Liudmila Moskaliuk

BENCHMARK OF AVAILABILITY OF BIM-OBJECTS FOR CONSTRUCTION PRODUCTS

BENCHMARK OF AVAILABILITY OF BIM-OBJECTS FOR CONSTRUCTION PRODUCTS

Liudmila Moskaliuk
Bachelor's Thesis
Spring 2018
Degree Program in Civil Engineering
Oulu University of Applied Sciences

ABSTRACT

Oulu University of Applied Sciences
Civil Engineering, House Building

Author(s): Liudmila Moskaliuk
Title of thesis: Benchmark of Availability of BIM Objects for Construction Products
Supervisor(s): Kimmo Illikainen, Jouni Hakkarainen, Hakan Nyman

Term and year of completion: Spring 2018 Pages: 34 + 1

The implementing of BIM-technology has lately become a topical subject not only for designers, but also manufacturers have started to finance the development of BIM-objects and software as the demand is constantly increasing. This thesis is made for Metsä Wood and is a study of the market of construction supplies providers. Several firms working in wood, steel, concrete and other industries, in which Metsä Wood is interested, has been studied in this work.

To show the state of the market and compare the impact and opinions of industries, the number of manufactures were studied on the subject of the availability of BIM-objects, services and attitude to the construction industry development. The study of the availability of ready-to-use objects reveals the actuality, usability, perspectives and needs in the field of building design for both manufacturers and designers.

The state of implementing BIM by manufacturers in Finland and the needs of designers were identified. The differences between the manufacturers' approaches to the work with BIM-objects were analyzed for successful providing the BIM-objects.

The main result of the market research is a table with listed Building Information Modeling objects provided by firms in question and a structured analysis of the information received.

Keywords: BIM, BIM-objects, Information model, BIM-technology, BIM-services, BIM-market

FOREWORD

Many thanks to Jouni Hakkarainen, who gave me an opportunity to write this thesis. Further thanks go to my lecturers Kimmo Illikainen and Heidi Hedström, who helped to polish the work, to solve a lot of problems and to learn a lot of things. And finally, last but not the least thanks go to my life partner, who constantly supported me during these months, just like he always does.

TABLE OF CONTENTS

TERMINOLOGY

BIM Building Information Modeling or Building Information Model

CAD Computer-aided Design

CAE Computer-aided Engineering

CDE Common Data Environment

PDM Product Data Management

PLM Product Lifecycle Management

IFC Industry Foundation Classes

DWG Drawing. Proprietary binary file format

NBS National BIM Library

1 INTRODUCTION

Work in co-operation within a project is a matter thing for businesses. With the progress of technologies, new methods of work have come to the aid of construction industry development. This thesis narrates one of the vital problems of the Building Information Modeling technology that runs through the whole process of building. Starting from the very early stages of construction and architectural design phase to building maintenance, it influences on product development in general and in particular.

During the last decades, the new approach to the building design has gained a lot of confidence. However, different parties of a project still experience difficulties with the acceptance of the technology. Therefore, the main objective of this work is to study the situation in the industry with the question of providing BIM-objects for the construction products by the manufacturers. The thesis is an assignment made for Metsä Wood which is a global provider of wood products for construction and industrial needs.

Taking into account theoretical benefits of the technology, this study concentrates on the products and services that are already being provided, the manufacturers' treatment of the subject and the designers' thoughts of the situation as they are the direct users of the objects provided. The intelligent way of distribution of responsibilities and teamwork efforts are the base of every project demanding the understanding of the benefits from every participant. Modernization of methods because of intelligent use of information defines the overcoming stagnation of the progress in the construction field in Finland.

The studies and analysis in this thesis are limited to a list of manufacturers provided by the supervisors, to the quantity of the companies that responded to the survey and the author's limited experience. The main goal of this analysis is to create a general picture of the market situation as every manufacturer operates according to their own needs and business models and there are still not enough officially fixed regulations for all the new technologies to follow.

2 BUILDING INFORMATION MODELING

2.1 Building design methods

Building has always been a very complicated, labor-intensive and inter-disciplinary field that constantly involves a huge amount of cooperation and requires unquestioning attention to detail as the human lives are at stake. The evolution of engineering science and technologies have brought a lot of new possibilities, but that means also a complication of the pre-construction stages.

2.1.1 Common methods

Ways of construction model implementation, which is based on graphic interpretation of the object, is usually called by the definition “Traditional design method”. Traditional 2-D drawing used during centuries is formed by lines and other graphical elements, which themselves do not contain element information, but grouped drawing objects that humans interpret as filled with information. Computer Aided Design (CAD) programs, starting from the mid 70’s, became the best friends with construction designers and architects that allowed to simplify the process of creation of the drawings itself and began to provide more functions for technical documentation creation. However, the general complexity of the business remained the same.

Nowadays most of the final drawings are produced with computer aided design programs, which not only give the possibility to create the 3D-objects for visualization (basic 3D solids, which do not contain any information about the attributes of an object). Eventually programs provide a lot of engineering and physical calculations.

The main problem in the projects based on 2-D and simple 3-D visualizations then and now is still that the project information transitions between humans, programs and sources influence data loss and complicate project control. The use of different programs, document formats and modeling styles often makes drawings difficult to use in many important stages, as for example simulation programs.

2.1.2 Innovative methods

The innovative design methods mean more intelligent way of product design and, as a result, more productive project data management. These methods are designed to make the total building life cycle management better organized and more controllable.

The process that allows to create a model of the final product, every element of which contains a full data packet describing material and geometric properties and attributes, is called Information Modeling Design. In construction engineering it is Building Information Modeling (BIM) process that involves the creation and management of digital building representations.

Information modeling design supports architectural and construction design objectives, pools resources and combines efforts in order to create multi-functional product.

2.2 Information Modeling

Product Information Modeling (Building Information Model) is a complete, integrated way to control building project data using a digital format. In addition to human interpretive reading, this format of information model is intended for data organizing and interpretation by computer programs. (2, p. 8)

The basic objectives of product modeling are to standardize the design process related terminology, improve methods, separated design processes and entire building design process. In addition, a main mission of design workflow that is based on information model is to develop the quality and productivity of building processes as well as produce a useful and powerful tool for life cycle management and customer services. (2, p.7,11)

According to the main idea, the use of information models in design and planning should reduce the problems on the site as various design and engineering fields are coordinated in advance. Nevertheless, BIM-information models are not created as a substitute for drawing or other documents. The precision of the

model is essential as well as the readability of drawings that can be formatted to match the drawing standards were appropriate.

To solve the general problem of data losses and product auditability by the non-technical stages of the project, the IFC (Industry Foundation Classes) format standard was created. IFC was developed by International Alliance for Interoperability (IAI) for ensuring the coordination between different software used in construction industry.

There are several BIM-design requirements and standard documents that describe the BIM-based project stages, process of making the information model and standardize objects marking and information transfer details:

- Common BIM requirements (7)
- Modeling instructions for designing prefabricated elements (5)
- IFC Base Standards (8)

All the international Finnish regulations existing can be found on the buildingSMART International web-page. (9)

2.3 CAD/CAE programs

There are two common ways to produce building informational models. The first idea involves creating a model from 2D-drawings. While 2D-plans are created using so called traditional CAD-programs, as CADS House for instance, the program builds in the object related information and produces the 3D IFC-format model.

Another technique is to use the programs, which requires managing with BIM-objects. The design process happens in 3D-enviroment. Being opposite to the method described above it allows producing 2D-drawings from created 3D-model. These programs are commonly named as “full-blooded BIM-software”. (3, p. 40)

As an example, on the following figures (Figure 1, Figure 2) is shown a 3D model made using Revit software, that is based on the work with BIM-objects.

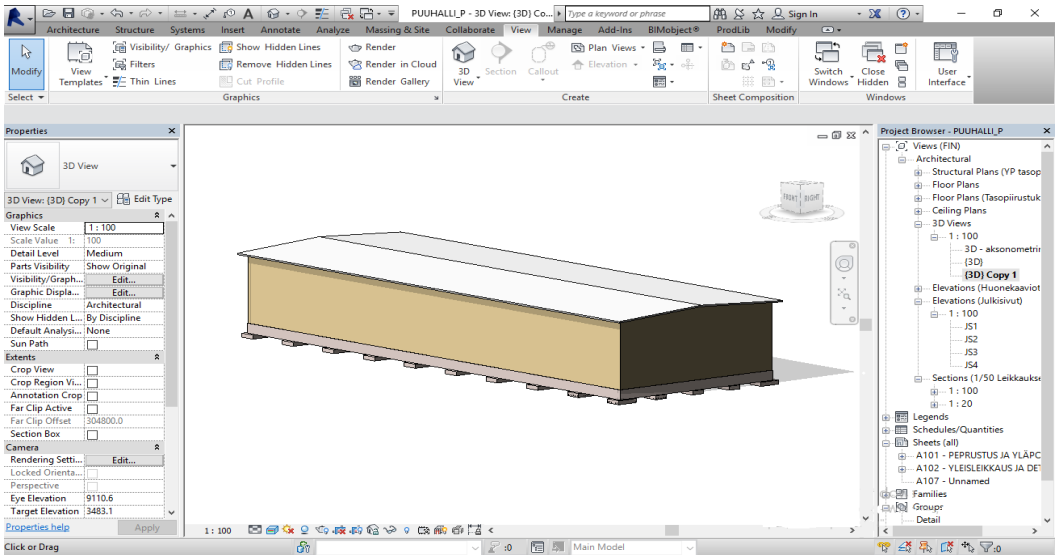

FIGURE 1. Example of the 3D- model in Autodesk Revit (17)

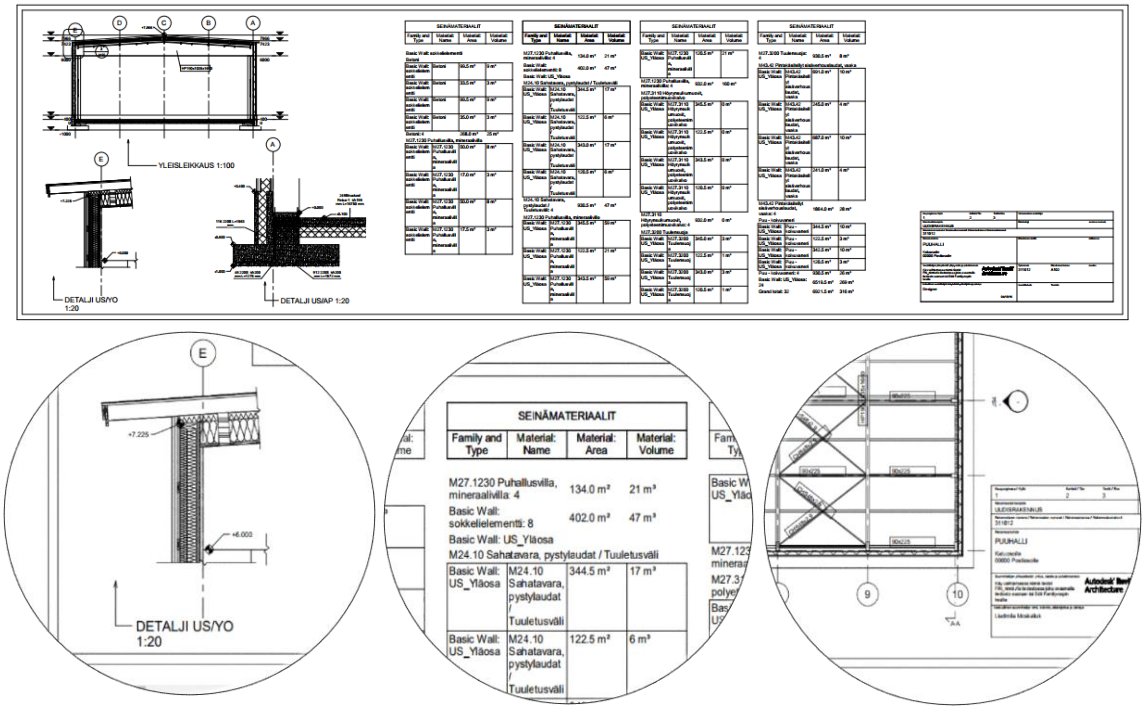

FIGURE 2. Example of drafting from the building information model (17)

A design software is usually at the very center of the BIM-process. Improving the usability of 3D-design BIM-based programs add such unique specifications to an extractable object as material properties, instructions from a manufacturer, installation and usage details, cost and many more specifications. Being object-orientated, BIM-modeling combines, spreads and manages data between not

only single project sections, but also gives a great opportunity to share data through the internet, which helps to create a huge knowledge-sharing community. (4, p. 16-17)

In addition to the main CAD/CAE-programs, manufacturers develop applications intended to be used with particular software. Most of these tools are free for download and allow to design structures using the products of the suppliers more easily. Web Calculators and simulators help designers not only to solve the stated problem, but may also be an advisor and promote the products.

The most popular software used for working with BIM varies between providers and, furthermore, between designers according to their needs. Surveys (12,13) reveal that designers prefer Graphisoft ArchiCAD and Autodesk AutoCAD while manufacturers mostly provide digitalized products for AutoCAD, Revit and Tekla structures. Taking into account the need of use of different formats for the different cases, the manufacturers that actively develop BIM-services are constantly extending the number of formats.

BIM levels

BIM levels (Maturity levels) is the range of levels defining the criteria required to be deemed BIM-compliant. Being defined from 0 to 3, these levels are describing the steps of implementation of BIM into workflow. The definitions of BIM levels are:

Level 0 BIM — 2D CAD drafts only, paper and/or electronic prints for output and distribution, no collaboration.

Level 1 BIM — Combination of 3D CAD-models for concept work and 2D for drafts and documentation. The team members do not share the models, but the common data environment (CDE) is used for electronic data sharing.

Level 2 BIM — All project team members use different 3D CAD-models and can work on the shared one, but not necessarily. The essential criteria for this level is data exchange between project groups,

	therefore every software is required to export to the common file formats as IFC.
Level 3 BIM	Complete collaboration between all the project members by using general shared building information model. Known as “Open BIM” (19)

With the complexity of the workflow, the software also needs to evolve. According to the Finnish BIM Survey 2013 (1), International BIM Report 2013 (11) and the National BIM Report 2017 (10), designers had a lack of confidence and understanding in using the CAD-software in 2013. Mentioned in the free comments, designers found CAD-programs, that are orientated on the professional users, too difficult to use, as the interface was not quite user-friendly and so 3D-modeling needed to be developed. Till the year 2017 a majority of survey participants described themselves as confident in knowledge and skills in BIM (55%) and only 23% are nor confident.

By the present time, software changed, became more available to unprofessional access, got more user-friendly interface and nowadays CAD-programs are being taught in universities as one of the compulsory courses. This means progress, but there is still a lot of things to learn, accept and develop.

3 BIM-BASED CONSTRUCTION PROJECTS

Unlike the traditional construction projects, the BIM-based projects are “model-centric” and therefore the adoption of BIM into mainstream practice has influenced not only on the process of creation and realization, but also created a new way of looking at how we work in general. Having loads of information makes both a manager and engineer think of new ways of its realization.

The steps and organization of a project lifecycle are evolving. Nowadays BIM-based projects have original process organization that requires and at the same time creates the conditions for better cooperation through teams and departments.

As the project managing is being renovated, there has been developed the concept of the team that continuously work on a project. It varies during the project lifecycle. Design phase is traditionally led by an architect, whose role is also the coordination of the team members and consultant engineers. Using project database, the architect controls many stages in real time and checks how the client’s wishes are being realized. The following figures (Figure, Figure 4) show the evolution of the design stage in project organization. (4, p. 33-35)

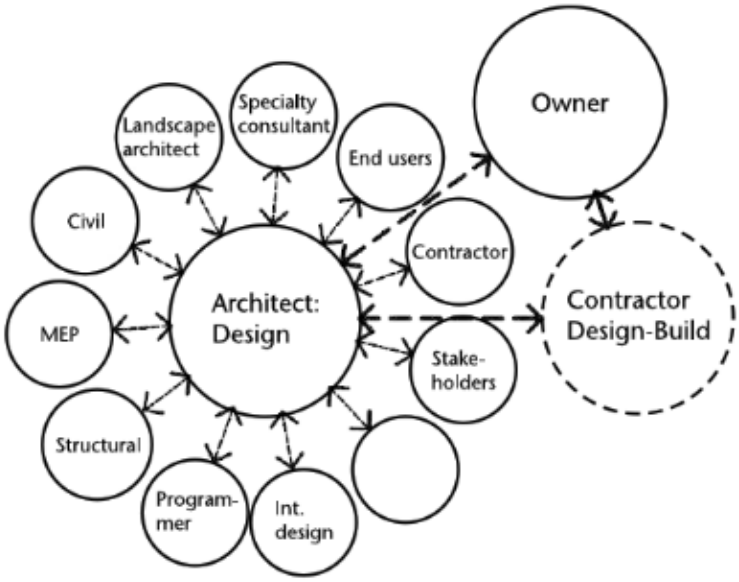

FIGURE 3. Pre-BIM design phase team (4, p. 34)

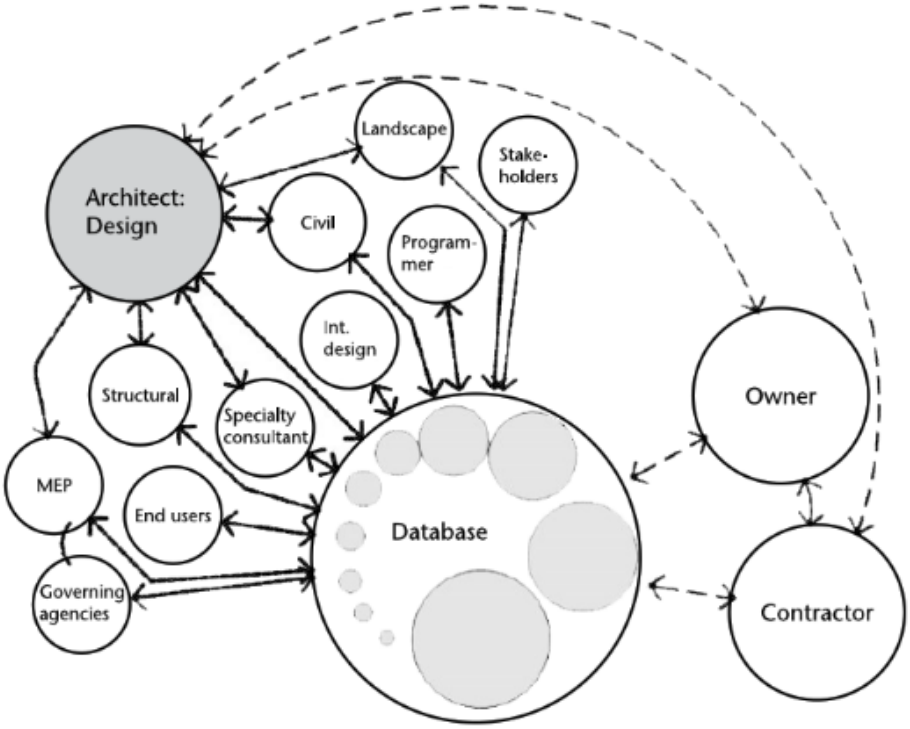

FIGURE 4. The design phase team organization (4, p.34)

3.1 BIM-objects

As the database is a central data resource and a main benefit of the BIM-projects, the quality of data organizing becomes essential. The question of an intelligent way of data sharing should not only be solved between sections and stages of a project, but also between users and providers of BIM-content.

Playing a role of structure elements in the Building Information Model, the objects themselves are the main data keepers.

Every BIM-object takes its start with some original documents such as 2D-drawings (either digital or hand drawn). In addition to redrawing the objects, some companies may provide the 3D-scanning of the already existing elements. Designers use the manufacturers CAD/CAM/PDM model data to make an object that fits for building design software. In order to create a smart BIM-object as a representation of the real physical object, designers fill the geometry with information from product specifications. Besides the apparent information about

the materials and textures of an element, the creators can also program the functions if needed. (6)

BIM-objects are created to be fully usable in IFC-model, therefore every unique object has to have correct definitions to work properly in a complex. While modeling the elements with specifically intended modeling tools for each element in question, the software usually define elements automatically: a column designed with the column modeling tool is marked as a column and has a table of information to fill in, which is specified for the data needs of a column. (5, p. 6-7)

3.1.1 Example of a BIM-object filled with data

A structure of properties and a variety of parameters of objects always vary. For instance, there may be such modules of properties as dimensions, analytical properties and general information. Under these modules there could be defined many different parameters, disclaimers, standards and many other things that may be useful to exchange the information. Individual values of parameters can be defined manually. In the picture below (Figure 5) is shown an example of the parameters defined for the door object in Revit.

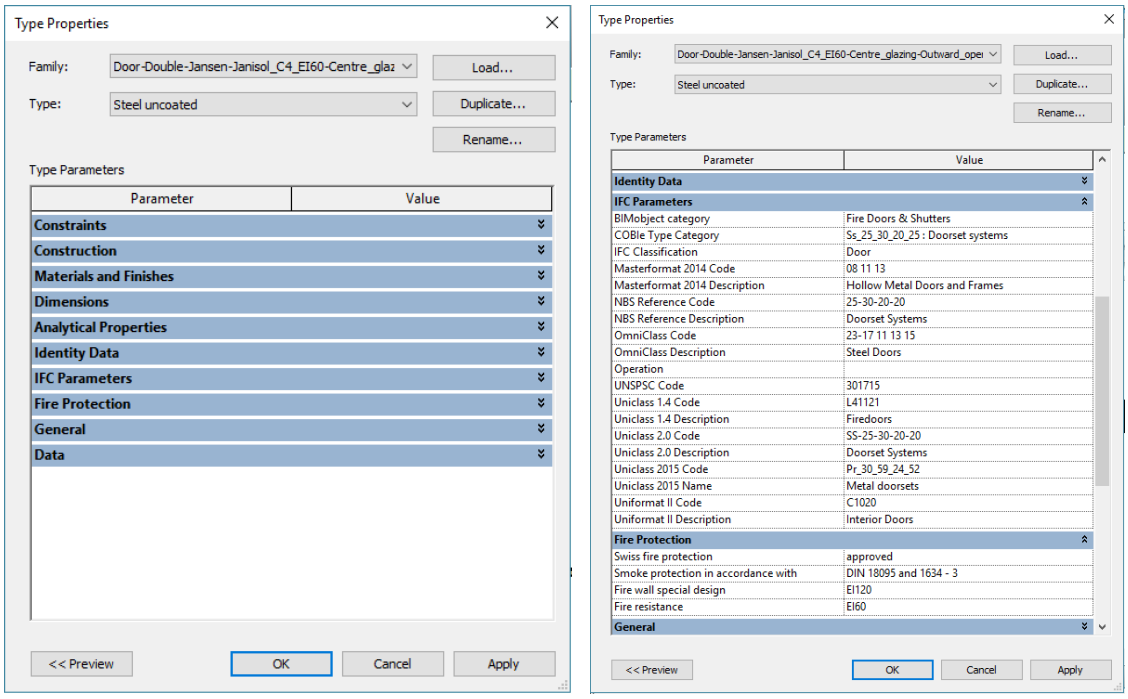

FIGURE 5. An example of properties of an object in Revit. (17)

In other cases, there may not be many parameters defined. It is very common that only identity data and general dimensions and materials are specified. In these cases, manual definitions are the only way to specify the needed parameters. For example, properties shown in the following figure (Figure 6) do not contain any information for the fire rating of an element. That could be easily added manually.

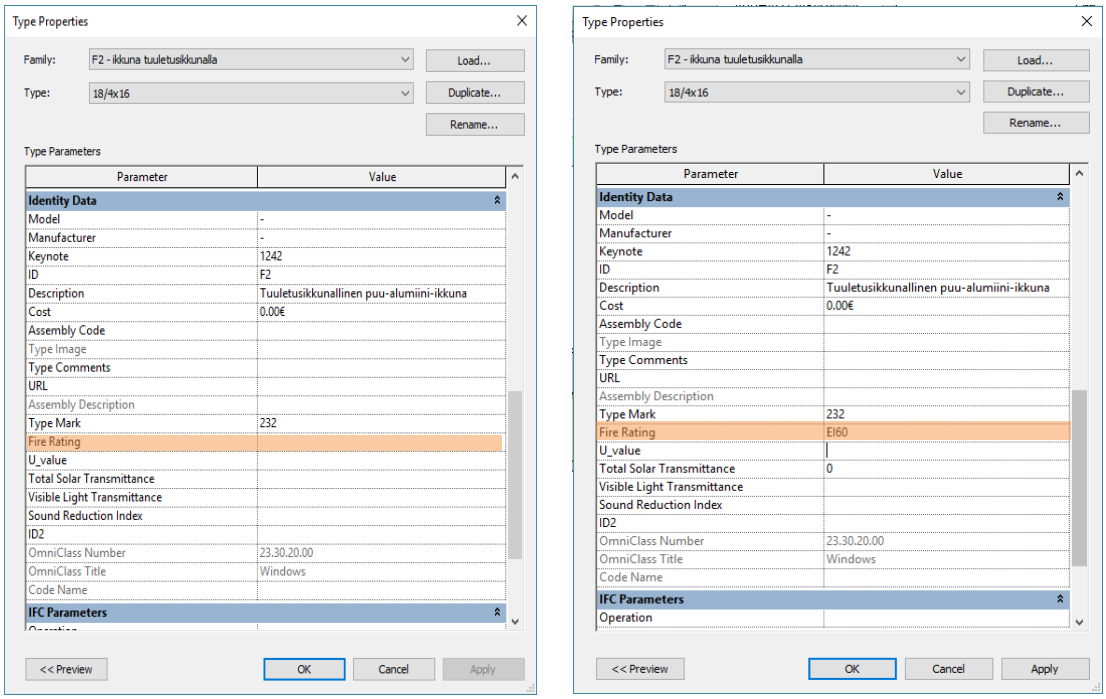

FIGURE 6. An example of the fire rating manual definition for window-object (17)

Considering the fact that during the design phase of a project there may be loads of completely unique objects, the development of an object is often a team work including both manufacturers and designers. These objects may lately be used in other projects or become a prototype for the new elements needed. Creating the objects scrupulously describing all the details from the very beginning, is a key to productive use of work time.

3.1.2 Specifications

Changing with implementing of BIM-technology, workflows need also the digitalizing of the services. Printed catalogues and brochures are becoming past. All the product information and its variations are now included in BIM-objects, linked data, online PDFs and web applications.

Well-structured information is the thing that occupy the minds of BIM-objects creators and, in the first place, manufacturers. Improving of the software tools now is equal to improving and extending their services. In the different parts of the project different information is needed, so the market of BIM-content in 2017 needs to provide not only a digitalized portfolio of the products, but also think about all the technical data that manufactures have within specifications, manuals and certificates.

Solving the problem stated above, there is a good example of a method, that has already become a common way of working with specifications. Specification services developed by NBS (National Building Specification) have already become the principal method of specifying in the UK with over 6,000 manufacturers registered in service. Manufacturers' technical data is linked with the different services and use of the specification products delivers the information from the cloud directly to the concrete user's work and current needs.

Meanwhile in Finland, designers hold the opinion, that there is no need for such a developed system for specifications. Despite the fact that they state the problem of poor data management, still the requests for structured data and specific BIM-objects come from different designers and planners so that neither of them wants to hold extra data as they work in different software.

3.2 The market of BIM-objects

The picture of the market of BIM-objects is still changing and evolving, but it already is very clear, that the supply of digitalized products is a new branch in construction business. The leading position in using BIM takes UK, where the use of the information models is supported and even forced by the Government by releasing the BIM-mandate. Despite the fact that Finland is often become an

initiator of many innovations in different fields, the construction industry here still remains conservative. Even if there are all the conditions to improve the industry in total, not having the structural directions to evolve do not harm the work, but significantly slow the progress.

There is no clear methodology of producing the BIM-content in Finland: every manufacturer or supplier decide about their services based on many criteria such as experience they have with their clients, budget and human recourses and, the most important, on their product type. The principal point here is a streamlined dialog between producers and users of the BIM-objects.

The cooperation of designers and manufacturers has a great impact on manufacturers' and suppliers' success on the market. The position of manufacturers in the building projects is not very strong as the supply requests are based on winning a competition. Therefore, manufacturers need to create all the conditions for intelligent data providing. "Developing product-service systems and influencing construction projects' procurement decisions" research (16) shows that the most common problem about the construction projects, according to the designers' interviews, is that designers constantly think of the creation of a brand new and unique building. For the construction of such buildings there is no fully suitable products or solutions. Therefore, the already existing products can be used as a base for further product development. (16, p. 62 – 64)

The main questions in creating a BIM-object are the amount and quality of the information included. Therefore, centralized, well managed and up-to-date data-collections is the theoretical key to the productive use of the BIM-objects. Practically, on the other side, the goal is difficult to achieve.

Although every design software now is being created to support the IFC-format, depending on the use case, the object is managed in the original format of a software. In this occasion, all the libraries related to the project must be also provided. Therefore, in order to successfully provide BIM-objects for their products, the suppliers need to create objects in many different formats. Together with increasing number of objects it also influences on the amount of support work that a collection needs.

3.2.1 The libraries of BIM-objects

Although many companies have digital models of their products nowadays, the data management still remains a problem. Without enough human resources it is quite hard to take into account and organize all the possibilities and advantages of the BIM-objects, keep the portfolio updated and be competitive in this developing discipline. However, as it happens with all databases, there are institutes that work on bringing the order to the construction industry.

There are several ways by which suppliers provide BIM-services. Some manufacturers use their own recourses to produce BIM-objects (and BIM-content in general). Others prefer to cooperate. Cooperation with IT-suppliers and other manufacturers (same or different industry), in the question of creating BIM-objects and supplementary BIM-tools, is already a strongly well-set-up way of working. Nevertheless, designers do not hurry to install a pack of additional tools, but they stay faithful to the most popular method of getting the BIM-objects – creating the objects with the project needs and then reusing the accumulated collection.

According to the Finnish BIM Survey 2013 made by NBS, buildingSMART and The Building Information Foundation RTS in Finland, top five ways to get CAD objects were: provided with software (84%), created and reused within the organization (56%), provided by manufacturers (38%) and used the available free online objects (36%). (1, p. 13 – 15). During the past years, the picture did not change much. According to the latest NBS National BIM Report 2017, the most common way to get the BIM-objects is the creation of the objects with the needs of a project and reuse of the objects within the organization (66%). Second popular sources are getting objects from the manufacturers and using the organization own inner library (58%). However, there is another new and advanced way for intelligent BIM-data providing: BIM-product libraries. (10, p. 23)

Although using the in-house libraries may seem practical for the workflow, it certainly brings difficulties with out-of-date information. Therefore, BIM-libraries naturally are the business that provide creation and management of digital portfolio of a manufacturer. These libraries are central, up-to-date and free-to-use

resources of BIM-objects and other services purposed to produce better data management.

Product libraries are the connection between suppliers and building designers. For manufacturers the use of library services brings organized and well managed data portfolio. There objects are being created, renewed, sorted and now can speak for themselves and promote the manufacturer to the designers while they are searching through the content. Digitized portfolio, that is in the open access, free for download and kept within the unified database of BIM-objects, do the marketing for the manufacturer to the potential clients right through all the levels of construction industry as they are available to the student access.

On the other hand, BIM-libraries for designers are not only the source of BIM-objects, but also a free internet platform for learning and experience exchanging. Working with BIM libraries, designers are getting a whole pack of information from the world of BIM. (15)

Summarizing the work of BIM-libraries, it is hard to overestimate the potential of this business and its benefits as a communicator between suppliers and designers. It brings individual benefits for different fields of construction industry, create the content and stands the new trends for the competition.

3.2.2 Using the libraries

The principals of usage of the international libraries of BIM-objects have been simplified to its finest and at the same time the services provide a whole collection of BIM-technology tools. The following pictures (Figure 7, Figure 8) shows the principle methods of work of the libraries.

Starting from the home page, the service provides the choice of several tools. Using the collection browser, there are several filters available. Sorted out by

many criteria, the needed object can be easily found.

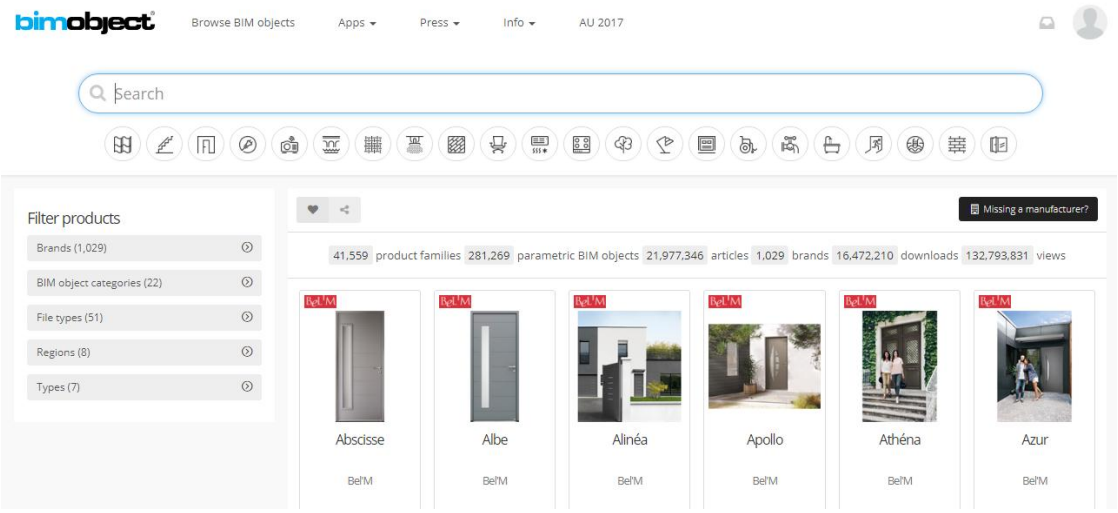

FIGURE 7. The home page of the collection browser of the BIMobject library (15)

The particular attention attracts such filter as “Regions” where local collections of manufacturers presented can be easily sorted out. Every product (object) presented has its own profile.

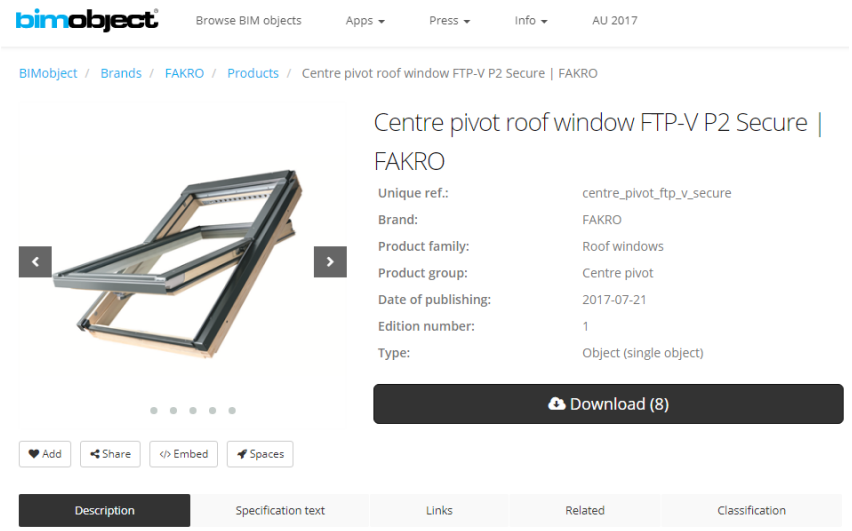

FIGURE 8. The chosen object profile in the collection of the BIMobject library (15)

The product profile includes descriptions, links and technical data related to the product. In addition, it has information on the BIM-object itself, showing what king

of object or object-family it is and what software it is made for. By downloading the object is added to the project or creates an additional objects-library depending on the software in use.

Another option of browsing the objects is the applications provided by the library services. A good example of this case is a ProdLib library of the BIM-objects for construction products. By downloading the application and finishing the registration it allows to install the updated collections filtered by the manufacturers. In addition to the brochures and technical data, the product profile may allow to choose the geometrical or material properties. The figure 9 shows an example of the product profile.

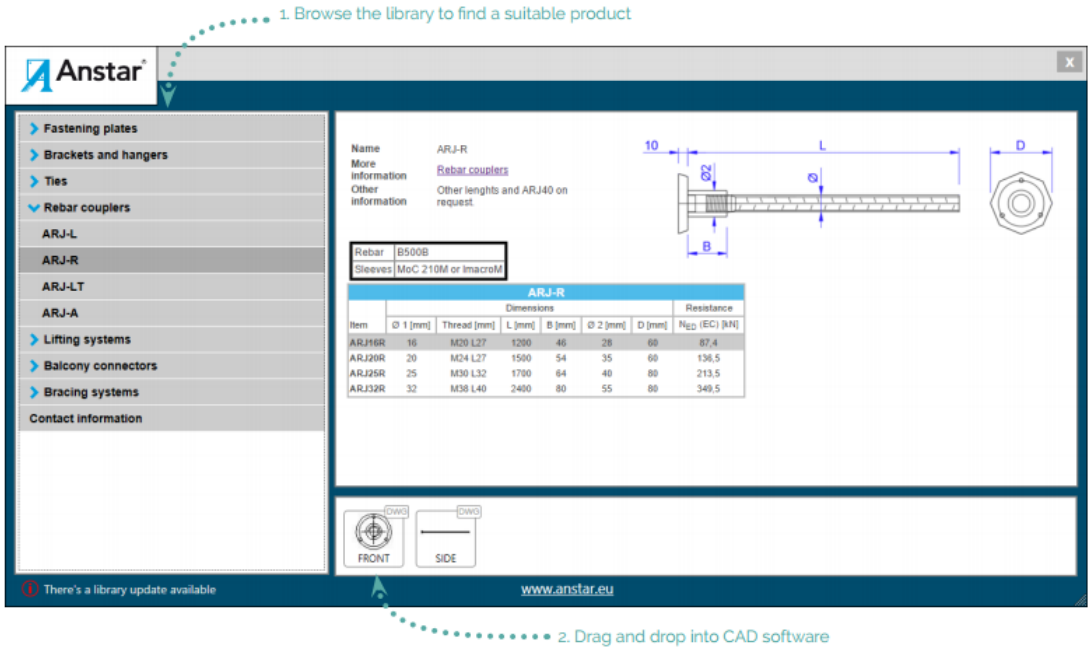

FIGURE 9. An example of the object profile in the ProdLib library (14, p. 6)

4 THE AVAILABILITY OF BIM-OBJECTS FOR CONSTRUCTION PRODUCTS

4.1 The objects of studies and research methods

The last research of BIM-use in Finland took place in 2013 and the main question at the time was not exactly the use of information models, but the adoption stage, the interest to the new technologies and the forecasts about the popularity. Since then there has been no more question about adopting the BIM-technologies when the absolute majority of people involved in construction industry is aware of BIM-benefits. In the year 2017 the main problem that occupies minds is the developing of the services provided for successful use of BIM-technologies.

The main target group of this research is manufacturers. The study discusses what BIM-objects already exist, how the suppliers manage existing data and their opinions on the services provided.

To determine benchmark group of manufacturers, has been created a list of 38 companies studied during this work (Appendix 2). The list includes companies divided according to industry one works in: wood, steel, concrete and other construction industries such as accessory and machinery industries. The companies are mostly leading manufacturers in their fields. However, the considered suppliers vary in scale, that allows to know the whole picture within the industries.

Using the basic internet research, the BIM-objects available in public access was collected to the summarizing table with all the links to the concrete sources of information.

Another method of research used is surveys. To find out principal positions on the question of providing the BIM-data, the manufacturers were asked several questions about the services provided and their opinion on the market situation in general (12). As the subject of the study is also the market of BIM-objects in general, it is clear that another big part of the objects studied are designers, who are the straight users of the provided BIM-objects and other services (13).

By asking both designers/planners and manufacturers about the co-working methods and problems, the stage of using BIM-technologies can be analyzed and the possible problems can be stated out.

In the next chapters the availability of BIM-objects will be considered and analyzed according to what products are presented, how they are distributed and how companies work with data management in general.

4.2 Summarized table of available BIM-objects

For the purpose of creating a summarized table of the BIM-objects all web-sources of the companies in question were studied. The process of collecting ~~of~~ the information started with what ordinary user is able to find in public access. The first stage was to collect and distinguish BIM-objects provided by the manufacturers in the table.

The table presents only 18 of 38 manufacturers as there is no other information in public access or the company turned down the proposal to answer the questions. BIM-objects are filtered to reveal the groups of products that manufacturers are ready to deal with. The table contains information about the formats of the BIM-objects presented on the market and there is also ~~the~~ additional information about the methods the suppliers spread the information and the links to the sources of information, that mostly are web-pages of the companies.

The numerous specified software applications created by manufacturers for design, calculations and simulations were not included. However, they have a particular meaning to the manufacturers depending on their specification.

Right after all the objects in public access were collected, the next stage was about narrowing to the industry and collecting the responses on the availability of the objects for the purpose of revealing possible objects available only by request. During the work with open resources and association with manufacturers' representatives, it became clear that the suppliers do provide needed BIM-data on demand, but do not hold fully updated BIM-objects for providing only by request. As these objects are created and updated according to the project

needs, their characteristics will be described, but such objects are not included into the table.

As the table contains links to all the sources used in its creation, they are not mentioned in the report.

4.3 Objects on the market

The situation within the industries is more or less homogeneous: some do develop BIM-objects, some not. The availability of BIM-objects varies with the product type. There is a great difference between the industries in terms of how customized their products are. The industries specified in steel, construction accessories and furniture can produce very limited in customization products such as different kind of joints and furniture. These industries have already done a great work and the number of manufacturers successfully provide well working source of up-to-date data. Competing with leading manufacturers, the trailing behind companies in these industries have also already done a step into the digitalizing or at least show a lot of interest in developing their services.

In general, there is also the question about the quality of the provided objects. The main part of the CAD-objects available for downloading from the open internet resources are represented in DWG-format, that cannot definitely be defined as a BIM-object as they do not hold the information required. The overwhelming amount of these objects are not even 3-dimensional. However, in addition to the DWG-models, in most cases the actual BIM-objects are also presented. They are designed for Autodesk Revit, Graphisoft ArchiCAD and other leading software in use, which are fully integrated with BIM.

The industries where products are fully customized for every project, such as concrete and wood industries, do not provide many BIM-objects, even the objects of the module-solutions or construction-solution products. In these cases, one of the solutions is to create an additional software that will calculate the placement of the products like facades, for instance. Another way to get customized elements done is to have a group of element-designers whose job is to design the element according to the project needs.

The wood industry presents such BIM-objects as doors, CLT-panels, mullions and the interior and outdoor furniture. In addition, there are several calculators that help to design, for example, the measures and quantity of CLT-panels needed. So, with the exception of individual cases, the collected BIM-objects, provided by the suppliers in question, are structural units. The individual cases mentioned have the particular collections of structural solutions, that in the assembling create an almost finished structure-model of a building as they have been designed as parts of one modular building. However, these modular elements are presented only as DWG-drafts of joints.

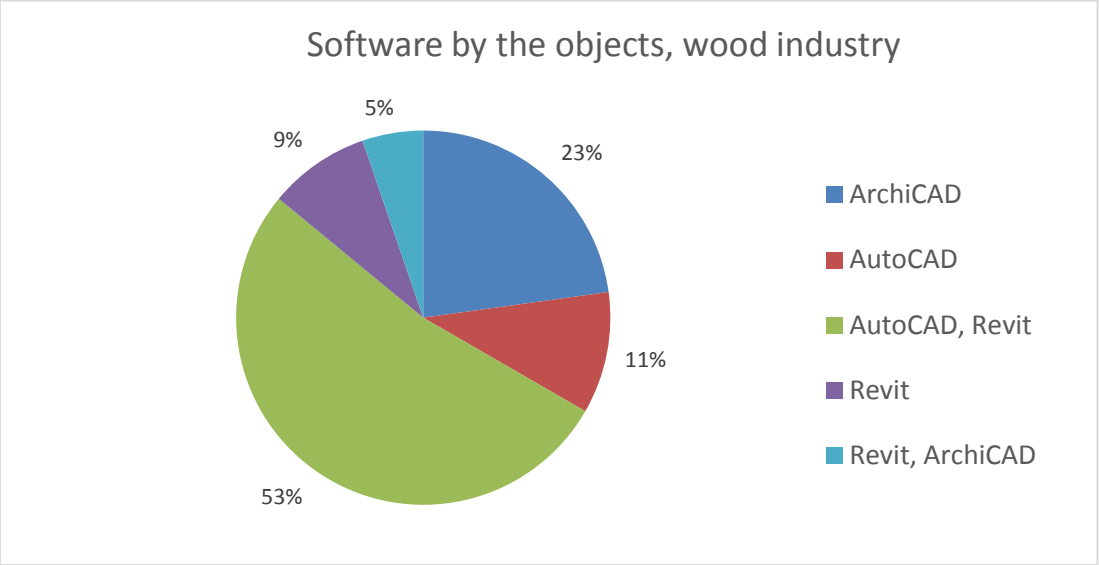

FIGURE 10. *The diagram of software grouped by the objects* (Appendix 5)

According to the table of collected objects (Appendix 5) there are 7% of wall-structures presented as 3-dimensional BIM-objects for ArchiCAD and Revit software. Also, as ~~it~~ shown in figure 10, nearly 53% of the objects created for the AutoCAD – Revit grouping, all of that are furniture, where the AutoCAD objects have both 2D and 3D models. 11% of all objects collected are 2-dimensional structure solutions.

The steel industry provides much various collections of unique BIM-objects. In this case, there are, for instance, welded and bolted connectors and connection systems for concrete elements and pre-cast walls. Sandwich-panels, façade claddings and panel flashings are pre-cast elements for which, in addition to connections, there are also the BIM-objects of corbels. As for non-structural

elements, suppliers provide models for doors, safety walkways and emergency exit equipment. The next figure (Figure 11) shows the distribution of the collected objects by existence in the different formats. The software is grouped according to one particular existence of an object.

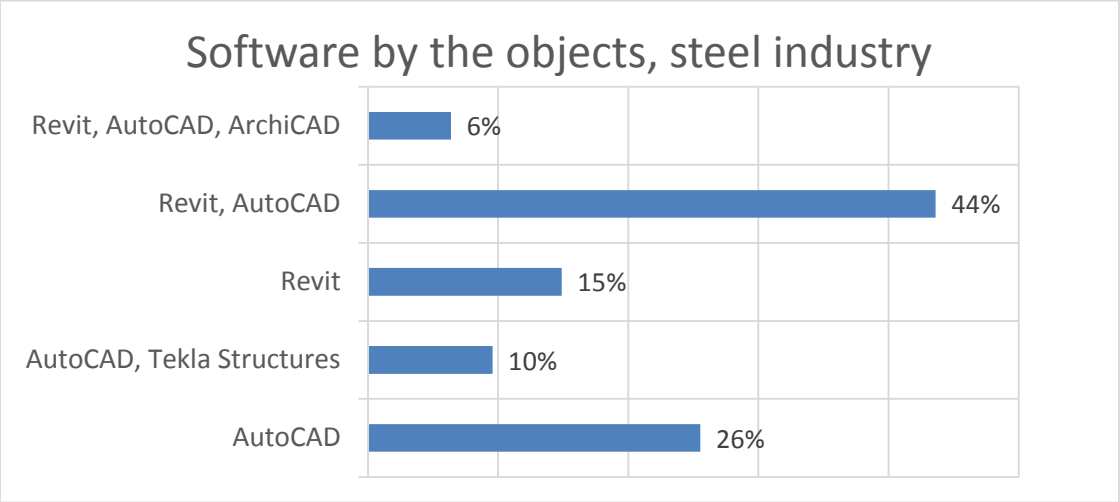

FIGURE 11. *The diagram of software popularity for the steel industry* (Appendix 5)

As shown in the figure above, almost all the objects are presented in DWG-format. In addition to that, the suppliers prefer to create models for Autodesk Revit, in which grouping with AutoCAD is the most popular to preset one object. However, in spite of the great number of available objects in steel industry, where 6 of 7 suppliers do provide BIM-objects, 49% of models are only available as 2-dimensional and 36% are available in both 2- and 3-dimensional formats, which are connections, lifting systems and architectural non-load elements. The 15% left are available only as 3-dimensional and there are such products as claddings, steel profiles and sandwich-panels.

Within the concrete industry there are very few BIM-objects available. Only one of four manufacturers of the concrete industry studied has a little number of objects, all of that are provided only in DWG-format. Nevertheless, all the manufacturers studied take immediate part in creating and using of the building information model. By the year 2017, some of the manufacturers currently use the BIM 4D technology and plan to implement the BIM 5D by the year 2018, improving on-site work with using less manual methods. The manufacturers of

the concrete elements also create specific programs providing better solutions for quality control.

Concrete elements are the kind of construction elements those models do not need a lot of additional specific information to be fully integrated. Every BIM-integrated software has special built-in tools to create a concrete element, a pillar, for instance. Concrete elements have limited customization in question of material properties, so the creation of the particular element is reduced to the adjustments of the geometric parameters. Considering that, creation of the unique BIM-objects by manufacturers may have no practical need as it also is with steel beams or pipes for example. However, within the industry in general, there are some examples of standard pre-cast elements as concrete poles for power lines.

The machinery industry that provides the equipment for construction project realization, has been working on the product supervising for a long time by now. During the last few years they constantly introduce methods of automation supervising state of the products while the machines are being used. By cooperating with the universities, manufacturers create a strong base for the future projects and experiment with trekking-technologies. They collect numerous factors of work that is done by the machines by implementing the life cycle control. These control-systems allow to service the machines effectively, that improves efficiency of business.

In this case, there was no objects provided by manufacturers found. However, there are resources that has been created as a community for designers. Within such communities, designers share the unique objects they make. There can be found numerous models of cranes and other types of machinery.

To the group of “Other construction industry” were included manufacturers specialized in insulation. Not much variety of the products can be found: insulation board models, wall, floor and roof structure types and solutions for basement, and ceilings. The following diagram (figure 12) shows the percentage of objects presented.

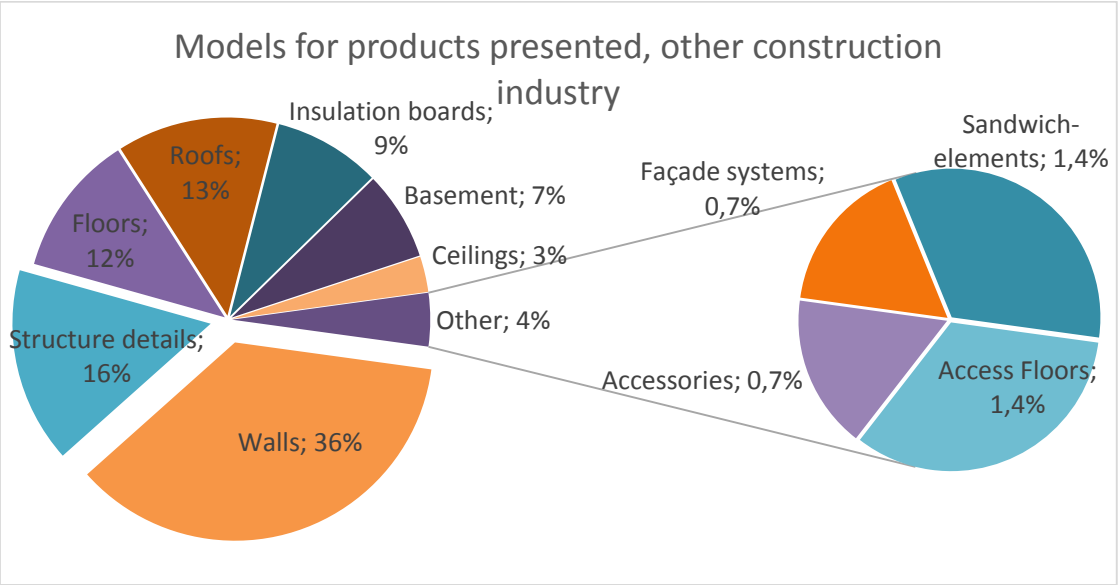

FIGURE 12. *The diagram of BIM-objects for products provided by manufacturers specialized on insulation* (Appendix 5)

It can be noticed that situation is the same as in wood industry: more than a half of all the available items are structure solutions or types, that again presented only by 2-dimensional DWG-format files. There, only about 4% of wall elements has 3-dimensional BIM-objects for ArchiCAD and Revit software. Others available only as structure solutions with DWG-format. Among all the items, only 14% are 3-dimensional. However, 4% of the objects available for the fully BIM-integrated software are available directly in IFC-format, that is almost unique.

The field of interest of this research includes also a non-construction industry such as accessory. The only manufacturer specializes on furniture. Here, the collection totally consists of 3-dimensional models for the office furniture and is oriented on interior designers as the formats of models are used by ArchiCAD, AutoCAD and 3Ds Max software.

5 DATA MANAGEMENT AND DISTRIBUTION OF THE OBJECTS

Although many of the suppliers has a portfolio of BIM-objects and take care of it well, there are a lot of difficulties with providing BIM-services for construction needs. The prevalence and quality of the maintenance are varying between the industries.

The BIM-objects and the general involvement into BIM-technology is being actively advertised by all the manufacturers and suppliers. However, not so many companies constantly work on public collections preferring to develop the product directly with the client.

5.1 Collections presented

As it was stated above, there are a lot of ways of providing BIM-objects or other BIM-data. Manufacturers in question have such formats of collections as collections on the manufacturers' own web-page, in the international BIM-libraries and, in addition, some inner collections consisting of the objects used in previous projects. Among the collection available in public access, the main part of BIM-objects collected were found on the manufacturers' web-pages. The following diagram (figure 13) shows the popularity of sources.

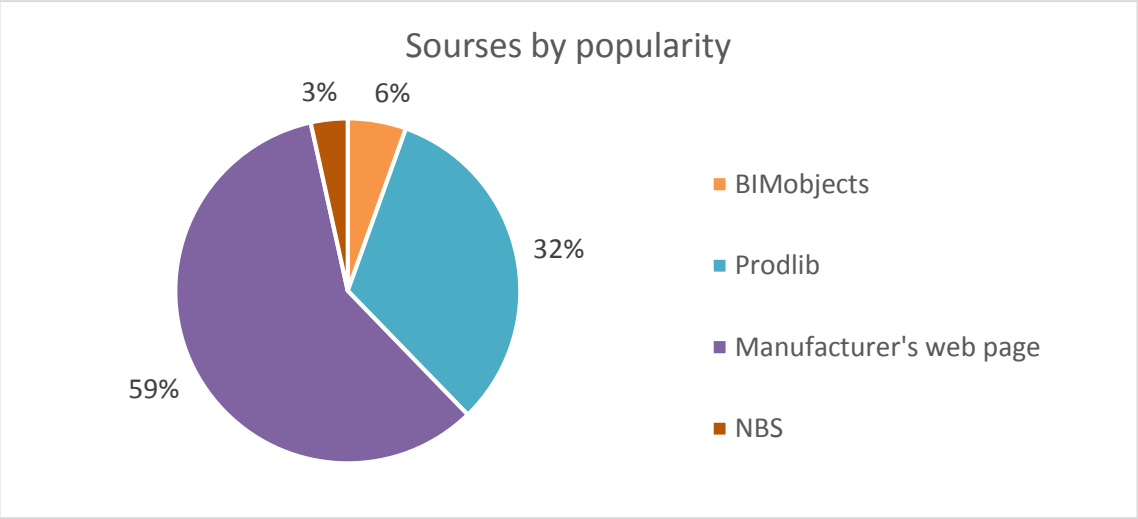

FIGURE 13. *The diagram of BIM-objects for products provided by manufacturers specialized on insulation* (Appendix 5)

There are cases, when manufacturer keeps all the updated objects on its web-site, and at the same time leaves several objects to one of the international libraries. These objects soon become irrelevant, but still represent the company within international environment.

The relations between the condition of the collection and general availability of the BIM-objects can be easily defined: if manufacturer is interested in providing the models for its products, it has more or less rich collection, where every object presented in several formats. Otherwise, provided models are not fulfilled with data or updated, and the general amount of objects form an unstructured collection that still can be used but do not make the work much easier.

5.2 Data management

As it was mentioned above, there is a great difference in the question of quality among the libraries.

Several manufacturers in question disorderly try to provide limited collections of the objects. Using the basic internet-research, it is hard to orientate among up-to- and out-of-date information. Trying to provide BIM-objects internationally and to be presented in stock that is accessible worldwide, the manufacturers keep their objects decentralized, that inevitably brings to a lot of omissions. Among the manufacturers studied for this thesis, there are many cases when the library of the BIM-objects holds out-of-date objects, while researching the manufacturer's web-page reveals a fully digitalized portfolio available.

Another general question in controlling the provided data is the internationality of the collections of BIM objects. Studying the number of the companies from the different countries, it became clear that web-pages designed for foreign customers not only provide less information than the manufacturer's native language page, but often there is no a single sign of existence of BIM-objects. This do not relate only to the Finnish companies. Swedish and German manufacturers also have no information of digitalized products available (although, there are Swedish objects included to the final table (Appendix 5). Besides, being the international supplier with English as a native language do not guarantee that the local web-sites will provide up-to-date data further, so there

may be collected a variety of BIM-objects from the different sources, that have not been updated in years. Even in the BIM-product libraries, as Prodlib, there are different collections in different languages. Certainly this depends on the suppliers' customer groups.

Besides the question of irrelevant information, there should also be mentioned cases of independent, good working and maintained collections. Manufacturers from wood, insulation and furniture industries mainly hold the objects using own web-pages. Among them, the most developed collections are of interior and outdoor furniture.

The great use comes from the collection of the ProdLib company that nowadays gives a possibility to Finnish manufacturers to create localized digital collections orientated on the market they are working with. Corresponding to their basic principles of working, international libraries of BIM-objects take care not only of creation of the models, but also they keep in touch with manufacturers to maintain the collections. Besides all the forums, trainings and other social events they hold, there is a great job is being done every day updating the objects, updating the software, keeping users of the objects updated with upcoming changes and discussing the product development with manufacturers.

For the understandable reasons, all the questioned manufacturers have a great interest in promoting their products. Therefore, they hold the presentations in design offices and invite designers to the company offices, send the e-mail promotion and participate in building fairs. Speaking of BIM-objects for their products, many manufacturers provide additional trainings to present the possibilities of the models. These trainings commonly are video tutorials and visits with presentations. However, all the questioned designers consider trainings necessary (Appendix 4). Although, even if the experienced users of BIM understand the principals of using any models, these tutorials and presentations still can be used as promotions.

6 CONCLUSION

It might seem that the concept of the Building Information Model is quite easy to understand. However, the concept of smart, elegant and co-operative workflow requires a brand new approach to the relationships between building creators demanding involvements of not only the building designers and owners. The concept of BIM is based on what is defined by “I” – “Information” in the term. The primary source of information is the manufacturers and they should be interested in effective use of the BIM-technology.

The computer technologies are evolving and according to logical stages, the simplification of products and services has a substantial importance. Narrowing into the creation of the building information model, the basic level that needs to be improved includes such things as understanding of the technologies and the importance of data producing. According to the statement of the professional BIM-designer working in ProdLib library of BIM-objects that is oriented on Finnish manufacturers, the dissemination of knowledge of the BIM-technology is essential because even nowadays, while discussing the partnership with the client, designers are forced to explain the very basics of working principles of BIM-technology to the manufacturers. (18)

Taking into account that the business of BIM-products in Finland is still gathering popularity, there are several typical problems inherent in present clients’ orientated data base. These cases are:

- weak product data management;
- lack of knowledge or interest in creating the BIM-objects among the manufacturers
- no standardization of the BIM-technologies in Finland in general.

Data collecting for this thesis became more complicated after the simple internet research. The second phase and the second method of collecting the knowledge was direct interviews with representatives of the suppliers and their participation in questionnaire. Considering the fact, that the research process grinds to a halt at this stage, some problems seems to be on the surface. These methods have

revealed the first problem – lack of interest among the manufacturers in creation of BIM-objects. Only a few manufacturers answered to the proposals of participation in the survey. Even having the explanation of importance, there was a case when a manufacturer declined further discussion of the subject in a rough manner. Afterwards, having the comments of the designers, revealed that there is a constant problem with not-streamlined dialog and the lack of interest:

"More manufacturers should see the benefits of creating bim objects of their products" (Appendix 4)

However, those suppliers, who answered to proposals, showed enough interest to admit the importance of any studies of BIM-technology. All these manufacturers provide BIM-objects or planning to provide, so some views on the current situation lead the research to the second problem statement: poor data management.

The general problem with data management of all the times has been about providing up-to-date data. As numerous manufacturers nowadays already successfully provide BIM-objects, it needs to be mentioned the fact that such manufacturers are now interested in the expansion of the number of formats for provided objects (Appendix 3). That shows the actual demand for the digital development of the products. Although, it also seems to bring new difficulties. According to the comments left to the questionnaire for manufacturers, the expansion and increase of information brings problems in data management.

"There is too many formats so when some product changes you need to update all formats. It's also a bit unclear what information would be useful for users and be inside product blocks" (Appendix 3)

Depending on the clients and projects, the manufacturers and designers focus on the present needs of a project. Working in cooperation, they do product development the base for that can be an already existing BIM-object of the product. At the same time, they do not use the benefits of good data management in the question of attraction of the new customers. As have been stated above, digital products connect the manufacturer with designers and a potential new

customer or even potential future manufacture worker as there is building informational modeling courses in universities. Some designers name the problem of irrelevant information and bad quality of the libraries as one of the reasons why BIM-objects cannot be used at all. (Appendix 4)

Good structured and well supported portfolio of BIM-objects does not question the progressivity of the supplier. However, considering problems stated above, the market of BIM-objects hard to control without a group of specialists. Creating, developing and managing the portfolio is a hard work required constant online-monitoring of the standards, product technical data and designers' needs. Therefore, many manufacturers may have a lack of interest in dealing with creation of the BIM-objects.

Based on the experience of searching the BIM-objects that are available in the public access, picture is forming that many of manufacturers do not work on their BIM-library on purpose, but often enlarge the portfolio by the objects made for particular project or provide the BIM-data for request.

The root of the problem of poor data management among the local collections relates closely to the third basic problem stated above: the regional standardization. Manufacturers comment the non-availability of their collections of objects to their foreign customers in the questionnaire (Appendix 3):

"Finnish structures might not be interested by other countries"

Although the Europe Union states basic standards for the structural design, there is a variety of regional instructions for construction, energy efficiency, fire resistance, etc. This factor has a great influence on the interest of the manufacturers in creating a database of BIM-objects on the local level. There are also some cases, when international supplier works worldwide, but has the digitalized portfolio for its native country only. In this question, the opinion of manufacturers that participated in the survey were divided 50 – 50 (Appendix 3). Apparently many companies do not see any benefit or need to create the library for the foreign customers. Designers have a huge interest in the development of the BIM-content, services and the market in total.

Furthermore, the standardization of BIM-technology in Finland can bring more order into the industry in general. Commenting the survey, designers mentioned that as the quality of BIM-products varies among the manufacturers, accepting BIM as a standard and creating the standards on provided products and use of technology can solve the multiple problems (Appendix 4):

“As being one of the suppliers, mainly answering from perspective of being a go-between (manufacturers/designers). Many suppliers don't have understanding of requirements that architects/engineers have considering BIM content. There for vast variety of available BIM objects exist with no "standard". General rules to generate various objects would help the industry and improve the quality of design content.”

By asking both designers/planners and manufacturers, the problem of not streamlined dialog between suppliers and users of BIM-object was identified. In addition, both groups valued their agreement with basic statements to get a clear picture of distinctions. Although the subject of BIM-technology interests every company according to their developmental politics and the wish to be innovative, not a great number of the companies want to discuss the problem or at least create the statistic that could help to understand the needs of the clients more clearly. This might show not only the lack of interest on the subject, but generally the root of all the complications about co-operating between two main parts of the building model creating.

In addition, designers and suppliers were asked the questions about the main problems with the use of BIM-objects provided and the main problem of providing BIM-object. Several comments have been collected on the situation when designers name the technical quality and existence of the objects as main barriers to successful use of BIM-products. On the other side, manufacturers name the lack of knowledge of exact customers’ need as a reason for not providing BIM-objects. That practically confirm the statement of the problem with communications.

More detailed description of forms of communication has been studied by Sariola, Rami in his master’s degree thesis (16). He mentions there that one of the forms

of communication between projects sides is being realized without direct connections, but only by the information shearing. Every part of the project has its own experience and working outs, so by the shearing the information, there can be created something new. Therefore, the development of co-working environment becomes essential.

To successfully develop the use of building information models in construction process and later in building maintenance, it is crucial to create a well-functioning infrastructure that would allow to use the technology with maximum efficiency in total and to every part of the project can productively work within their tasks not wasting the time on extricating from the uncomfortable work conditions. Nowadays, although most of the BIM-objects are accessory-types, according to one of the comments, sometimes generic objects are the only choice (Appendix 4). Nevertheless, there are a lot of BIM-objects for architecture-designers, but very few for construction products. Taking into account the facts mentioned above that formed the present statement of the market of the BIM-objects, manufacturers from their side need to listen to their partners needs and at the same time understand the benefits they get from using the technologies.

SOURCES

1. Finne, Christer – Hakkarainen, Merja: Rakennustietosäätiö; Malleson, Adrian: NBS. 2013. Finnish BIM Survey 2013. Rakennustietosäätiö RTS. https://www.rakennustieto.fi/index/rakennustieto/tutkimus/6IzIzmpAR.html

2. Penttilä, Hannu – Nissinen, Sampsa: Mittaviiva Oy; Niemioja, Seppo: System-studio Oy. 2006. Tietomallintaminen rakennushankkeessa. Tampere: Tammer-Paino Oy.

3. Metsola, Jyrki: Kymdata Oy. 2017. Tietomallintamisen monimuotoinen maailma. RIA ry:n jäsenlehti 1/2017, Helsinki: Rakennusinsinöörit ja –arkitehdit RIA ry.

4. Epstein, Erika. 2012. Implementing Successful Building Information Modeling. Norwood, MA: Artech House.

5. TPK, 2013. BEC 2012 Modeling instructions for designing prefabricated elements (version 1.03) https://ru.scribd.com/document/266826040/BEC2012-Modeling-Instructions-for-Designing-Prefabricated-Elements-V103

6. BIMobject® 2013. Creation Process. http://info.bimobject.com/How%20to%20make

7. Finnmap Consulting Oy, Gravicon Oy, Olof Granlund Oy, Lemminkäinen Talo Oy, NCC companies, Pöyry CM Oy, Skanska Oyj/VTT Technical Research Centre of Finland, Solibri, Inc., SRV Rakennus Oy, Tietoa Finland. Oy, 2012. Common BIM requirements, 2012 https://buildingsmart.fi/en/common-bim-requirements-2012/

8. ISO 16739, 2013. Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries. https://www.iso.org/standard/51622.html

9. BuildingSMART. 2017. http://buildingsmart.org/standards/

10. NBS, 2017. National BIM Report 2017. https://www.thenbs.com/knowledge/nbs-national-bim-report-2017

11. NBS, 2013. International BIM Report 2013. https://www.thenbs.com/knowledge/nbs-international-bim-report-2013

12. Survey "BIM-objects for manufacturers", 2017. https://goo.gl/forms/auj1SarIhlvOtc103

13. Survey "BIM-objects for designers", 2017. https://goo.gl/forms/OsSsCFUddnoOIvcG2

14. ProdLib, 2017. User manual. http://www.prodlib.com/downloads/ProdLib_usersmanual.pdf

15. BIMobject®. Home page, 2017 http://bimobject.com/en

16. Sariola, Rami. 2013. Master's thesis. Tuote-palvelujärjestelmien kehittäminen ja rakennusprojektin hankintapäätöksiin vaikuttaminen. Tampere, Tampere University of Tecnology. http://urn.fi/URN:NBN:fi:tty-201309111334

17. Moskaliuk, Liudmila. Course project. Puuhallin suunnittelu. 2015.

18. Virtanen, Janne. ProdLib. 2017. Letter.

19. McPartland, Richard, 2014. BIM Levels explained. National Building Specification. https://www.thenbs.com/knowledge/bim-levels-explained

APPENDICES

Appendix 1 Lähtötietomuistio

Appendix 2 The list of manufacturers studied

Appendix 3 Survey: BIM-objects for manufacturers. 2017
https://goo.gl/forms/8LH1uVOtcjPZQilp1

Appendix 4 Survey: BIM-objects for designers. 2017
https://goo.gl/forms/C3ZCVqFfy84OpbyY2

Appendix 5 Table of available BIM-objects