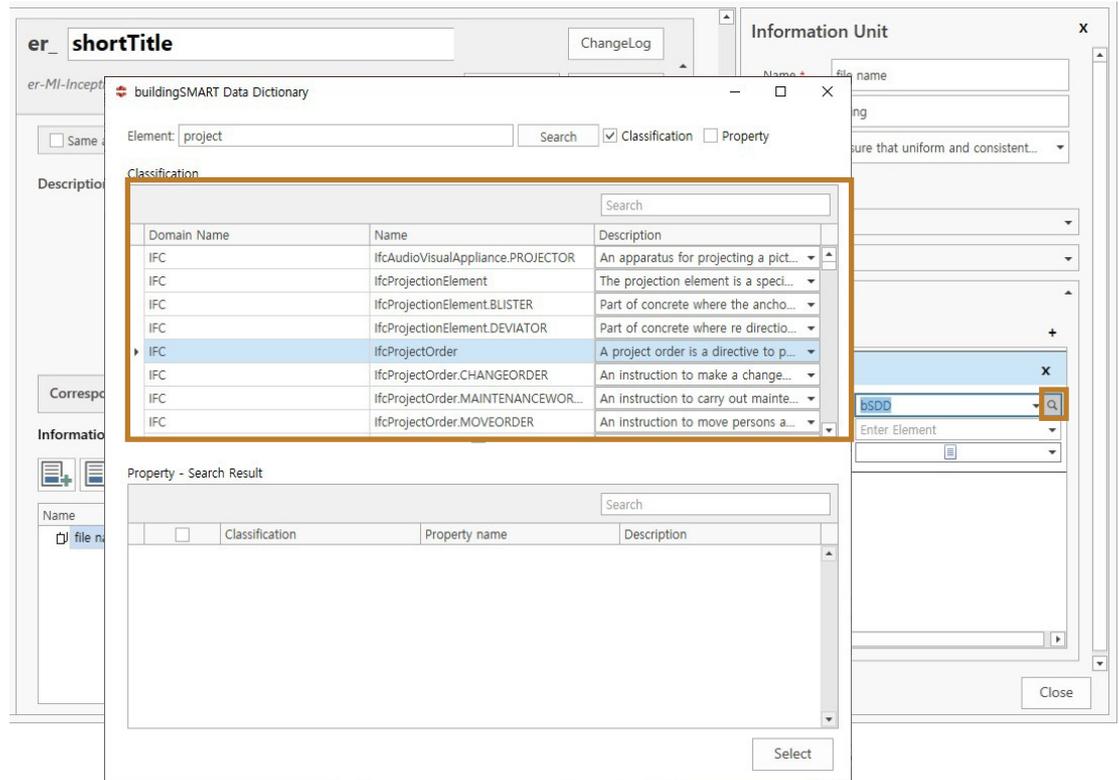
The screenshot displays a software interface for configuring an Information Unit. The main window is titled "er_ shortTitle" and contains a "ChangeLog" button, "Open ER", and "Delete ER" buttons. Below these is a dropdown menu with the option "Same as the IDM basic information". A "Description" field with an "Edit" button is present, followed by a large empty text area. A "Corresponding MVD" dropdown with a "+ Add" button is also visible. The "Information Requirements" section includes icons for adding, deleting, and navigating requirements, along with "+ER", "-ER", and ">ER" buttons. A table lists the requirements:

Name	Data Type	Definition	Mandatory	Icons
file name	string	Ensure that unif...	<input checked="" type="checkbox"/>	⊕ ⊖ ⊞

An "Information Unit" dialog box is open on the right, showing fields for "Name" (file name), "Data Type" (string), and "Definition" (Ensure that uniform and consistent...). The "Mandatory" checkbox is checked. Below these are sections for "Example", "Constraints", and "External Element". The "External Element" section is highlighted with an orange box and contains a "Basis" dropdown menu with "bSDD" selected. A magnifier icon is visible next to the "bSDD" selection. Other fields in this section include "Element" (Enter Element) and "Description". A "Close" button is at the bottom right of the dialog.

Link an Information Unit to IFC Elements via bSDD

- Look for an IFC entity directly relevant to the selected information unit by reviewing the name and description of an IFC entity in the bSDD window



Link an Information Unit to IFC Elements via bSDD

- You can also look for the IFC properties that match the selected information unit from the bSDD window

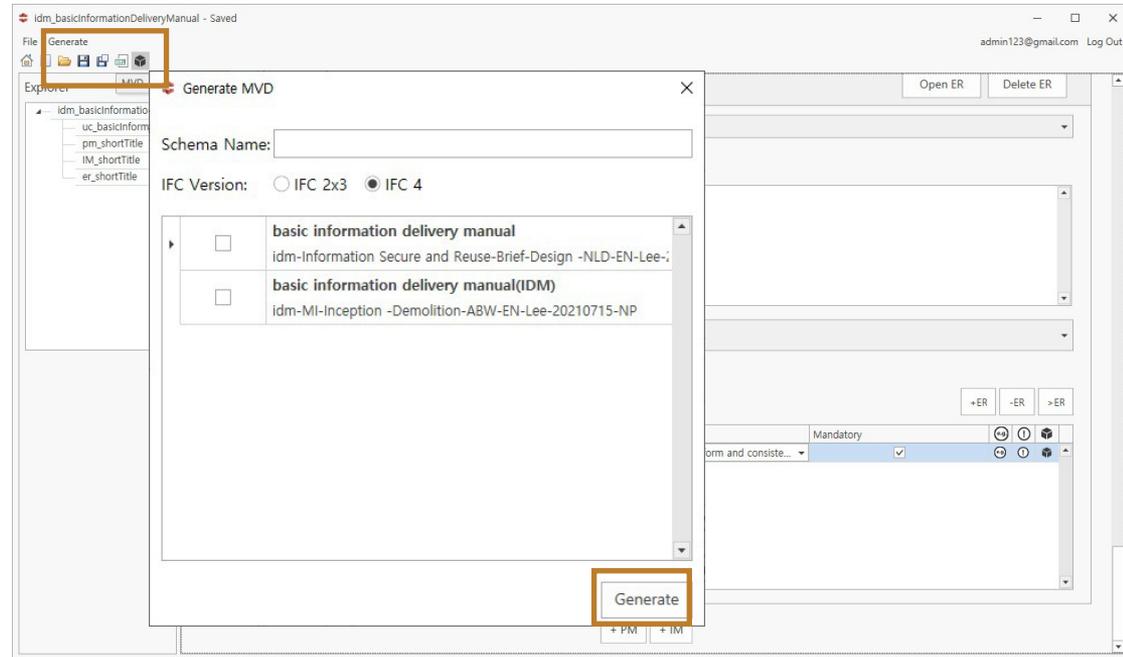
The screenshot displays the 'buildingSMART Data Dictionary' application. The main window is titled 'Information Unit' and shows a search for 'project'. The search results are displayed in a table with columns for 'Domain Name', 'Name', and 'Description'. The 'project name' property is selected in the 'Property - Search Result' window.

Domain Name	Name	Description
IFC	IfcAudioVisualAppliance.PROJECTOR	An apparatus for projecting a pict...
IFC	IfcProjectionElement	The projection element is a speci...
IFC	IfcProjectionElement.BLISTER	Part of concrete where the ancho...
IFC	IfcProjectionElement.DEVIATOR	Part of concrete where re directio...
IFC	IfcProjectOrder	A project order is a directive to p...
IFC	IfcProjectOrder.CHANGEORDER	An instruction to make a change...
IFC	IfcProjectOrder.MAINTENANCEWOR...	An instruction to carry out mainte...
IFC	IfcProjectOrder.MOVEORDER	An instruction to move persons a...

Classification	Property name	Description
<input type="checkbox"/>	Project developer	natural or legal person propo...
<input type="checkbox"/>	Project end coordinates	latitude, longitude, altitude o...
<input type="checkbox"/>	Project Identification Number	Project reference number
<input type="checkbox"/>	Project letting date	Project letting date
<input type="checkbox"/>	Project manager	natural or legal person in cha...
<input checked="" type="checkbox"/>	project name	Name of the project
<input type="checkbox"/>	Project start coordinates	latitude, longitude, altitude o...
<input type="checkbox"/>	Project type	Project type

Create an MVD from an IDM document

- Currently, this MVD generation feature only works with IFC schemas
- After specifying information units and associated external elements, click "Generate > MVD" or the MVD icon
- Select a basis IFC schema and click "Generate"



Link an ER to an MVD

- If there is already an existing MVD that corresponds to the specified ER, you can link them through the “Corresponding MVD” menu

er_ ChangeLog

er-MI-Inception -Demolition-ABW-EN-Lee-20210715- Open ER Delete ER

Same as the IDM basic information

Description Edit

Information Requirements *

Name	Data Type	Definition	Mandatory	

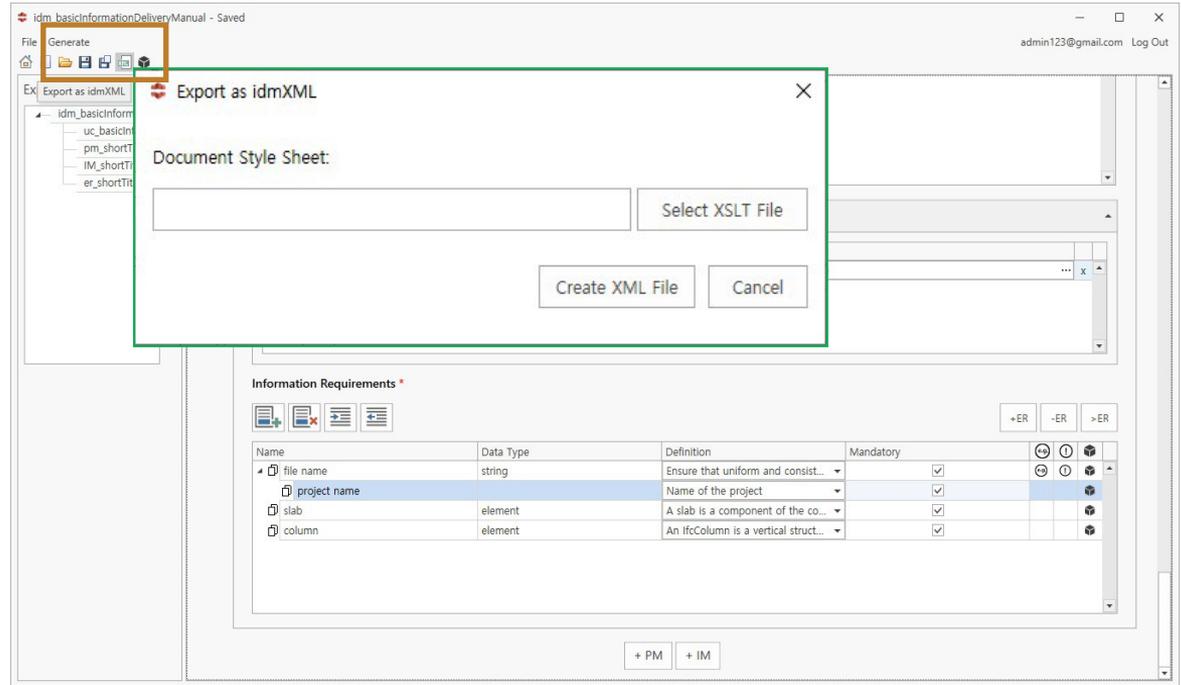
Link an ER to an MVD

- Click “+Add” to expand the “Corresponding MVD” menu
- Select the basis schema (e.g., IFC 4.0 and cityGML) that the MVD is based on
- Add a description and an MVD file, if applicable

The screenshot shows a software interface for linking an ER to an MVD. The interface is titled "er_ shortTitle" and includes a "ChangeLog" button. Below the title, there is a dropdown menu with the text "er-MI-Inception -Demolition-ABW-EN-Lee-20210715-". There are "Open ER" and "Delete ER" buttons. A checkbox labeled "Same as the IDM basic information" is present. Below this is a "Description" field with an "Edit" button. A "Corresponding MVD" section is highlighted with a green border, containing a table with columns "Basis Schema", "Description", and "File". The "Basis Schema" column is expanded to show a list of options: bSDD, IFC 4.0, cityGML, and bSDD. The "Description" and "File" columns are currently empty. Below the table is an "Information Requirements" section with several icons and buttons: "+ER", "-ER", and ">ER".

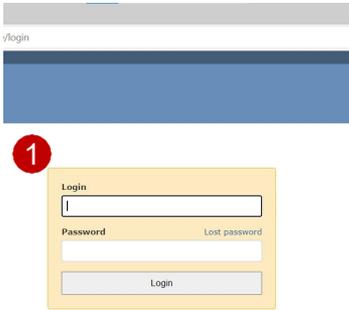
Export the IDM specification as an IDM xml File

- Click the **XML** icon in the menu bar
- Optionally, an XML style sheet (*.xslt) file may be selected, if applicable
- Click “Create XML File” to create an IDM XML package folder



Bug report

- <http://www.inno-lab.co.kr:8000/redmine/login>
- Login ID: Sign-in email
- Password: xppm (change password after login)



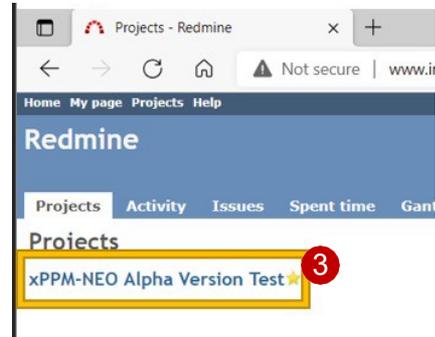
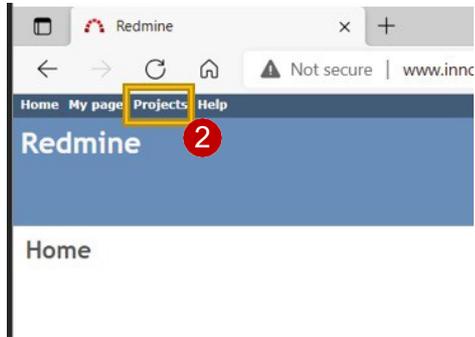
1

login

Login

Password [Lost password](#)

Login



4

Home My page Projects Help

xPPM-NEO Alpha Version Test

+ Overview Activity **Issues**

Overview

xPPM-NEO Alpha Version Test

Issue tracking

	open
Bug Report	3
Comment	0

Bug report

Once you have been registered as an xPPM-neo user, you will be registered for the “Redmine” system—a bug report system—as well.

Home My page Projects Help

Logged in as elena@inno-lab.co.kr My account Sign out

xPPM-NEO Alpha Version Test

Search: xPPM-NEO Alpha Version T... ▾

+ Overview Activity **Issues**

Issues

5 [New Issue](#)

▼ Filters

Status ▾ Add filter ▾

► Options

✔ Apply 🗑️ Clear

<input type="checkbox"/>	#	Tracker	Status	Priority	Subject	Updated
<input type="checkbox"/>	10	Bug Report	New	Medium	테스트 일감	07/16/2021 09:51 PM
<input type="checkbox"/>	9	Bug Report	New	Low	123	07/16/2021 09:48 PM
<input type="checkbox"/>	8	Bug Report	New	Low	Test	07/16/2021 09:32 PM

(1-3/3)

Also available in: [Atom](#) | [CSV](#) | [PDF](#)

Issues

View all issues

Summary

Thank you.

<Acknowledgements>

This research was supported by a grant (21AUDP-B127891-05) from the Architecture & Urban Development Research Program funded by the Ministry of Land, Infrastructure and Transport of the Korean government.