OPEN SYSTEM PLATFORM FOR OPEN BUILDING MANUFACTURING

Maseda, Jose M.

Sustainable Building and Built Environment, Construction Unit.

ABSTRACT

This paper describes the OMSP-Open Manubuild System Platform designed in the Manubuild Project. ManuBuild is a 6th FPM project that focuses on creating an Open Building Manufacturing System, a new paradigm for building production by combining an open system for products and components offering diversity of supply and building component configuration (on demand) opportunities in the open market, and value driven, innovative, efficient and safe manufacturing and assembly in factories and construction sites.

The OMSP has been designed to support all the generic construction process, including different roles and phases. The OMSP is conceived as the support and integration of the Information and Communications Technologies (ICT) tools and services that are required to support activities for open building manufacturing: design for manufacturing, offsite manufacturing and logistics and assembly planning. The OMSP is designed as the sum of ICT tools that share a common data model and provide services that make it feasible to perform the identified demonstration scenarios.

Keywords: Open building manufacturing, open platform, ICT.
INTRODUCTION

One of the fundamental problems that the construction industry has failed to address in past decades is in relation to its processes. As a result, the construction industry is very slow to innovate and unable to develop or even effectively implement new technologies particularly those cascading from technologically more advanced industries. It is necessary a deeper knowledge and control over the construction process to reach radical and sustainable changes in performance and competitiveness. *ManuBuild-Open Building Manufacturing* project objective is to achieve significant impacts to solve this problem through the development and implementation of a new ambient and ultra-efficient manufacturing based paradigm.

*ManuBuild* is a 6th FPM project that focus on creating an Open Building Manufacturing System by combining an open system for products and components offering diversity of supply and building component configuration (on demand) opportunities in the open market, and value driven, innovative, efficient and safe manufacturing and assembly in factories and construction sites.

*ManuBuild* project targets the construction of affordable, customised and flexible buildings improving the quality of life and providing better value to the customer by the manufacturing of the building process. This objective involves open manufacturing in construction, ambient and scalable manufacturing methods, and value driven business processes appropriately supported by Information and Communications Technologies (ICT).

A new model for a generic construction process has been defined to include all these concepts. One of the characteristics of the construction sector is the collaboration of many stakeholders who work together for limited periods of time. The complexity and long life cycle of products is other key characteristic. Several roles (designers, developer, suppliers,…) and phases have been identified in the model to integrate all activities and agents involved. One of the main roles in the process is the end user, as the whole process is defined to involve him/her from the early stages to the operation phase in the open building process. Main phases identified are Pre-activities (requirements setting), Design, Off-site manufacturing, On-site manufacturing and Operation and Services.

This complexity justifies the necessity of achieving holistic ICT support covering the project life cycle. A platform has been designed to support all the generic construction process, including different roles and phases. The OMSP- Open ManuBuild System Platform is conceived as the support and integration of the Information Communications Technologies (ICT) tools and services that are required to support activities for open building manufacturing: design for manufacturing, offsite manufacturing and logistics and assembly planning.

The OMSP is designed as the sum of ICT tools that share a common data model and provide services that make it feasible to perform the identified demonstration scenarios. The common data model has been defined based on the analysis of a general scenario for information requirements and the actual data models of integrated ICT tools, in order to facilitate sharing and reuse of information to facilitate open manufacturing. This platform paves the way for an open system for the construction industry open, modular, holistic, pluggable and expandable in the future. Research and developments concerning OMSP in Manubuild are described in next paragraphs.
MANUBUILD PROJECT

The goal of the ManuBuild project is to create an Open Building Manufacturing System. The project targets a radical paradigm shift to create a new European "open building manufacturing" industry transforming and improving the construction industry by fundamentally re-engineering the whole construction lifecycle process for buildings and integrating with it ambient production methods supporting scalable manufacturing and plug and fix component assembly (and production) on site as per user customisation demand.

Manubuild proposes a transition from a heavily craft and resource-based industry to a knowledge-based manufacturing industry using ambient and scalable manufacturing and "plug-and-fix" components from the open market and assembling them efficiently on site into customised buildings. The proposal of ManuBuild targets radical changes in the current ways of working of the industry.

The key elements addressed by ManuBuild Open Building Manufacturing System include open building concepts (lifecycle guides, key products, connections); business processes (value Management, process models); production technologies (fixed factories, mobile factories, site production); ICT support (open ICT system, critical ICT tools); and are supported in terms of implementation through training & education and standards.

Concerning ICT support, research in the project focus the definition an ICT architecture and tools and standard interfaces towards an open ICT system.

Processes supported by ICT tools in ManuBuild

The general process for ManuBuild is defined including the activities for every actor. This can not be considered as unique as different organisations may have their own process according with their internal protocols. The proposed process has been identified as a model that could be adapted or modified to different situations. This general process has been developed based on discussion by several stakeholders involved in the building process and was considered as a model for a more general case, then the actors and processes for the building creation to be supported by ICT tools of ManuBuild have been identified. The main processes are the following:

- Managing catalogue objects (components)
- Managing templates
- Configuration of buildings based on component catalogue
- Customisation of dwelling design based on customer preferences
- Management of building production
- Management of supply and assembly
The diagram shows the identified processes to be supported by ICT tools for the template generation and building project creation. The ICT tools that are integrated in the platform that are in charge of each process are also shown: GDL&OWL tools, design configurator, sales configurator, manufacturing configurator and logistic and assembly planning tools. These processes are broken down into activities in the ManuBuild process maps.

**OPEN MANUBUILD SYSTEM PLATFORM**

**OMSP concept**

The Open ManuBuild System Platform (OMSP) is defined to support the Information Communications Technologies (ICT) tools and services that are required to support the following activities:

- Design for manufacture,
- Offsite manufacturing, and
- Logistics and assembly planning.

The OMSP is conceived as the integration of ICT tools that share a common data model and provide services that make it feasible to perform the general scenarios identified in the project. The OMSP identifies the required exchange requirements by tools, based on the analysis of the different data models of the tools developed in order to facilitate sharing and reuse of information.
The OMSP involves the use of open methods and tools to design and implement ICT architectures that are expandable in both capacity and features. Such a platform supports flexibility in the use of hardware and software. Future feature expansion of the platform would be easier as the industry steps towards open systems and the distinction between industry tools would be changed.

As an open system, the platform supports and facilitate an integrated, streamlined construction process and collaborative business models. The ideal is a construction process that is receptive to innovation with:

- All the various phases thoroughly integrated,
- Consistent and timely information to the construction site,
- Non-adversarial, partnering agreement among all stakeholders in the construction process, and
- Integrated ICT tools that link all capabilities across all phases of the process from conception to operation.

The OMSP enables free and/or commercial services to everyone involved within the construction processes customers, stakeholders, architects, suppliers, manufacturers, producers etc. by using the tools integrated in OMSP.

OMSP functionality

The OMSP functionality comes from the integration of the various ICT tools and services. The platform enables the ICT tools and BIM applications to effectively share information and enable other new applications to successfully share and use the IFC, PMO, and XML information that the OMSP data model is built upon. The OMSP provides the means to enable such tools to effectively communicate with each other. The OMSP enables software tools or users to interact and share with the information that is needed to enable design, manufacturing and logistics and assembly planning.

The OMSP can be considered as the integration of the ICT tools that share common data and provide services that make feasible to perform the building creation scenarios.

The next figure shows OMSP functionality schema from integration of tools and services.

![OMSP functionality schema](image)

*Figure 2: OMSP: Tools and services integration.*
OMSP COMMON DATA MODEL

The Open ManuBuild System Platform (OMSP) provides the common data model to support the tools interacting. It is not a sharing of individual files but a common understanding of the meaning of the information in a file must be agreed and documented to capture the Exchange Requirements between that various processes. The information is defined using the Information Delivery Manual (IDM), which has been developed by BuildingSMART and will be published as an ISO international standard.

By having a common understanding of the information it enables the various ICT tools and BIM applications to effectively share information and enable other new applications to successfully share and use the Product Modelling Ontology (PMO) information that the OMSP is built upon. Therefore, it is a specification that will enable ICT tools to communicate to enable the ManuBuild System to be supported.

A general process map has been designed to describe the flow of activities within ManuBuild business process. It defines the sequence and the actors in the process, as well as references to the information that is required to be exchanged and/or shared by the various ICT components within the OMSP (and actors) that are described through Exchange Requirements (ER) that define the common data model. The information is shared through the Catalogue Server, which is an information platform that provides services to other tools.

The overall integrated process in ManuBuild is a complex process that is decomposed in several sub-processes. Most of the activities are supported by the ICT tools developed in the project, while others not. Activities related with finance and tender processes are performed in parallel with all the process but are not treated by ManuBuild ICT tools.

The supported activities are the following ones in the housing development:

- Strategic design
- Design
- Manufacturing
- Assembly

The next figure shows the process map diagram for building model creation sub-process from a high level perspective. This process is performed in the design phase and it is previous to the sales process. Exchange Requirements for generic building template and basic building model are defined for sharing information.
CONCLUSIONS

OMSP- Open Manubuild System Platform has been designed to support all the generic construction process, including different roles and phases. The OMSP- is conceived as the support and integration of the Information and Communications Technologies (ICT) tools and services that are required to support activities for open building manufacturing: design for manufacturing, offsite manufacturing and logistics and assembly planning.

ICT tools in OMSP share a common data model and provide services that make it feasible to perform the identified generic scenarios. The common data model has been defined based on the analysis of a general scenario for information requirements and the actual data models of integrated ICT tools, in order to facilitate sharing and reuse of information to facilitate open manufacturing.

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- Intelligent Catalogues
- Design, Sales and Manufacturing configurators
- Logistics Management and Assembly Planning

Figure 3: Process map: Building model creation.
OMSP involves the use of open methods and tools to design and implement an ICT System Architectures that is expandable in both capacity and features. The platform paves the way for an open system for the construction industry open, modular, holistic, pluggable and expandable as the industry steps towards open systems and the nature of competition and distinction between industry tools would be changed.

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