

MASTER

International opportunities BouwConnect library threats and opportunities for expansion of BouwConnect to the German construction market

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International Opportunities BouwConnect Library

Threats and opportunities for expansion of BouwConnect to the German construction market

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Preface

This report is the result of the graduation project for the master course Construction Management & Engineering at the Eindhoven Technological University at the faculty of Built Environment. This graduation report has been fulfilled in corporation with the company the Twee Snoeken, located in 's-Hertogenbosch, the Netherlands.

1. Introduction

In this chapter the context of the research will be discussed, furthermore the research approach including the research problem and research questions will be elaborated. This chapter will conclude with the research model in which the used research methods will be discussed and a reading guide will be presented.

1.1. Context

The results of a building project are for many people just the realization of a building or road at the construction side. But this is only the work that someone sees in public, in fact there are more parties involved in realizing a project. Every project is a collaboration of multidisciplinary parties which are involved in the process from design to realization of a project, for example the architects, engineers, constructors and parties involved in the installations within a project.

This multidisciplinary nature of projects in the building sector means that for example the architect designs a building with certain specifications. Then the engineer needs to draw the constructional framework of a building, while integrating the decisions made by the architect. Also installation parties will use these 2 dimensional drawings for designing their systems. In all of these phases every party needs to look up specifications of certain products that are integrated in the design to make a final product.

In the history of building a lot of projects have seen unforeseen costs and delays due to miscommunication between several parties. The main reason which causes cost overruns and delays has been identified as rework. Love, 2002, defines rework as “the unnecessary effort of redoing a process or task that was incorrectly implemented the first time”. Rework contributes to 52% of total cost overruns and can increase the schedule overrun by 22% (Han et al, 2011). Han et al, 2011, also state that design errors are a major contributor to the problem of rework. When a design error is identified, rework has to be done which results in additional costs and time delays. For example in the US the US General Accounting Office reported that 20 civil infrastructure project, ranging in costs from \$205 million to \$2.6 billion, have seen cost overruns ranging from 40% to 400% (Han et al, 2011).

Isikdag, 2010, notes that the construction industry is extremely “document-centric” of nature with construction project information being captured mainly in documents. This information is often digitally available, but it is still treated as a document. Because of this document-centric nature of the construction industry and the insufficient integration and interoperability between software applications has resulted in problems in communication and coordination between involved parties. To tackle this problem a Building Information Model can be used, also called BIM. BIM is a field of research which has become more actively in recent years. In short, present day BIM’s are capable of supporting collaboration between various stakeholders by acting as an information backbone through the entire building lifecycle (isikdag 2010).

The National Building Information Model Standard Project Committee (NBIMS, 2012) defines BIM as follows:

“Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder.

The US National BIM Standard will promote the business requirements that BIM and BIM interchanges are based on:

- A shared digital representation,
- That the information contained in the model be interoperable (i.e.: allow computer to computer exchanges), and
- The exchange be based on open standards,
- The requirements for exchange must be capable of defining in contract language.”

Bouwconnect is a cooperation between the architects of “De Twee Snoeken” and communication specialist “KPN” (BouwConnect, -). Bouwconnect provides a platform independent database as universal information source for an integral solution for information supply and communication in the building sector. This database is called the “BouwConnect Bibliotheek”, or BCB in short, and supplies fully specified building elements from hundreds of companies. These building elements can be straightly used in several types of software such as AutoCAD, Arkey-ASD and Revit. Every element has a unique WUID, with component specific information, which ensures that the chosen building components can be used in several different software packages. The information which is specified for each element goes as far as CAD information, building physics, costs and information to compile the “bestek” (Dutch for building specifications) of a project.

1.2. Research approach

In this paragraph the research methods that will be used to answer the given research questions will be explained. In the research the following methods will be used:

- Literature study;
- Consulting experts;
- Case study.

The gathering and synthesizing of the scientific literature and other relevant literature will be used to gather useful information to answer the stated research questions. The international developments, the threats and opportunities of these developments will be done with the use of extensive literature research. Also the uniqueness of the product will be investigated with the use of the literature research. This literature research will be used to make a sound foundation on which the research can be developed further.

The main portion of the research will consists of a case study, the expansion of the BCB to Germany. To make a sound conclusion, the BCB itself will be described in detail to find any possible constraints for implementing German made products in the library. The information will be gathered with by consulting experts.

The case furthermore exists of a literature research of the German construction market, the size of the market, the specific characteristics of the construction market, technical differences between the construction markets, and more.

Furthermore data will be gathered by consulting experts, personnel of the Twee Snoeken, professors of the University and other experts in the field of research.

Figure 1 shows the research model which is used in this research.

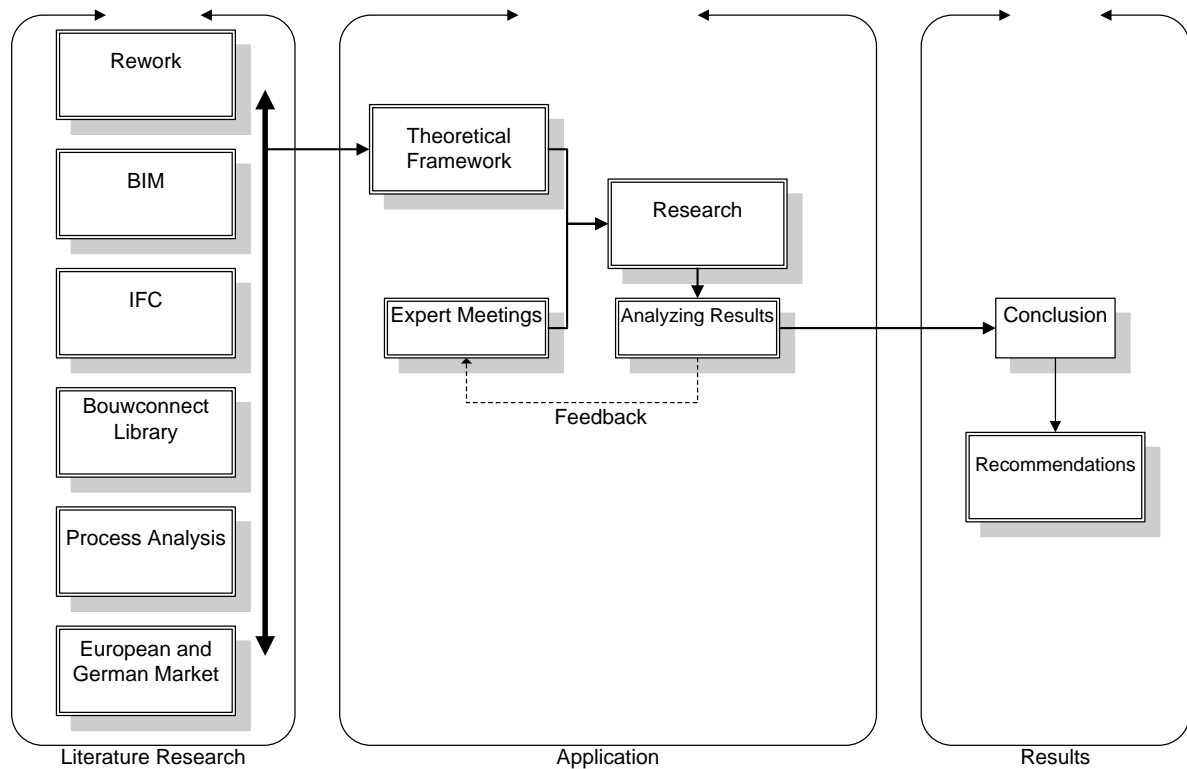


Figure 1: research model.

The theoretical framework consists of the information gathered by the literature research. The literature research can be found throughout the report. Information on rework, BIM, IFC can be found in chapter 2. An introduction and more detailed information concerning the Bouwconnect library can be found in chapter 3. Information concerning the European and German markets in chapter 4 while the literature review concerning the Process analysis can be found in chapter 5. This theoretical framework, and information from expert meeting, is used as the foundation for the research that is handled in this report. The results of the research are verified with the experts of the company. This is mainly done in chapter 4.3 and chapter 5 of this report. The results of the research are analyzed and presented in the conclusions section of this report, chapter 6. These conclusions have also led to the stating of recommendations.

1.2.1. Problem definition

The problem that will be dealt with in the research is stated in this problem definition.

The “BouwConnect Bibliotheek” (BCB) has been developed in the last years and it already has a large number of companies joining in to share information. For now it seems to be successful in the Netherlands. There are also plans to bring the products to other markets such as China and Germany, but it is unknown whether the technical demands of potential customers are the same as in the Dutch market.

Therefore the problem statement is: “The Company the Twee Snoeken wants to expand to the German market, but there is little research available concerning the international developments in this specific market and the technical differences between the Dutch and German construction industry!”

1.2.2. Research questions

Based on the described problem definition, which is stated in the previous paragraph, research questions can be drafted. This research is done in cooperation with “de twee Snoeken” and therefore the research questions are provided by the company and are modified in such a way that they can be used for scientific research.

1. How can BouwConnect compare itself to national and international developments?
 - 1.1. How unique is the concept of “BouwConnect Bibliotheek”?
 - 1.2. What are the opportunities for BouwConnect?
 - 1.3. What are the threats for BouwConnect?
 - 1.4. How could BouwConnect react to these developments?
2. What is the current added value of the Bouwconnect Bibliotheek for the building sector
3. What are the changes for international expansion of “BouwConnect” to Germany?

1.2.3. Research aim

The aim of this research is to provide the company “de twee Snoeken” with scientific research about their product the “BouwConnect Bibliotheek” (BCB).

First the current technical structure of the BCB will be described and the technical properties of the BCB. This includes the current added value of the BCB in its current form.

The second part of the research will show the results of the research concerning the international opportunities of the BCB product, the focus for this expansion will be the German construction market. The characteristics of the German building market are probably different from the Dutch market, this last chapter will elaborate the technical differences in the demands between these 2 markets. The extracted data will be used to make a sound conclusion whether it is possible to expand to this new market.

The current technical structure of the BCB will be investigated with the use of expert meetings, this analysis will have a large influence on the end result of this report. The German market will be investigated with the use of a literature study in the consulting of experts.

Finally a process analysis concerning the market introduction of the current BCB will be shown and in addition a process analysis of the introduction of the BCB in Germany will be presented. This includes the past planning, future planning, SWOT analysis, MKDH analysis and a cost analysis.

1.3. Reading guide

Section 2 of this report focusses on the BouwConnect library, including the technical properties and the way the technical parts of the library are designed. Section 3 of the report will focus on the theoretical background of the conducted research. This includes information and references about rework and BIM. The case of the research is elaborated in the 4th section, main focus on the German market and shows the threats and opportunities of a shift to the German market. The fifth section focusses on the process analysis of introducing the BCB in the Netherlands and the possible strategies for a German market introduction.

The final, 6th, section will consist of the conclusions and recommendations which can be concluded from the research.

2. Theoretical background

In this chapter the theoretical background and underlying scientific information is presented which is needed for a good understanding of the following chapters.

2.1. Rework

Every construction project is a collaboration of multidisciplinary parties who are involved in the process from the design phases to realization phase of a project, for example the architects, engineers, constructors and parties involved in the installations within a project. Until a few years ago each party worked with 2 dimensional drawings including schematic ground plans and cross sections. These drawings needed to be sent to each party involved, when something changed on paper, everyone needed to get a new hardcopy of the document.

This multidisciplinary aspect of the projects in the building sector means that for example the architect designs a building with certain specifications. Then the engineer needs to draw the constructional framework of a building, while integrating the decisions made by the architect. Also installation parties will use these 2 dimensional drawings for designing their systems. In all of these phases every party needs to look up specifications of certain products that are integrated in the design to make a final product.

According to (Isaac & Navon, 2013) design changes often have a major impact on the client objectives in construction projects, and even in successful construction projects the costs associated with post award design changes typically amount to 5-8% of the contract value.

They furthermore note that design changes include any modification of existing design data, which alters previous decisions made by the project team and other actors. Causes of such changes may include the following:

- Change in orders: For example, changes originating from the client, due to omissions in the requirements, changes in the clients' activities, or a better understanding of client needs.
- Rework: For example, changes originating with the project team, due to errors or solutions which emerge during the development of the design and planning, and the actual construction.
- Changes originating with suppliers, due to changes in technology or the inability to meet the original planning targets.
- External causes, such as new regulations.

In the history of construction a lot of projects have seen unforeseen costs and delays due to miscommunication between several parties. The main reason which causes cost overruns and delays has been identified as rework. Love, 2002, defines rework as “the unnecessary effort of redoing a process or task that was incorrectly implemented the first time”. Rework contributes to 52% of total cost overruns and can increase the schedule overrun by 22% (Han, et al., 2011). Han et al, 2011, also state that design errors are a major contributor to the problem of rework. When a design error is identified, rework has to be done which results in additional costs and time delays. For example in the US the US General Accounting Office reported that 20 civil infrastructure project, ranging in costs from \$205 million to \$2.6 billion, have seen cost overruns ranging from 40% to 400% (Han, et al., 2011).

Fragmentation is an important aspect of the construction industry structure and client base, because of the traditional nature of the industry involves bringing together multidiscipline in a one of a kind project (Isikdag & Underwood, 2010). Furthermore Isikdag et al, 2010, notes that the construction industry is extremely “document-centric” of nature with construction project information being captured mainly in documents. At present day this information is often digitally available, but it is still treated as a document. This document-centric nature of the construction industry and the

insufficient integration and interoperability between software applications has resulted in problems in communication and coordination between involved parties. To tackle this problem a Building Information Model can be used, also called BIM which is a field of research that has become more actively in recent years. In short, present day BIM's are capable of supporting collaboration between various stakeholders by acting as an information backbone through the entire building lifecycle (Isikdag & Underwood, 2010).

2.2. BIM

Through the years the construction phase of a building has become more and more complex. The first construction drawings emerged in the 19th century. Before that time buildings were built with the components available. Since the emergence of construction drawings the complexity of the drawings has become more and more complex showing more and more information about the project. In recent years the drawings are drawn and shared digitally. The shift from paper-based to electronic documents has had significant impact on the creation and the handling of construction documents, however many systems simply replicate paper-based documents (Mao, et al., 2007). The next step in this digitalization of the Architecture, Engineering, Construction and Operations (AECO) industry is the use of Build Information Model (BIM), which will cause a technological and procedural shift (Succar, 2009).

According to Linderoth, 2010, the first reports of the potential of Building Information Models in the AEC industry emerged in the late 1980's and early 1990's, but it took almost 15 years before positive outcomes appeared from the development of BIM in the AEC industry. But already in the 1970's there were several prototype integrated systems developed which attempted to integrate building descriptions. These included BDS from Applied Research of Cambridge, CEDAR and HARNESS, the SSHA-DOE Housing Model developed at the University of Edinburgh, ARCH-MODEL from the University of Michigan, and GLIDE and GLIDE-II by Carnegie-Mellon University, the latter for the U.S. Army Corps of Engineers (Eastman, 1992).

The first models had the objective to generate a comprehensive model of a building, sufficient for design and analysis and often called a "building model". Since then the goals have been broadened to, for example, include additional information concerning the construction planning of a project and information about the operation and maintenance of an object (Eastman, 1992).

The National Building Information Model Standard Project Committee (NBIMS, 2012) defines BIM as follows:

"Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder.

The US National BIM Standard will promote the business requirements that BIM and BIM interchanges are based on:

- *A shared digital representation,*
- *That the information contained in the model be interoperable (i.e.: allow computer to computer exchanges),*
- *The exchange be based on open standards,*
- *The requirements for exchange must be capable of defining in contract language."*

A Building Information Model is thus a digital representation of a building, which contains the information of the specific components of that building. This information can be used in all stages of

the life of a building, from the design phase to the building phase, but also in the operating and demolition phases. The main difference between working with the BIM method in comparison with traditional CAD designing is the 3D view of the building object. The main difference between 3D and 2D modeling is that the buildings are modeled instead of just drawn (Sacks & Barak, 2008). Drawings are no longer the main source of information, but are simply design information generated from the full building model.

Using BIM results in some benefits compared to other pre-BIM methods. Manning & Messner, 2008, have identified 6 primary benefits, rapid visualization, better decision support upstream in the project development process, rapid and accurate updating of changes, reduction of man-hours required to establish reliable space programs, increased communications across the total project development team, and increased confidence in completeness of the scope.

Using BIM results in a faster and more cost-effective project delivery process, and creates higher quality buildings that perform at reduced costs (Eastman, et al., 2008). The study of Sacks et al, 2008, shows that the use of BIM in a project can offer an increased productivity ranging from 21% to 61% in drawing production activities of a firm. According to Sacks et al, 2008, drawing production activities account for 68% of the hours spent on a typical construction work. With these figures it is achievable to reduce the total hours spent on a construction project between 15% and 48%. This development will probably lead to a sharp decline in the amount of drawing personnel in the involved industries. The research of Kaner et al, 2008, has shown that there is a steep learning curve when introducing BIM to a project. They investigated 2 companies with several projects and measured productivity gains from 2% to 20% between projects and even 28% to 47% between phases of a project when making use of the BIM methodology. The researched companies experienced a commercial advantage over their close competitors. The use of BIM is being encouraged by the US General Services Administration (GSA), as well as the US Army Corps of Engineers (USACE). The GSA even requires utilization of BIM for all Major projects which receive funding since 2007 (Leite, et al., 2011).

The whole idea of BIM is thus that the building information will be available to everyone in the building chain, from the architect with the first ideas right up to the company that will eventually demolish the building. The main question will be who is responsible for storing the digital documents, and how they have to be kept available over a long time (Rijksgebouwendienst, 2012).

According to (Gu & London, 2010) the expectations of BIM-users vary across the multitude of disciplines in the construction sector. For example the design disciplines see BIM as an extension to the previous way of working with 2D CAD (Computer Aided Design). On the other side contractors and project managers expect BIM to be a more intelligent DMS (Data Management System) which is able to extract data from CAD packages directly for analysis, time sequence & cash flow modeling and simulation & risk scenario planning. So users such as contractors and project managers, with DMS background, expect visualization and navigation to be an important feature of BIM that is missing in existing DMS solutions. According to (Gu & London, 2010) it is notable that, excluding a few exceptions, current studies mostly emphasize BIM as an enhancement to CAD and downplay the document management aspects. They assume that this is possible the result of the possibility that current studies concentrated towards design disciplines.

2.3. Use of BIM Worldwide

This paragraph gives a short overview of BIM usage worldwide, for a more extensive review see appendix A

Literature (McGraw-Hill Construction, 2010), (Rijksgebouwendienst, 2012), (WSP, -), (Liebich, et al., 2011) has shown that the use of BIM worldwide varies per country. These literature shows that the implementation of BIM has taken a leap in the US, while European countries (Germany, UK and France) lag behind. In the EU the architects are the parties who use BIM the most and almost 75% of all respondents of the McGraw-Hill research report a positive perceived return on their investment in BIM.

The main difference in the adoption of BIM lies in the fact that the construction sectors of the US and Europe differ on the amount of renovation projects. In Europe this sector is quite large, while the US sees more large scale construction projects. This has as result that almost 1 out of 2 American contractors have experience with BIM while only 25% of the European contractors do.

The adoption rate of BIM in Germany is about 36%, the adoption is led by architects (43%, than engineers (33%) and contractors (24%). Of the respondents who say they are familiar with BIM, 51% think that they are advanced or expert users. The implementation of BIM in Germany is on the low side, probably caused by the large amount of home grown software packages. Also the decentralized political structure has resulted in a more fragmented construction industry which makes it harder for BIM to be adopted.

There are also initiatives to boost the implementation of BIM, for instance the Mefisto project in Germany and the RGD BIMnorm in the Netherlands. The Mefisto (management/Führung/Information/Simulation im Bauwesen) project is initiated by the German office of Education and Research (2009-2012). This project is meant to make it possible to increase the interoperability between parties in the building chain (although not specifically focusing on BIM).

The report "10 truths about BIM" (WSP, -) states the current states of BIM in several European and other countries. It can be concluded that the implementation of BIM in the Scandinavian countries has taken a leap in comparison with other European countries. These countries have in common that they are technically advanced, have a small construction industry and a small government who are both promoting the use of BIM. The adoption in the UK is lower due to skepticism of the local construction industry. Germany is going its own way for now.

The **United States** has a large construction industry which makes it more difficult to implement new technologies such as BIM. BIM will lead to a shift in responsibilities and new collaborative relationships, which is being retained by the American culture of lawsuits and large damage claims. In **Australia** BIM is starting to take off but the government and industry associations need to encourage the use of BIM even more. The Sydney opera house is a famous example of how BIM can be used in the management/operation phase of existing buildings (WSP, -).

A widely used figure for showing the degree of adoption of a certain product is the adoption curve. Figure 2 illustrates the current position of a couple countries in the adoption curve. It is immediately clear that most countries are still in the pioneering phase of the implementation with only the early adopters using BIM. Only the Scandinavian countries, which are really the forerunners, are in the process of that the early majority has embraced the use of BIM in practice. Germany is a country where only the visionaries use BIM, there is a long way to go before the majority of engineers and architect in Germany will use BIM, thus there is a huge potential for new applications that are BIM-proof and help the implementation.

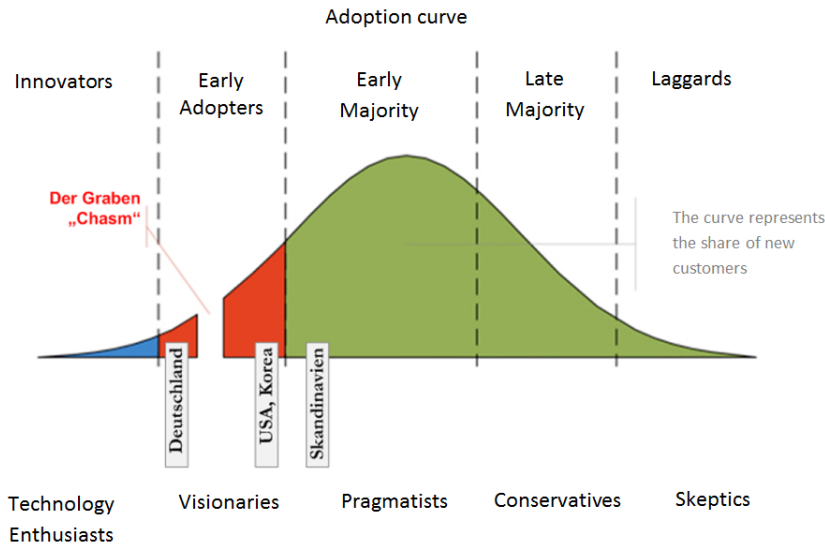


Figure 2: Adoption curve of BIM with the position of Germany, USA, Korea and Scandinavian countries illustrated source: (Leibich, 2012).

2.4. IFC

Interoperability can be defined as the ability of diverse systems and organizations to work together (interoperate). BIM capable tools serving the AEC–FM (Architecture, Engineering, Construction – Facility Management) industry cover various domains and have different internal data model representation to suit each specific domain. There is not one single application that can provide the entire set of functionalities required for the whole AEC/FM industry (Eastman, et al., 2008).

Furthermore according (Young Jr., et al., 2009) 8 out of 10 users in the United States of BIM software tools consider a lack of interoperability between software applications to be the limiting factor in achieving the full potential of BIM.

Because of the need to exchange digital information when using BIM, a universal file format is needed. The Industry Foundation Classes (IFC) are the main data exchange models which have been developed by buildingSMART. At this moment the IFC format is registered by ISO as ISO/PAS 16739, and is in process in becoming an official international standard (ISO/IS 16739) (buildingSMART, 2012). IFC is a common data scheme that makes it possible to hold and exchange data between software applications. The IFC model specification is open and available for use, the format does not belong to a single specific software vendor thus it is neutral and independent of software developments of a single software supplier.

The history of IFC starts around 1994 when Autodesk formed a consortium of multiple companies to advise the company on how to support integrated application development. Initially the initiative was named Industry Alliance for Interoperability, but was soon renamed to the International Alliance for Interoperability. This new alliance was recognized as a non-profit and industry-led organization for implementing the IFC format to the AEC sector. In 2005 the name changed to buildingSMART which now handles the development of the IFC specification. The latest release to date is the IFC4 release candidate 4 which has been released on September 3th, 2012 (Liebich, 2012).

2.5. IFD

IFD stands for the International Framework for Dictionaries and is a standard for terminology libraries or ontologies (Bjørkhaug & Bell, 2007). The standard has been in development since October 1999 and in 2007 it has been published as the ISO 12006-3 standard. It is one of the core components of the buildingSMART technology, along with the IFC standard and IDM/MVD. A library

based on IFD provides flexibility for an IFC-based building information model, connecting the model itself with various databases consisting of, for example, project and product specific data.

Large construction works have seen more internationalization in the last few years, in which language is a large obstacle. Therefore the IFD standard describes objects through relationships with other objects. Therefore IFD offers the GUID (Global Unique Identifier) or UUID (Universal Unique Identifier) as an alternative for the common used “label” or “name-tag” for objects. For example a GUID representing a door set concept looks like the following string of numbers and letters:

3vHRQ8oTOHsm00051Mm008 (Bjørkhaug & Bell, 2007)

Bjørkhaug & Bell state that the GUID's are created using a standard algorithm which assures that there never will be 2 identical GUID's can be produced for different products. The whole idea is that rather exchanging words describing objects in a BIM, you can simply exchange the GUID in communication between 2 or more parties. The user receiving the GUID's might want to see the names of the objects with a specific name in their own language, they can use or software that can decode the GUID or have access to the open available IFD library online.

2.6. Barriers encountered when implementing BIM

Because BIM is a new way of working, new users have to get acquainted with the method. Naumann, -, states that the implementation of BIM in the German market knows some difficulties because of the differences in the supply and demand of BIM bases products. The factors are also applicable to other markets than Germany. Software developers try to push the implementation of BIM capable products while the supposed users are surrounded by obstacles and barriers which hold back the implementation of BIM in the German practice. The main obstacles and barriers are:

- Organizational barriers;
- Technical barriers;
- Price technical barriers;
- Use and acceptance obstacles;
- Legal barriers.

A further subdivision of these barriers is shown in appendix B.

Several other sources state more obstacles when considering adaptation of BIM in structural engineering firms, for instance a shortage of personnel skilled in both BIM and structural engineering interoperability between BIM software tools (Kaner, et al., 2008), developing of new workflows and standards for better use of BIM (NBIMS, 2012) required investments in software, training, setup of templates and component libraries (Sacks & Barak, 2008). Kaner et al, 2008, also show that the companies studied experienced that their BIM operators had to undergo a significant change in thinking from their original CAD approach and the productive use of BIM requires careful planning on how a building is to be modeled. The implementation of BIM on a construction project requires practitioners to configure and align BIM based tools, project work processes, and the business models of the companies that work together on a project (Hartmann, et al., 2012).

Also there needs to be a shift in focus from cost/benefits for individual stakeholders to cost/benefits for the project (Dehlin & Olofsson, 2008). The main difficulty in the AEC industry is the characteristic that the networks between companies are just temporary, after every project the project team changes. This has an impact on the willingness to implement new work methods in this industry (Linderoth, 2010).

3. BouwConnect Library

This chapter will elaborate the capabilities and features of the BouwConnect library software. In paragraph 3.1 the more global information is presented, while in paragraph 3.2 and onward the BCB will be elaborated more in depth on a technical level.

In the old accustomed way of working in the construction industry every party made his own drawings on the basis of information of other actors. This way of working has a lot of moments at which interpretation of the designers play a significant role. For example the architect makes a drawing on basis of the information he receives, this is the first interpretation moment. This model gets sent to for example the person who writes the building specifications. This person interprets the drawing of the architect, and bases his work on this interpretation of the drawings. This information gets sent to for example the engineer who designs the fan-ducts. On basis of the building requirements he interprets the information which he will need to choose a fan-duct that fits the requirements.

Because of the document-centric nature of the construction industry and the short partnerships which change per project, actors want a system in which information is available at a level that everyone knows what to do with this information and which can only be interpreted one way. BIM is a way of working that can unite all actors in the construction process and concentrating all the data of all actors into one model. Just like with the introduction of the 2D cad models, there is a need for object libraries through which the time lost in drawing an object multiple times, in different projects, can be reduced.

BouwConnect is a cooperation between the architects of “De Twee Snoeken” and communication specialist “KPN” (BouwConnect, -). BouwConnect provides a platform independent database as universal information source for an integral solution for information supply and communication in the building sector. This database is called the “BouwConnect Bibliotheek”, or BCB in short, and supplies fully specified building elements from hundreds of companies. These building elements can be straightly used in several types of software such as AutoCAD, Arkey-ASD and Revit with the use of custom made API’s which connect the library with the CAD-software. This has resulted in a current user base of 6000 users, mainly architectural firms, architects and engineers in the Dutch building sector. Because of a new focus on the MEP sector the share of users from this branch is rising as well.

The information which is specified for each element goes as far as CAD information, building physics, costs and information to compile the “bestek” (Dutch for building specifications) of a project. The software also houses several configurators to compose walls, stairs, windows frames, escalators, elevators, etc. With the use of these configurators it is possible to compose custom larger multi-object based objects with all the information available. The target of the BCB is to deliver all the information of all building parts and products for which there is a demand in the whole building chain. The library contains both abstract and manufacturer specific models, the abstract models can be used in the start of the design phase, and can later on be replaced by manufacturer specific models. This way the whole decision making process is covered with the BCB. In the most ideal situation a complete building can be constructed with the use of the BCB, so that there is a model with all the necessary information which is need in the several stages of construction.

3.1. Product information

Every element that is included in the BCB has a unique “WUID”, Warehouse Unique IDentifier, which can be seen as the DNA of a building component. Every object that is included in the BCB, or made with one of the configurators, gets this unique ID code. This WUID is always 100% unique for every generated building component and is 100% reproducible. As a result it is not necessary to share the entire models with each other but just the WUID, when importing the WUID into the BCB the user

will get the building component and accompanying information he needs. The WUID is not based on the UUID or GUID which are incorporated in the IFC/IFD standard and which is promoted by the BuildingSMART platform. Although it is not based on the UUID or GUID of BuildingSMART, it shares the same objectives namely providing a unique key for exchanging data between parties in the construction sector.

For example, an architect selects an abstract building component in the BCB according to the program of requirements, in this case a ventilation grill. This object gets WUID Code 1, and sends it to the designers of the general contractor. The color and controls are not yet chosen and therefore the component cannot be ordered yet. The designer of the contractor chooses a product from a manufacturer, which gets the WUID Code 2. This WUID will be send to the engineer of the contractor who chooses the way it operates and the colors. This way the product is orderable, and gets WUID Code 3, the WUID of the final product which will be incorporated into the model of the construction. This process is visualized in Figure 3.

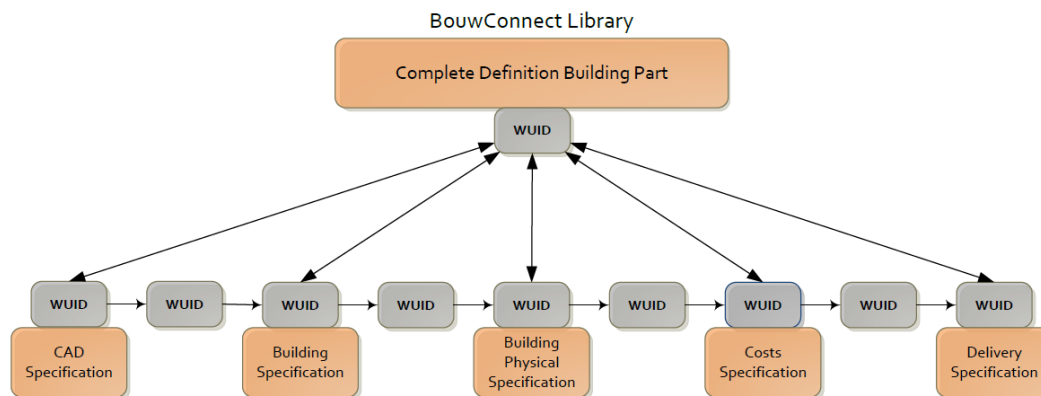


Figure 3: Information flow with the use of the WUID (source: BouwConnect, -)

This way every actor in the process gets the information he needs, without the need to interpret drawings from other actors. In every step the BCB will be used to retrieve information and add extra information needed for the next actor.

With the use of the BCB it is possible to work faster and more efficient because of the library of elements which contain high quality information for every party in the building chain. There are also environmental gains, because everyone in a project works with the same data and information this will lead to fewer errors, less waste and more durable building across the whole building chain. This will also result in a decrease of failure costs in the whole building chain, which leads to more profit for the participating companies and less cost overruns and time delays of projects..

The drawings that are included in the library are also available through web-api's, making it possible for manufacturers to show the information of the BCB on their own website. This is also the case for the configurators for window frames etc., making it possible that customers can design a window on the website of the manufacturer without having a license for the BCB. The customer is then able to order the product he designed and the manufacturer has all the information available that he needs, including detailed drawings and specifications. This is all done automatically and thus avoids the process of a designer drawing every ordered stair/compiling specifications, showing the same advantages as for the other parties in the construction sector. An example of the window frame configurator is shown in Figure 4.

To summarize the previous, the data that can be found in the BCB ranges from 2D and 3D CAD-information to STABU-specifications, information concerning the manufacturer, building physics, general and more detailed product information, and information concerning the costs of a product (globally).

Because of the ongoing development of the BCB there are new features added periodically such as more information about environmental data. The latest release of the BCB, the grand release of October 2012, offers enough products to model 70% of all the products and material that are needed to engineer/design a whole building.

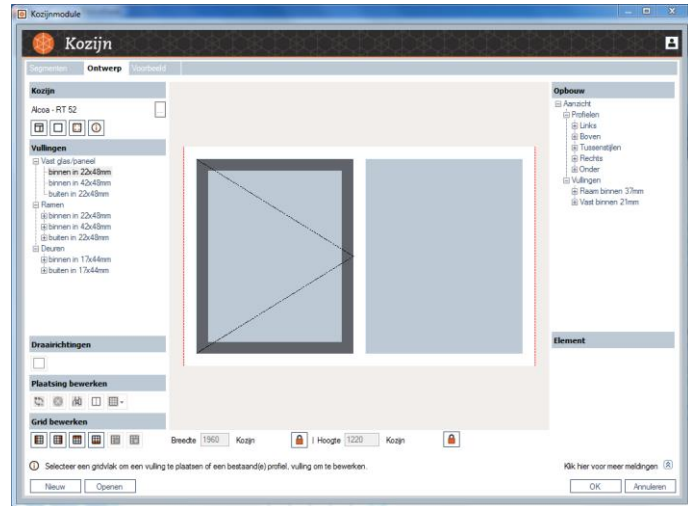


Figure 4: Window frame configurator in BCB.

At this moment there are several configurators available, an overview is given in Table 1. An overview of the elements needed for example for the window framing configurator is given in Figure 5.

Available configurators	
Balustrade	Radiators
Perforated plates	Grids
Façade ladders	Rebar metals
Wooden stairs	Revolving doors
Louvre walls	Walls
Ceilings	

Table 1: Available configurators in the BCB.

The implementation of the BCB in the Dutch construction industry can be divided into 2 phases. The first phase is the phase in which a smaller groups of companies use the BCB. The users in the first phase have a direct benefit of increased working rate because of the quick implementation of objects, better information because it is supplied from 1 source, the models contain verified information and will see a decrease in error rate. When the market share of the BCB rises and more and more companies in the whole building chain use the BCB, this will lead to phase 2. This includes a better communication between parties due the use of the WUID and therefore increases the supply chain integration, from first idea to realization and maintenance of a building. These phases are visualized in Figure 6.

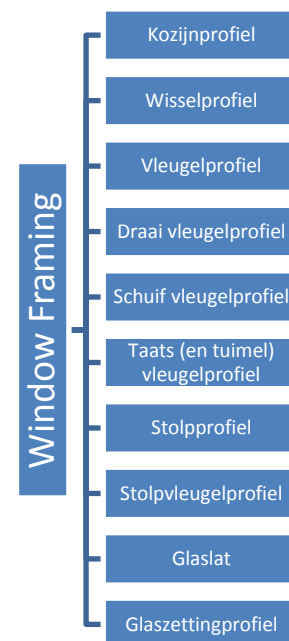


Figure 5: Decomposition of the windows framing configurator.

What are the benefits?

Library

Direct
Increased working rate
Better information
Decreased error rate



Phase 1

Implicit
Unambiguous definition
Platform independent
Information contained in
WUID
=
precondition for better
communication

Connection!

later
Better communication
Supply chain integration



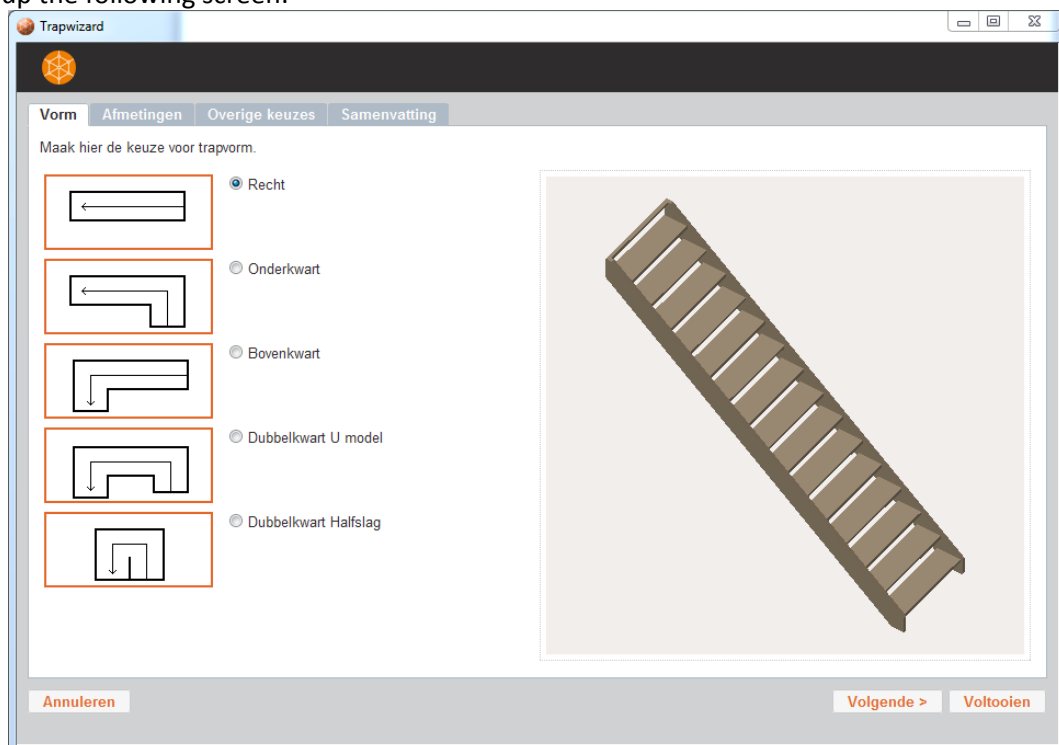
Phase 2

Figure 6: the 2 phases of implementation of the BCB in the building chain.

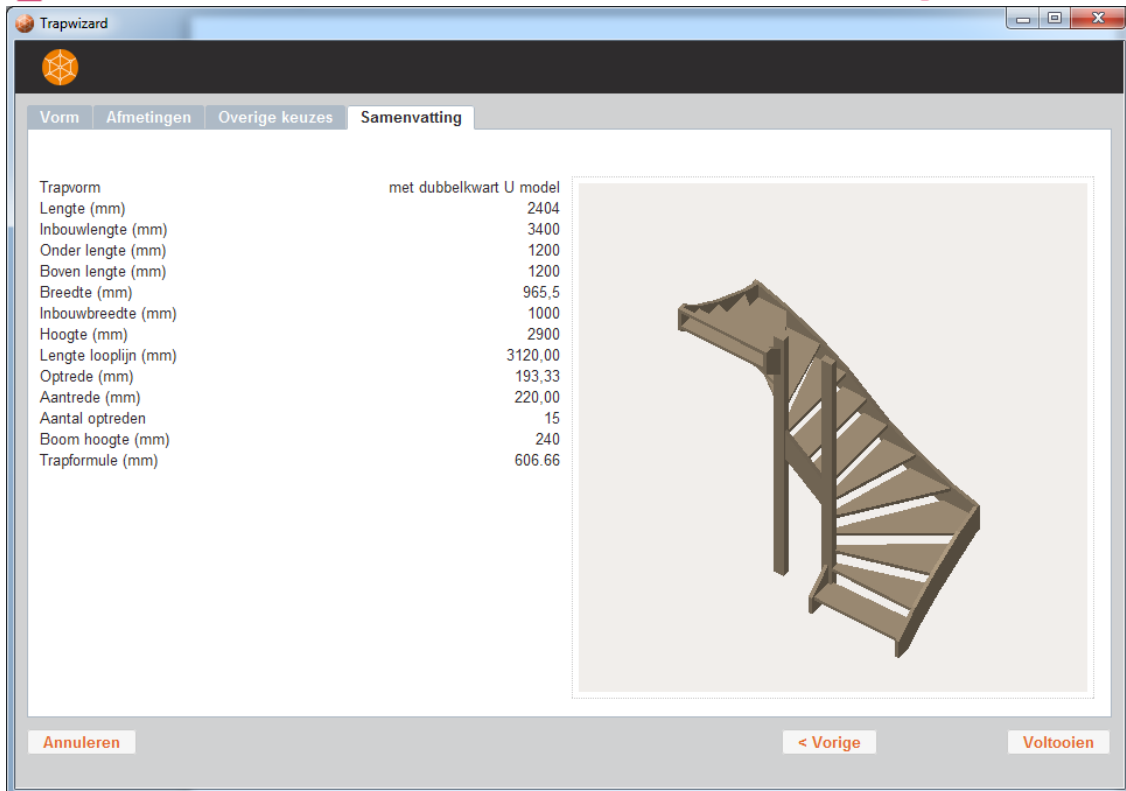
3.1.1. Example of exporting an object from the BCB to IFC and analyzing its data.

This chapter will present a short overview of how to use one of the configurators which are available in the BCB. The result of this process will be presented with data retrieved from Solibri IFC viewer to show what data is available in the model. In this case this will be done for a stair, for which a configurator is available. Using this configurator will lead to an abstract model. When wanting to design a stair of a supplier, other steps have to be taken.

When opened the BCB, search for “trap” and select the option to open the configurator. This will bring up the following screen:



In this screen it is possible to determine the needed shape of the stair which is needed in the building that is being designed. When selecting a new shape, the image on the right changes immediately to show the results of the choices that are being made. The following 2 screens show the options that are available for the stair concerning the dimensions. These are all summarized in the last screen, the picture shows the result that will be imported to a cad-package:



When exporting the model it is possible to export it in IFC, 2d or 3d format. In this case the IFC export is used to open the file in Solibri. This software package is able to open IFC files and look up the information that is contained in the file, and the data of the objects in it. The data shows clearly the identification information of the object, it is a “open trap met dubbelkwart U model” The second figure shows the information that is passed through from the BCB as well, with the most important information being the NL-SFB code of the object, the WUID, and the main measurements of the object.

Material	Relations	Classification	Hyperlinks	BCB
Identification		Location		
Property	Value			
Model	open trap met dubbelkwart U m			
Discipline	Architectural			
Name	open trap met dubbelkwart U m			
Type	Undefined			
Material	Default Material			
Layer				
Geometry	Boundary Representation			
GUID	1zvqBfHJP3BQw43hmZDZsL			
BATID				

Identification	Location	Quantiti
Classification	Hyperlinks	BCB_Set_
Property	Value	
NL-Sfb tab...	24.1	
WUID	AgAAAFxM77wJAAAAb8cBAAWwE/	
breedte	965.5	
inbouwlengte	2,643.854	
kenmerken...	hout	
lengte	2,624	
lengte looplijn	3,340	
merk	Abstract	
optrede	181.25	

3.1.2. Uniqueness of the BCB

The uniqueness of the BCB product is investigated with the use of a literature review and internet research. The uniqueness of the product in this context is linked to the amount and kind of competitors who operate in the same market. The results are shown in appendix C, this table only shows similar products as the BCB and libraries with a significant amount of objects or which is hosted by a significant party in the market of BIM capable software.

According to (Gu & London, 2010) the main problem with existing object based libraries for BIM capable tools is that there are interoperability issues across different commercial software packages. This is mainly caused by the use of different file formats and a different focus of the software on the use of a model. They furthermore state that most product libraries target specific commercial applications with a wide market base. Furthermore there is not only a need for a standard format for data exchange, there is even a greater need for standard vocabulary for the consistency of data when exporting data from one package to another (Gu & London, 2010).

From Appendix C it becomes almost immediately clear that most of the object libraries are focusing on the US market or offer international products without the focus for just one specific country. The internet research has not shown any large German object libraries for BIM capable software. The table also shows that most object libraries are focusing on 1 particular software package, in particular the Revit software family of AutoDesk, just like (Gu & London, 2010) stated in their research. A lot of libraries contain user generated content which is not validated by manufactures or are just abstract models, not specifically assigned to a certain product. Furthermore it has become clear that most of the libraries that can be found on the internet are offering just geometrical models, and are thus lacking the information richness which is integrated in the objects that are available in the BCB library.

It is notable that numerous object libraries have made specific plugins for software packages, which can explain the focus on a specific software package. The development of plugins can take months of work of multiple software developers and is therefore costly. The BCB also offers specific plugins such as for Arkey-ASD, AutoCAD and Revit, software packages that are used the most in the Netherlands, but also offers an IFC export function. This way the BCB can also be used with other software packages. Although the IFC-format is supported by multiple software packages, the implementation can differ which can cause anomalies in the drawings.

Furthermore there are several libraries that focus on a particular segment of the market such as DigiPara, who focusses on elevators. This plugin is solely available for Revit and is meant for creating a whole elevator with the use of a single plugin, including the shafts and other characteristics of the used elevator.

According to the table we can conclude that there are no real competitors who offer the same amount of possibilities as the BCB does. This does not automatically mean that the market is ready for a product like the BCB, this needs to be researched with a follow up market research. ArchiCAD is one of the largest CAD parties in Germany who hosts its own website with components and is thus an important party to keep in mind, especially because people are used to work with this combination.

3.2. Process of adding objects to the BCB

This paragraph and sub-paragraphs are meant to give an insight in the way objects are added to the BCB. The process is elaborated in this paragraph and is summarized in Figure 8.

The models in the library have been drawn with either Revit Architecture or Arkey-ASD which results in geometrical drawings in multiple file formats such as .RFA and .DRW. The geometrical data used in the library is stored in a file with a .DHG format, which is a custom made format called the DigitaleHuisGeometrie format. The transition of the geometrical data from .RFA and .DRW to .DHG is done with the custom made application called the DHcomp. After the phase of transforming the geometrical data, the possibly 2 new .DHG files will be joined together in 1 .DHG file with the use of an application called “sluismuis”. This is both done for materialized and non-materialized drawings.

From this point the data concerning the drawing properties can be added to the geometrical data. This data contains all the information concerning the way a material is drawn, for example the hatching of an object, the contours, colors and bitmaps. An example of drawing properties of a brick is shown in Figure 7 and appendix D. The data for materialized drawings is added in the first DHcomp conversion, while the data for unmaterialized CAD drawings is added in a later step. Furthermore the data belonging to the objects can be imported with the use of the VulProgramma, which is further elaborated in paragraph 3.2.1 and further.

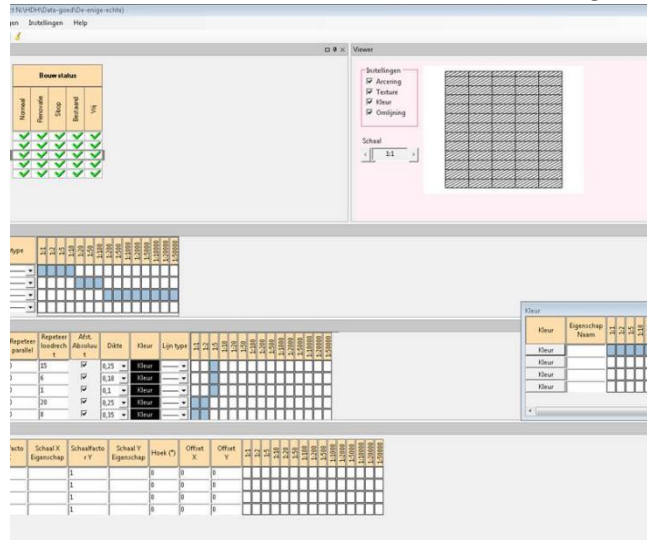


Figure 7: Drawing styles of a brick (example).

After this step the DHComp software takes care of exporting the .DHG data to data that can be extracted to CAD packages such as Revit, AutoCAD and Arkey and adds all the information that a model can hold, including the unique WUID of an object. In this step it is also possible to extract data to an IFC file with all the needed parameters.

The inner workings of a product configurator work the same as mentioned for objects. A configurator basically puts loose objects together to make a new object. The data is thus also stored in .DHG files and is exported to software packages with the use of DHComp.

This process is graphically shown in figure 8 and appendix E.

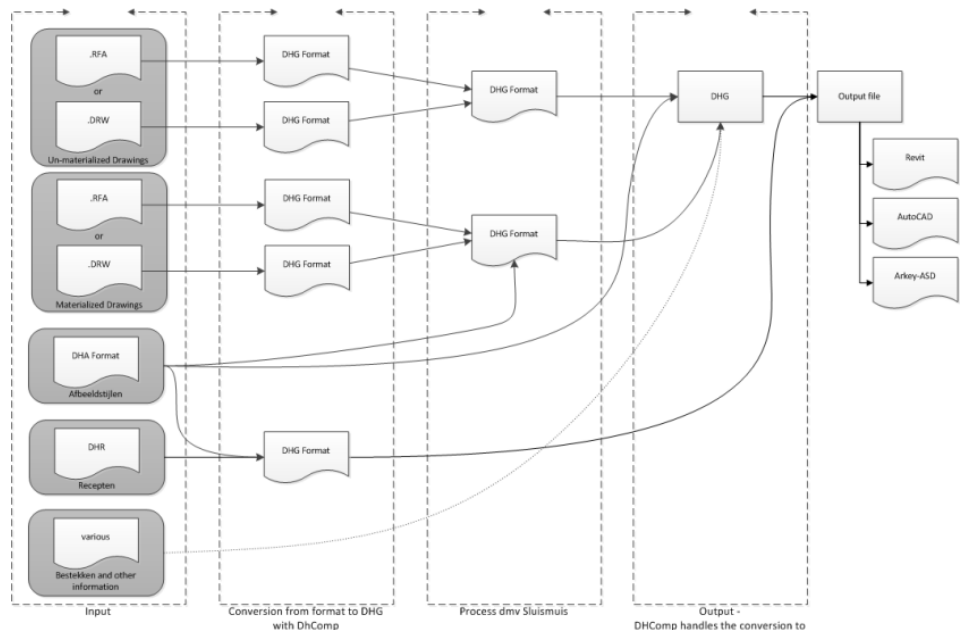


Figure 8: Scheme of process in the BCB.

3.2.1. Adding objects

The process of adding objects to the library starts with an agreement with a supplier in the building chain to import their products into the library. When all information about the objects is available the items will be drawn in CAD software, more specifically with Arkey and/or Revit. Both packages are used because of individual pros and cons that are important in constructing a model, everything is drawn in Arkey until Revit specific features are necessary. After drawing the objects get converted to the .DHG format. At the same time, the information of the objects is imported with the use of the VulProgramma, after which the product specific information and the geometries can be linked. When necessary a “recept” will be constructed to be able to construct complex shapes, calculations and more. This process will be further elaborated in the next paragraphs.

3.2.2. Adding objects and properties

The BouwConnect team at the Twee Snoeken mainly consists of the fillers of the library, the persons who draw the objects, design the configurators, who add the information concerning the objects and construct items like the “recepten”. The geometrical drawing of objects are currently built with the use of Arkey-ASD and Revit Architecture, these CAD-files are also called the “brongemetrie” (source geometrics). Geometrical data can also be generated with the use of a recipe, for more information see paragraph 3.2.3. The VulProgramma is the main piece of software needed for adding objects to the library. Additional information that can be added can consist out of drawings, templates, CAD-files, product-descriptions, “recepten”, limitations etc. For the filling of objects the fillers use templates to ensure the uniformity of information, whereby a template is defined as a BouwObject with only 1 kind of DeelObject and 1 shape-defining DeelObject.

The main purpose of the VulProgramma is the filling of properties of BouwObjecten. BouwObjecten are the essential foundations of a model, a whole building can be divided into these BouwObjecten. These BouwObjecten are the cornerstones of the digital model, an example of the importance of this division is that for example a living room is a completely other object than a steel HEA-beam. The division is not only done for structuring purposes but also for the possibility to connect different elements together. These BouwObjecten are placed in different BouwObjectTypes, furthermore it exists out of 1 or more DeelObjecten. This is graphically shown in Figure 9 for an abstract steel HEA-180 profile.

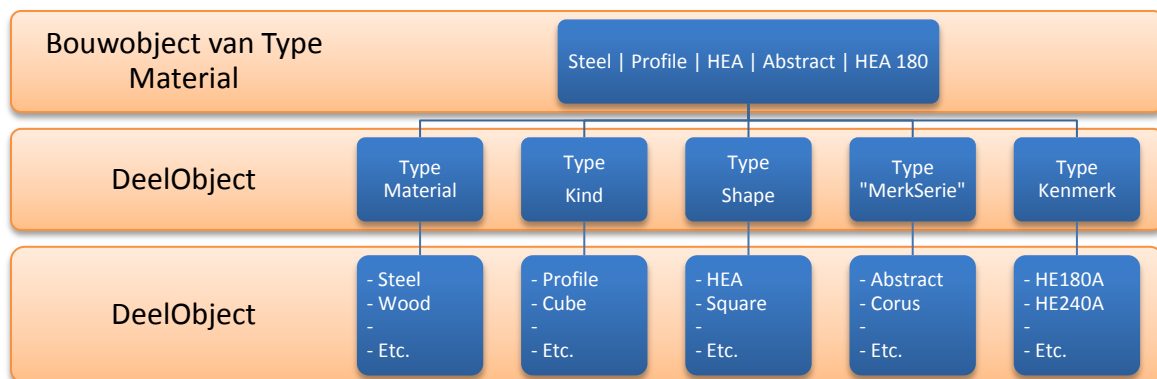


Figure 9: Decomposition of a BouwObject, showing the information of a HEA-180 steel beam.

When adding new objects it is possible to create a “normal” or a “sub” object, the first is an object which the manufacturer can deliver, the sub-object is a part of a larger object which cannot be delivered solely. After choosing for adding a new object, it is needed to compose the new object out of other “DeelObjecten”, these provide the possibility to search for the object and to supply the object with the needed set of properties which can later be filled with information.

The main function of the “VulProgramma” is thus the creation of BouwObjecten to define parameters or variables which is “something” that can contain a variable that can be used in a later stage. A BouwObject exists out of at least 1 DeelObject which contains the values of information and the domain of this information. Every BouwObject contains at least 1 DeelObject in a DeelObjectType and can be seen as the carrier of information. When there are more than 2 DeelObjecten the collection is called a cloud. An example of a DeelObject is a lintel. A DeelObjectType, for example “kind of product” is a category in which a DeelObject can be placed and is crucial for the properties a DeelObject consist out of. The parameters have an own data type, for now these are numbers, whole numbers, text, logical (yes/no), files, images, geometrics and structural specifications. Every DeelObject is made up from a maximum of 5 DeelObjectTypen that carry information like the material, shape, pattern, etc. For adding new DeelObjecten several pre-verified templates are available which need to be used.

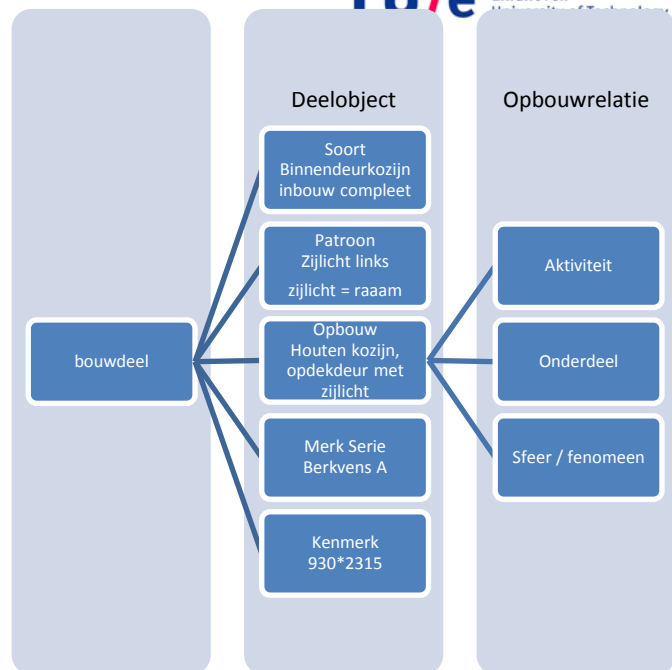


Figure 10: Example of a decomposition of a BouwDeel.

There are a couple of special BouwObjecten and DeelObjecten. For example the fictive DeelObject which contains all the properties of a DeelObjectType can be defined as an item container, for users a kind of bowl which contains all properties. There is also a “Toegewijd(dedicated) BouwObject” which is only used exclusively for the creation of larger models and will never be used solely. Furthermore there are the “kenmerk” DeelObjecten which is a special DeelObject which does not contain properties but is used to store property values, these are specific for a certain “kenmerk”

When adding new objects with the use of the VulProgramma it is possible to give all the measurements their own reach. This is for example,

- Category A: absolute reach, which is physically possible,
- Category B: structural reach, the measurements of objects the manufacturer can deliver in addition to the common measurements and
- Category C: common reach, the common objects a manufacturer provides.

These measurements are thus dependent on the kind of products a manufacturer can deliver. These measurements are all based on the used templates of the TweeSnoeken, see paragraph 4.3.4

After selecting these options it is time to select the manufacturer from a list, when the object is needed for non-specific usage, the manufacturer will be “abstract”. These abstract properties are used in the earliest stages of designing when the specific components to be used are not yet known.

A characteristic of an object is the “grondstof”, which determines the main raw materials of a product. When a product contains multiple “DeelObjecten” there are probably multiple raw materials assigned. One part of an object needs to be assigned as the characteristic raw material, for example:

- Building part framing: Characteristic raw material is the building part framing-profile;
- Building part stair: Characteristic raw material is the building part step;

- Building part brickwork: Characteristic raw material is the brick element

All this information is stored per product in .xml file, which will be combined with the geometrical .DHG files. The coupling of the data with the geometric files happens with the use of the “voorportaal”. The voorportaal is a folder where the .dhg and .xml files are stored, mainly as a work in process. After the adding of the objects to the library, this folder will be empty, with the use of the VulProgramma it will be transferred to the folders containing the items that are shown in the library.

DhDataVullen can also be used for adding information to the database, but is harder to use than the VulProgramma. When all data is added to the database of the library, the data can be managed and maintained with the use of DhDatabaseer.

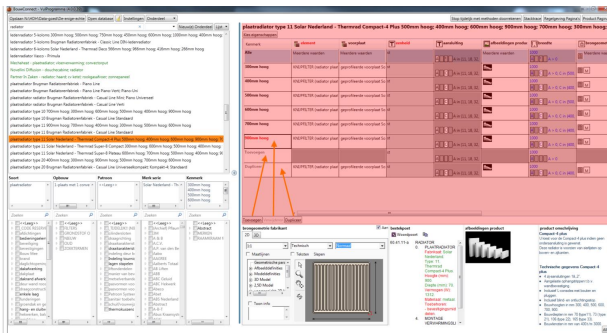


Figure 11: Properties of an object, larger version in appendix F.

To keep the information in the BCB as unambiguous as possible several templates are available. For every DeelObject that will be imported into the BCB a template has to be made if there is not already one available. A template is made in cooperation with at least 2 persons to keep the data consistent. This way it is ensured that the data of the same kind of objects is imported the same way for different companies, which makes comparisons between products possible. Furthermore the templates define the specifications of an object, for example the thickness of an object needs to be defined the same way as other objects of the same kind. This is for example the case at the points where doors and door-framings meet, all the data needs to be consistent to be sure everything fits perfectly. The templates furthermore define multiple aspects of an object:

- The way a component is placed in the warehouse;
- The position of the placement point, additional reference points and control point;
- The naming of the shape parameters, such as length, height, etc. These parameters can also be used for the stretching of geometrical shapes;
- Interdependency between multiple variables;
- The used projections of the object for 2D CAD files;
- The way layers need to be used in the drawing process, for both 2D and 3D.

An example of a template is provided in paragraph 4.3.4.

These templates dictate the way an object needs to be drawn and defines the measurements and characteristics of a type of object. The templates are designed for use for Dutch objects, incorporating measurements that are in use in the Netherlands. The differences between the Dutch and German measurements are discussed in paragraph 4.3.4. In case there are differences, no matter how small, new templates have to be generated. Products modeled according these templates have to be adjusted as well when the supplier can supply these items in both the Netherlands and Germany.

3.2.3. Creating Recipes

Some objects are harder to model than others or are formed with the use of other objects or shapes, in these cases recipes are used, thus for the more dynamic objects. Furthermore the recipes are used

for the conversion or calculation of data. The execution of a recipe can be visualized as a factory, you put something in it which gets processed and results in an output. More formal: A recipe can be seen as a gathering of operations in a specific order concerning objects. As input of a recipe the input-objects (variables) are loaded, which will be processed by a set of operations. After the execution of the recipe the result will be a set of export-objects which are ready to use.

The recipes itself are stored in custom .DHR or .XML files. Recipes are mainly used in the following cases:

- As a tool for more extensive calculations;
- The designing of geometrical shapes;
- The determining of “afbeeldstijlen”;
- The calculation of prices;
- The composing of the building specifications;
- The checking of objects to building standards;
- Possibilities are endless.

Thus with the use of recipes it gets easier to model complex products and especially in the case when there is a large amount of almost identical objects which only differ in size.

A recipe is for example used in the case of a façade ladder, which exists out of steps, cages, etc. The recipe calculates the necessary amount and size of each of these separate elements.

The making of a recipe will not be covered in this report since this is a programming activity which is behind the scope of this project.

3.3. Database structure

This chapter will deal with the database of the BCB. First a general overview of databases will be presented, followed by the structure of the BCB database.

3.3.1. General information about databases

A database is a (digitally) organized collection of data. The data which is contained in a database is dependent on the function the database has to fulfill, and is thus dependent on the requirements of the user. A database contains data that can be shared by different users for different applications simultaneously. To avert any ambiguity, the term database in this report means the data and its supporting data structures, not the data management system. The software used for storing, modifying and extracting information from a database is called a Database Management System, which is often shortened to DBMS.

The remainder of this chapter is roughly based on the works of (Elmasri & Navathe, 2000) except where explicitly noted. They define a database as being a collection of data, in which data is a known fact that can be recorded and that has an implicit meaning. A database has 3 implicit properties:

1. A database represents some aspects of the real world;
2. A database is a logically coherent collection of data with some inherent meaning;
3. A database is designed, built and populated with data for a specific purpose.

A database is maintained with the use of a DBMS which consist of one or more software programs that enables database managers to create and maintain a database. The DBMS is used to define, construct and manipulate the database, defining means for specifying of data types, structures and constraints. Constructing a database means the process of storing the data, while manipulating the data includes functions such as requesting data, updating the database, and generating reports from the data.

3.3.2. Database BouwConnect Library

In this section, a conceptual class diagram of the BCB is shown. This class diagram is restricted to links between classes without multiple associations. This conceptual class diagram underlies the final database structure.

It is impossible to store real-world objects in a database, therefore we only store information about them by means of properties called attributes. A class includes these properties and an object is an instance of class with assigned values for these attributes. The conceptual class diagram shows the links between related classes behind the database structure of the BCB. Table 2 shows the class descriptions of the classes of the conceptual class diagram, while Figure 12 shows the conceptual class diagram.

Type	Type of data	Domain
Klasse		
Klasseld	Unique identifier	Based on GUID
Naam	nvarchar	Variable set of characters
KlasseType	tinyint	Integer data max 255
DeelObjectType	tinyint	Integer data max 255
Bouwobjectklassel	Unique identifier	Based on GUID
AlgObject		
AlgObjectId	Unique identifier	Based on GUID
VolgNr	int	Integer
Klasseld	Unique identifier	Based on GUID
Naam	nvarchar	Variable set of characters
Synoniemen	nvarchar	Variable set of characters
AlgObjectType	tinyint	Integer data max 255
OpbouwItemRelatie		
BovenObjectId	Unique identifier	Based on GUID
OpbouwItemId	Unique identifier	Based on GUID
PresentatieVolgnu	tinyint	Integer data max 255
VerplichtBijSamenst	Bit	1 or 0 or null (null not allowed)
Item		
ItemId	Unique identifier	Based on GUID
VolgNr	Smallint	Small integer (-32,768 - 32,767)
ItemType	tinyint	Integer data max 255
Naam	nvarchar	Variable set of characters
Synoniemen	nvarchar	Variable set of characters
Eigenschap		
AlgObjectId	Unique identifier	Based on GUID
EigenschapItemId	Unique identifier	Based on GUID
Waarde	nvarchar	Variable set of characters
Disciplines	Smallint	Small integer (-32,768 - 32,767)
WaardeStatusLow	Bit	1 or 0 or null (null not allowed)
WaardeStatusHigh	Bit	1 or 0 or null (null not allowed)
Zoekbaar	Bit	1 or 0 or null (null not allowed)
AltijdTonen	Bit	1 or 0 or null (null not allowed)
ItemMapping		
HoofdAlgObjectId	Unique identifier	Based on GUID
HoofdEigenschapItemId	Unique identifier	Based on GUID
MapAlgObjectId	Unique identifier	Based on GUID
MapEigenschapItemId	Unique identifier	Based on GUID
DeelObjectRelatie		
BouwobjectId	Unique identifier	Based on GUID
DeelobjectItemId	Unique identifier	Based on GUID
DeelobjectId	Unique identifier	Based on GUID

OpbouwRelatie

BovenObjectId	Unique identifier	Based on GUID
OpbouwItemid	Unique identifier	Based on GUID
OnderBouwobjectl	Unique identifier	Based on GUID
IsDefault	Bit	1 or 0 or null (null not allowed)

AlgObjectClusterRelatie

AlgObjectClusterId	Unique identifier	Based on GUID
AlgObjectId	Unique identifier	Based on GUID

Table 2: Class descriptions of the classes of the conceptual class diagram of the BCB.

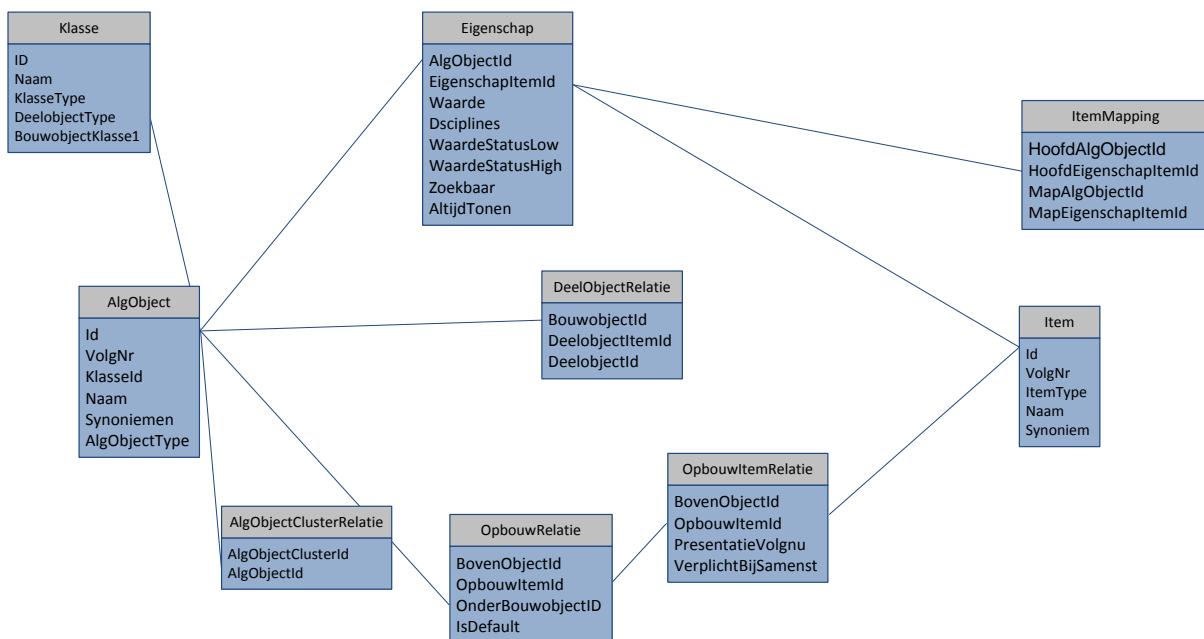


Figure 12: Conceptual class diagram of the BCB (it should be noted that the referral attributes are not all included).

The database of the BouwConnect library is constructed in such a way that the database itself is not a barrier for adding new types of information. For example when there is a difference in the definition of the height of a door between the Dutch and the German construction industry, this does not matter for the structure of the database. Of course there is a difference, but this information needs to be imported by the people working for the “vulploeg”, the people who build the models and who enter all the relevant information of a specific object. Thus that is where the changes need to be made when necessary.

4. Overview Western and German construction markets

This report is written in cooperation with the company De Twee Snoeken, who wants to bring their BouwConnect library to the German construction market. Firstly the European market will be investigated to see whether the choice for Germany is the right choice based on the market developments. After this investigation the focus will shift to the German market. The current BCB product is only focused on the Dutch construction market, when having the intention to expand to another market it is important to know the technical and organizational differences between the two construction sectors. Finally this chapter will conclude with an overview of implications for the BCB to operate in Germany.

The main part of this research is about the possibilities of the BCB to operate in the German market on a technical level. In this chapter the market in which it will operate in will be discussed. Dutch companies are often high-tech and often operate across the Dutch borders. The Dutch export sector is therefore larger than expected on the size of the country and the amount of residents. For companies there are mainly 5 reasons to expand their business to other countries:

1. The will to grow with your company in new markets;
2. Spreading risks by operating in a larger area, for example by strong competition in the home market;
3. Having a successful product which is expected to have potential in other markets as well;
4. The home market is saturated, by expanding to other areas the company gets less dependent on the home market;
5. Because of international developments the trading barriers between countries are disappearing, expanding is needed to stay competitive.

The reason of this research is that the companies the Twee Snoeken and KPN have a successful product in the Netherlands and think the product has potential in other markets as well.

4.1. Western construction markets

The world economy finds itself in one of the most destructive crises in modern history, which started in 2007 in the United States. Since then the complete economy has suffered from this crisis, and in particularly the construction sector. Before the crisis in 2007 the European market showed its 13th year in a row of uninterrupted growth (Gluch, 2007). It was expected that the growth would at least continue for 3 more years. In the early 1990's the European market grew mainly because of a short boom caused by the German reunification and extraordinary public subsidies. At the end of the 1990's the growth of the European market came mainly from the eastern European markets which showed a double digit growth (Gluch, 2007).

During the financial crisis which started in 2007 all construction markets in the western world saw a decline in the demand from customers. Because of the nature of the construction market this didn't immediately resulted in a slowdown of new constructions, since many projects were already in the works. This is caused by the turnaround time of construction projects, for example ca. 25 months for projects with 20-100 dwellings in the Netherlands (CBS, 2012).

The UK market showed an increase of new projects of 8% between 2009 and 2011, but it is still 50% lower than at the top in 2007. The German market showed only a marginally growth of 2% in 2011 (Bouwend Nederland, 2011).

The following figures from Eurostat show the trend from the start of the financial crisis until the most recent available figures except for Finland. These figures are indexed, year 2010 = 100 (average and corrected for seasonal influences) and the figures have been rounded to whole numbers. Figure 13 shows a graph of the Euro Area (group of countries using the Euro as currency), Germany, the Netherlands, and Belgium, for a more comprehensive graph containing more countries see appendix G.

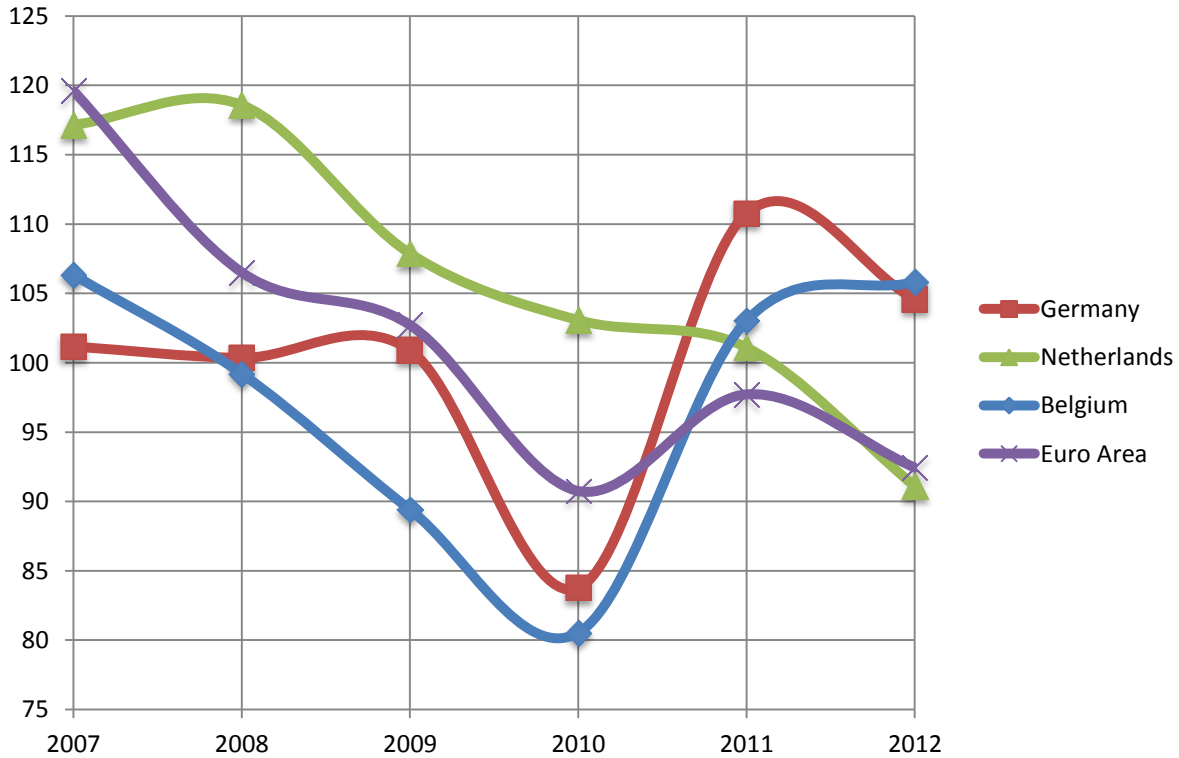


Figure 13: Developments turnover of European construction markets. Source: Eurostat.

The table and figure above show clear signs of a decline in construction output in the years 2008 2009 and 2010, and an increase in construction output in 2011 and a normalization in 2012. The construction output in the Netherlands keeps showing a downward trend.

Arch-Vision has produced a report (Arch-Vision, 2012) in which they conclude that the construction industry in the European countries that are examined are showing the first signs of recovery, but that real growth is not expected before 2015. Germany, together with the UK, is the only countries which show a quarter-quarter increase in their order book development. As seen in Figure 14 it is forecasted that the European market in total will show a decrease in the coming years, at least 'till 2014. Germany is the only country listed that is believed to show opposite figures, the market is expected to grow until 2013/2014 slowly, and after that the growth will increase.

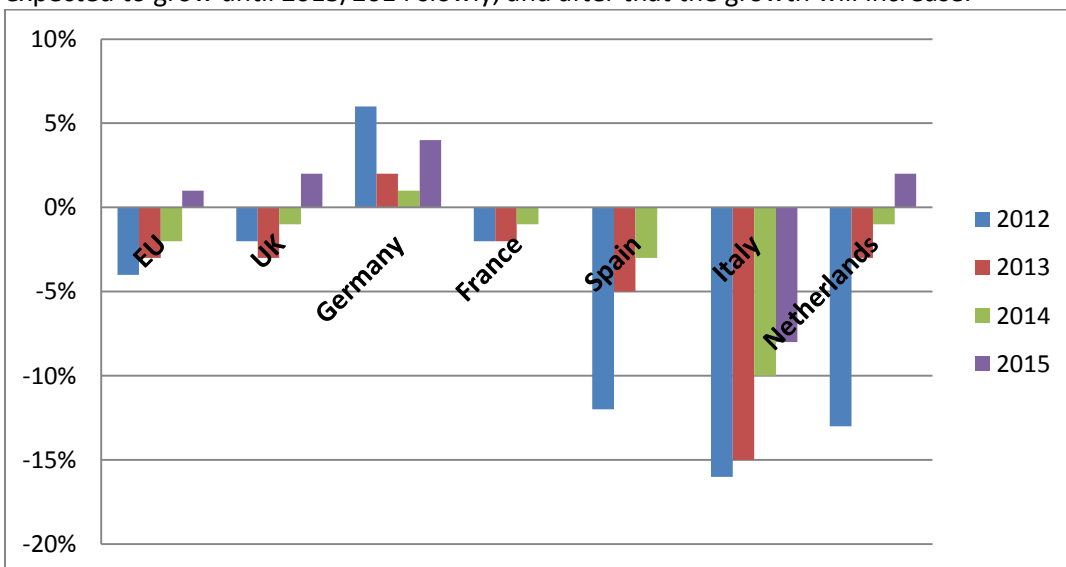


Figure 14: Graph of annual forecast in building volumes 2012-2015. Source: (Arch-Vision, 2012)

Based on the figures reported in this paragraph it is plausible to look at the German market for the expansion of the BCB product. It is the only market that still shows growth and is expected to grow in the near future.

4.2. Characteristics of the German construction market

This paragraph will show the results of the literature research of the German construction sector. The construction sector is a very broad concept with a lot of characteristics, of which most are not relevant for this research and will therefore not be covered in this report. The scope of this research it is not meant to give a full overview of all relevant German standards, however the most important and deterrent aspect will be dealt with.

4.2.1. German market

In 2011 the construction output of the German market was worth 258 billion euro, a total of 10% of the total German GDP and employed almost 2,5 million persons, a total of almost 6% of the total German working population. Most of the construction companies in Germany are small based firms with 1 to 19 employees (Die Deutsche Bauindustrie, 2012). Table 3 shows the market share of several sizes of companies in the German market, and their accompanying share of the turnover of the construction market. These figures show that the majority of the market, 65% of the total market, is being served by small companies which employ 1 to 49 persons. Only 12% of the market is served by large companies who employ more than 250 persons, but these companies have a large share, 22%, of the total turnover of the market.

Company Size	Share of market	Share of turnover
1 – 49 employees	65 %	48 %
50 – 249 employees	23 %	30 %
250 and more employees	12 %	22 %

Table 3: Division of the German construction market to size (2009). (Die Deutsche Bauindustrie, 2012)

From Figure 15 it is clear that the employment rate in the German construction sector has shown a downward trend since the reunification of Germany. The number of employees in the German construction sector has declined between 1995 and 2005, stayed steady between 2005 and 2009 and shows a low growth after 2009.

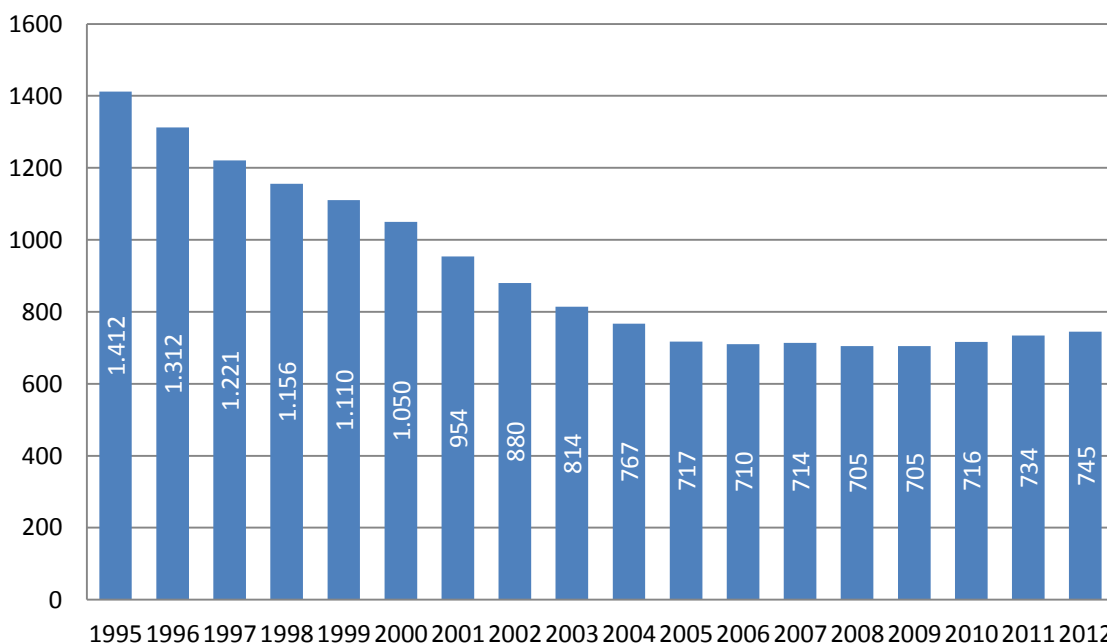


Figure 15: Number of employees in the construction industry, in thousands. Source: (Die Deutsche Bauindustrie, 2012).

The turnover of German construction industry has shown a year to year decline since mid-1990's, after a short boom after the reunification in 1990. Figure 16 shows an almost constant decline in turnover until 2005. From 2005 and onwards the market jumps from positive to negative growth, mainly because of the implementation of stimulus packages from the federal government, the federal states and local authorities.

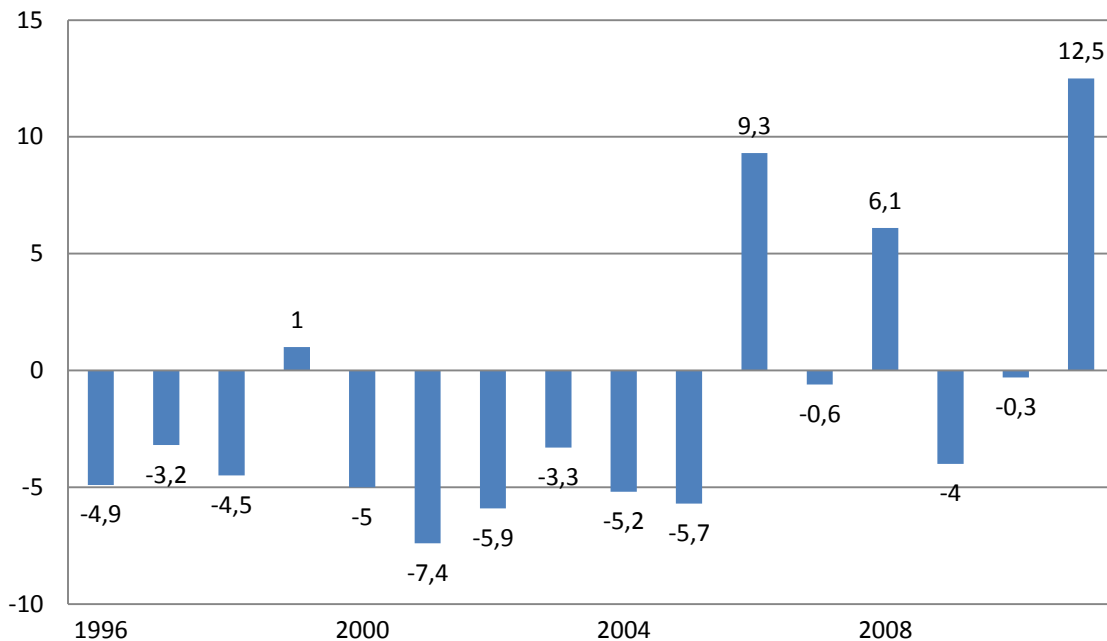


Figure 16: The year-to-year differences in turnover. Source: (Die Deutsche Bauindustrie, 2012).

According to the German statistical bureau the amount of approved building permits in 2012 grew with an annual growth of almost 5%, which was not as high as the absurdly high growth in 2011, caused by the crisis year of 2010 but still worth mentioning.

Figure 17, based on (NRW.bank, 2013), shows that the prices of all houses in Germany have risen since 2005 after showing a dip between 2005 and 2010 (yellow line). The price index, q4 2005 = 100, shows that the new one and 2 family housing has shown a steady growth without any noteworthy dips (blue line). The price index for used housing shows a strong decline until 2010 followed by a rapid growth which has compensated the increases of the years before (red line). In the last quarter of 2012 the price-index showed a 100+ figure.

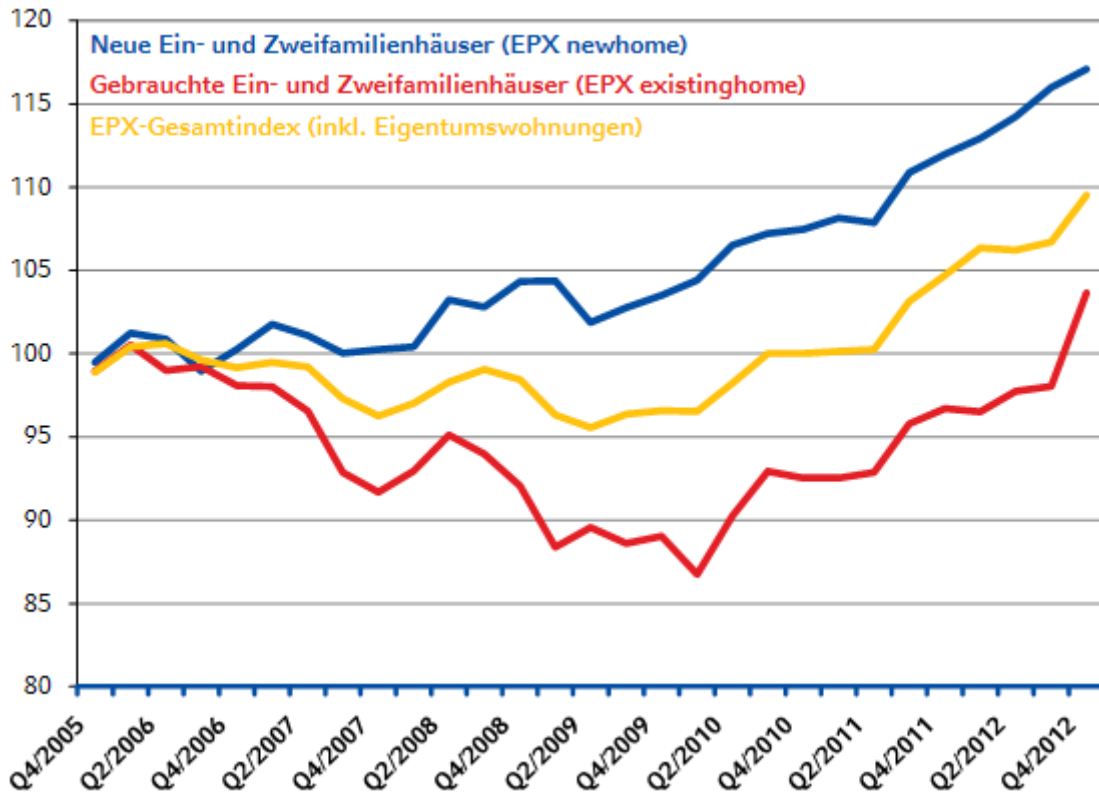


Figure 17: Price indices of new and used housing in Germany from 2005 to 2012.

Furthermore it must be noted that the German market mainly drives on works on existing buildings, see Figure 18 (Gornig & Hagedorn, 2012). The main reason for this rise in construction volume on existing buildings is caused by a large number of subsidies launched by federal government, see Figure 19. However because of these subsidies, the total construction volume on energy-efficient construction has not risen since 2010.

Residential Construction Volume in Germany

Nominal values, in billion euros

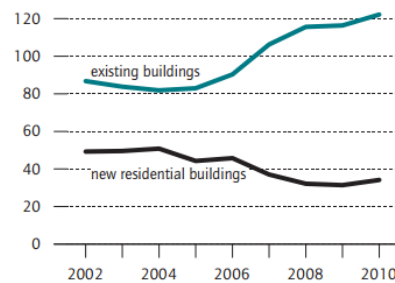


Figure 18: Relation between work on new and existing buildings in Germany.

Government Subsidization of KfW Programs for Energy-Efficient Construction and Modernization

In million euros

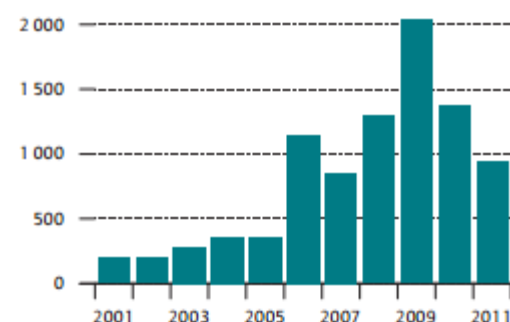


Figure 19: Federal subsidies.

4.2.2. Structure of the German construction market

In this paragraph the specific characteristics of the German market will be elaborated. This way it is possible to point out the differences comparing to the Dutch market which de twee Snoeken have to keep in mind when expanding to the German market.

The construction process in Germany has globally the same structure as the Dutch construction industry. An overview of the German situation is shown in Figure 20. The first phase is the initiative phase, in which a project is being set up. The main actors in this phase are the client and an architect as advisor. After this phase the definition phase starts, in this phase the client and his advisors setup all the requirements which the project has to comply to in order to satisfy the needs of the client. The following phase is the design and construction preparation phase, in which the architect, general contractor (ideally), advisors, and engineers, setup the first design.

Following this stage is the tender phase in which the client and general contractor(s) play the main role. In this phase the project is being awarded to a general contractor who has fulfilled the requirements of the client in the best possible way. The next stage is the execution phase in which the project is being engineered and build, the main actors are the general contractor and, if any, sub-contractors. The delivery and service phase is being handled by the general contractor. The user phase and maintenance phase are the longest phases in the lifespan of a building, the main actors are the users, the client and the operator of the building. Because of the, generally, long lifespan of a building these actors can change as the building ages.

The final stage of the building process is the demolition of a building.

The BCB focusses mainly in the design and construction preparation phase of the process, but because of the BIM way of working the data generated by the BCB will ideally be used in the following stages of the project, all the way to the demolition phase.

This building process does not form any barriers concerning the implementation of the BCB in the German construction sector.

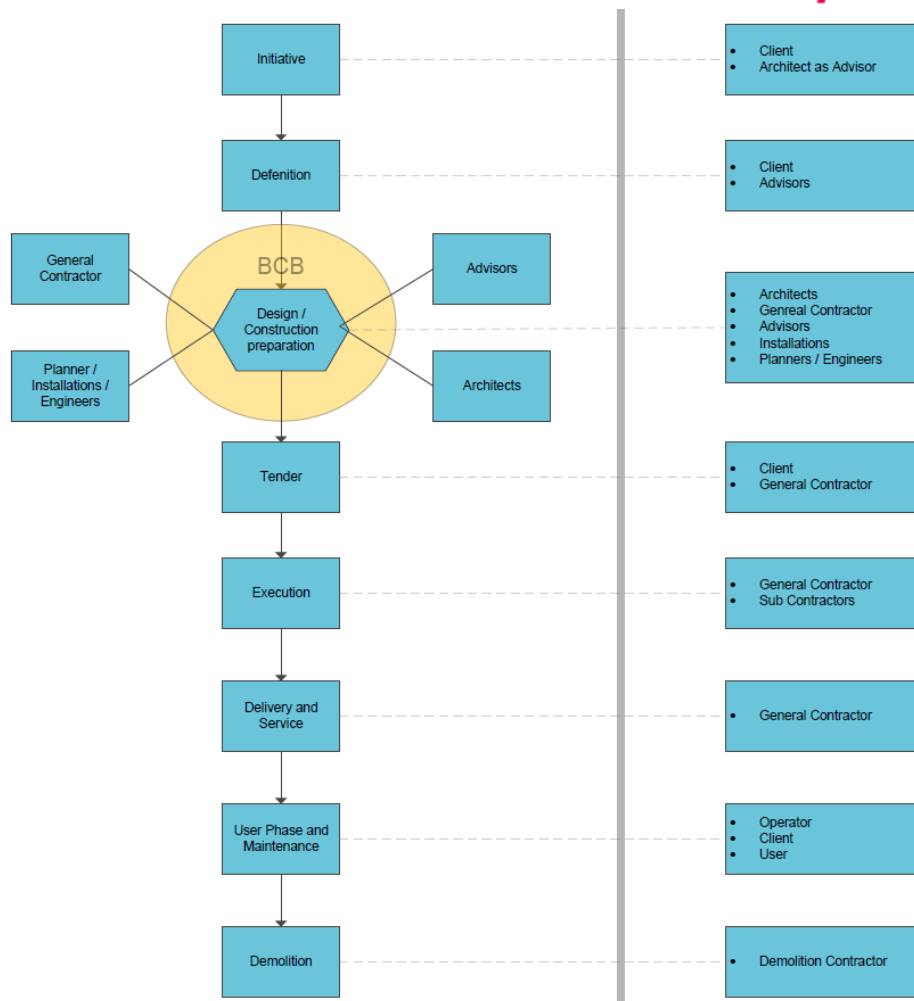


Figure 20: Overview of the German construction industry and the involved parties.

4.2.3. Regulations of the German construction market.

The German construction market knows a lot of different construction requirements. In the Netherlands we have one building act, the “bouwbesluit”, in Germany there are 16 different versions of the building act (Bauordnungs). This is mainly because of all the states (Bundesländer) of Germany have their own regulations, which can cause large differences in regulations even between 2 nearby cities in different states. For many components of a building there are different regulations, for example the amount of parking places is stated in the “Stellplatznachweis”, staircases are regulated through DIN 18055 and the flat roofs are regulated with the “Flachdachrichtlinien”.

Furthermore, every function that a building can have has its own regulations. The technical specifications of a building need to meet the “Liste der technische Baubestimmungen (LTB)” and the method of applying for a building permit is determined in the “Bauvorlagenerlass (BVErl)”. But first you have to check whether you are even authorized to submit the building permit via the “Nachweisberechtigtenverordnung (NBVO)”.

Furthermore there are even regulations concerning the spaces and organization of these spaces in a building, there are different requirements for specific functions. Regulations concerning the specifications for buildings with personnel it is necessary to comply with the “Arbeitsstättenrichtlinien (ASR)” and “Arbeitsstättenverordnung (ArbStättV)”, which for instance determine the number of toilets that are needed. For specifications concerning the sanitary areas the “Sanitärräumen(VDI 6000)” is available (Habracken, 2011).

In the previous paragraph only a couple of building regulations are shown. When designing and constructing a building in Germany it is advised to have a good understanding of the local market, and get informed of all possible building regulations by someone who is well known with the local practices. Furthermore, in business, many Germans do speak English but it is recommended that initial contacts are made in German and that documents and correspondence are produced in German.

The book of Meijer et al, 2002, deals with the problem that all countries in the EU have their own building laws and standards, which interfere with the integration of the EU and the possibilities of companies working cross-border. Because of the fact that in Germany the federal states have their own codes, this book uses the state Hessen as an example.

The system of building regulations in Germany is thus mainly determined on the country's federal structure and the reliance on a strict system of product approval. Building regulations still differ from state to state, despite the years of efforts to reach federal uniformity. Local or regional control authorities are responsible for building permits and building control, of which some parts can be performed by private specialists. To obtain a building permit you need approval from a recognized institute, except for products and construction types which are widely used over a longer time. (Meijer, et al., 2002)

The state building regulations are uniform and are described in the National Building Code. At a federal level there is the Model Building Code (Musterbauordnung) which can be used as an example for the individual building codes. In the state of Hessen the norms and codes follow the model code for more than 80%.

4.2.4. HOAI (Honorarordnung für Architekten und Ingenieure) (Fee structure for architects and engineers)

The prices for design and engineering tasks in Germany are regulated by a state law, the "Honorarordnung für Architekten und Ingenieure" (HOAI). The first traces of the HOAI lead back to 1976. This law regulates the prices design and engineering tasks, from which deviations are permitted in only a few specific cases. One of these cases is the situation where a general contractor provides regularly construction works, i.e. in the course of a comprehensive work. The HOAI has been initiated with the idea that with a fixed price every architect and engineers is able to ensure the quality of designing, tendering, procurement and site supervision. This leads to the situation where there is no price based competitiveness but a more quality based competition. The use of HOAI is mandatory for all projects initiated by public clients.

At this moment there are several studies whether the HOAI is in violation of with the European rules of free competition. The current version of the HOAI has been established in 2009 after some concerns raised by the European Union. This version applies to contracts established after august 18th 2009. The fee for the architect or engineer is determined with the fee tables for the same kind of projects, following an eligible costs and the fee bandwidth. This bandwidth is divided in 5 categories, each differ in range according to the complexity of a project, which results in both the minimum and the maximum fee for the work.

In this newest version the time fees (hourly rates) are freely negotiable, the bandwidth of the fees has been expanded with 10% and new amortized-cost calculations are now the rule and basis for payment of all phases, instead of actual construction costs. This version is furthermore adjusted to incorporate project based working and it contains less power binding rules (Heintzenberg, -). Furthermore it is not necessary anymore for foreign companies to comply with the HOAI (Kalusche, -). Starting the 2009 edition the majority of the rules stated in the HOAI only comply to actual designing tasks, consulting services are exempted.

The HAOI is divided into 5 sections which deal with different phases and different kinds of works in the construction industry (Kalusche, -).

1. General requirements;
2. Land use planning;
 - 2.1. Development planning;
 - 2.2. Landscape design;
3. Building design;
 - 3.1. Construction and interior design;
 - 3.2. Exterior design;
 - 3.3. Structural design;
 - 3.4. Infrastructural design;
4. Engineering;
 - 4.1. Structural design;
 - 4.2. Building installation design.

The HOAI divides the work of the architects and engineers in 9 phases, of which the first 4 are more design oriented and the last 5 more implementation orientated:

1. Basic evaluation;
2. Preliminary design with cost estimates;
3. Preliminary design and costing;
4. Approval of design;
5. Implementation design;
6. Preparation of tender, including the determination of total amounts and putting up the bill of quantities;
7. Participation in the tender, including cost estimates;
8. Project supervision and establishing costs;
9. Property maintenance and documentation.

It must be made clear that the HOAI thus does not regulate the services an architect or an engineer decides to deliver, only the prices. According to (Liebich, et al., 2011), this leads the case that there is no incentive to start innovative changes of new compensation models, which will collide with the HOAI. (Liebich, et al., 2011) Therefore conclude that it is reasonable to conclude that the HOAI and the way it is used in Germany restricts the acceptance of engineers towards BIM methods.

In May 2013 the newly updates HOAI will be put into force, officially the changes have not been presented yet and thus cannot be elaborated in this report.

4.2.5. German-Dutch cross-border employment

Since the 2000's the German construction sector has seen a downturn in the amount of projects and a rise in unemployment. At the same time the Dutch market grew, the German contractors saw possibilities because of the Dutch Underemployment in the sector (Voorde, 2002).

The Dutch ministry of VROM has released the document "Informationsbulletin für deutsche Bauunternehmen in den Niederlanden" in which it states the main differences between the Dutch and German construction industry for contractors. This article shows the results of a research done in the Dutch provinces of Drenthe and Groningen, the provinces in which German construction companies often participate in residential construction projects.

The German variant of the Dutch "Bouw- en woningstoezicht" only checks whether the building plans are complying with the current land use plans, and therefore there is no need to hand over technical drawings and calculations. In the Netherlands the building plans are tested with the use of a risk analysis, but the liability stays with the client. In Germany the liability also stays with the client, but it

is easier to keep the contractor responsible for errors due to the fact that in Germany there is a warranty of 5 years for visible defects and 10 years for invisible defects, both large and smaller defects.

Differences are for example the measurements of a door. In the Netherlands it is stated that a door needs to be at least 0.85m wide and 2.30m high, in Germany doors indoors need to be 0.8m wide and exterior doors at least 0.90m wide. In Germany there is no minimum height, all widely available doors are about 2.25m high.

4.2.6. Cultural differences between the Netherlands and Germany.

Although the Dutch and German people are much alike, there remain large cultural differences in the way the people interact with each other. (Jansen & Komorowski, -) of the Dutch-German handelskamer have researched the main language and cultural differences between the 2 countries, resulting in the following points.

1. Germans base their first impressions mainly on appearances, looks and professionalism;
2. Germans are very proud of their language and are profound of protecting their language against English influences. This does not mean that a German conversation partner doesn't speak English at all. In conversations between Dutch and Germans there are often prejudices from both sides, many Dutch think that Germans do not speak English and many Germans assume that the Dutch know foreign languages.
 - a. Concluding: A lot of Germans do speak English, however communication in the German language is preferable to English.
3. Germans are more courteous and distant, they appreciate the use of appropriate forms of address such as the Doctor title;
4. E-mail exchange with German partners is often experienced as difficult, in general it takes a long time before an e-mail gets answered to. The direct answering of e-mail from a German partner not recommended since this can seem that you have not given much thought about the standing issue or that you do not take the issue serious.
5. The Dutch are more verbally oriented, while Germans like to have written confirmations;
6. It is important to prepare well for negotiations because it is probable that you will get detailed questions which cannot be answered with "Das kriegen wir schon hin"(We will get back to that) because this will raise questions about your skills.

Furthermore the Dutch ministry of Economics has put out a presentation, (Soest, 2012) which deals with the cultural differences between the Netherlands and Germany with a focus on international businesses, shown in Table 4.

Netherlands	Germany
Process focused	Result and knowledge focused
Flexibility	Conservative
Creativity	Product oriented
Consensus Model / Egalitarian	Hierarchical / formal
Improvisational power	Perfectionistic
Direct and open in relations	Direct in depth discussions
Open for changes	Etiquette /
Thinkers	Implementers
Feminine	Masculine

Table 4: Cultural differences between the Netherlands and Germany.

Furthermore the following points stand out in research available concerning the starting of a firm in Germany:

- In the Netherlands there is protection for creditors, in Germany there is more legal protection of de debtor;
- The Germans put a lot of confidence in approval labels, certificates and references;
- Germans prefer to do business with GmbH companies, which are businesses with limited liability (BV in the Netherlands);
- Germans prefer a more personal approach instead of “cold calling” and mailing lists;
- Dutch companies with partners in Germany are advised to set up decent contracts and keep track of all agreements made in the past;
- Germans prefer to be addressed with their surname.

German companies are often pleasant and reliable to have as a trading partner. A major characteristic of German businesses is that they are time-driven and attach great value to a strict time-management approach. Costs are not the most important aspect for German businesses, the most important is quality. The overall main goal is to deliver a perfectly working product or the perfectly performed assignment. Concluding, the Dutch are more process oriented while the Germans are more result-oriented.

4.2.7. Comparison of software usage between the Netherlands and Germany

When trying to put a new software based product in the German construction market it is important to know the differences in software use between the Dutch and German construction sector. Because the BouwConnect library is designed for the Dutch construction market, it is important to know the differences in architectural software packages. For instance the most 3D BIM-capable packages in use in the Netherlands are Arkey AutoCAD and Revit, for which the BCB has special tailor made plugins. Archvision, 2012, shows the usages of different software packages in several European countries. AutoCAD has a strong position on the European market, being the most used software package in almost all of the researched countries. Only Germany shows different ratios, German software packages have the largest portions of market shares. For all the results see Table 5.

Netherlands	Germany	United Kingdom	France	Spain	Italy
AutoCAD 27%	ArchiCAD / Nemetschek Allplan 18% (both)	AutoCAD 50%	AutoCAD 34%	AutoCAD 64%	AutoCAD 61%
ARKEY 18%	AutoCAD 16%	ArchiCAD 10%	ArchiCAD 22%	Allplan 8%	ArchiCAD 10%
Revit 13%	Vectorworks 10%	Vectorworks 7%	Allplan 13%		
Other / not known 35%	Other / not known 38%	Other / not known 33%	Other / not known 31%	Other / not known 28%	Other / not known 29%

Table 5: CAD usage in European countries. (USP, -)

Research Company WSP has issued a report called the 10 truths about BIM in which they compare the situation of BIM in different countries and the software they seem to use for BIM-oriented designing. In most of the countries AutoDesk Revit is the main player in the BIM capable software segment, which is mainly caused by the use of the AutoCAD platform in the past. Germany is an exception to most of the rest of the world because architects mostly use German CAD software packages, making the transfer to the Revit package less common. Nemetschek dominates the 3D design market with their software package Allplan. WSP, -, also notes that the concept of BIM is less common in the German literature. English written articles are 20 times more likely to mention BIM than the German equivalents. This may be caused by the fact that the meaning of BIM is popularized

by Autodesk, who has a low market share in Germany. Since 2011 the market share of Revit seems to have grown in spite of Allplan, but the market share is still so low that it isn't mentioned in Table 5. A short comparison in software use is shown in Table 6. This table shows clearly that the Netherlands are more internationally oriented in the field of software usage. German companies mainly use German made software, which can prevent international developments from being implemented.

Phase	Stakeholders	Netherlands	Germany
Initiation	Client Architect as advisor	<i>Office-package</i>	<i>Office-packet</i>
Definition	Client Advisors	<i>Office-package</i>	<i>Office-packet</i>
Design	Architects Contractor (ideally)	ArchiCAD 27% AutoCAD 18% Arkey 13% Revit	18% ArchiCAD 18% Nemetschek Allplan 16% Autocad 10% Vectorworks
	Advisors	CAD software AutoCAD (Revit) MEP	ElektroCAD RIB software
Tender Preparation	Contractor Advisors	<i>Compatible cad software</i> STABUtext DunCalc	<i>Compatible cad software</i> Architext Pallas Nemetschek Auer AVA RIB software for planning and visualization
Tender			
Construction preparation	Contractor Sub-contractors	<i>Cad Software</i> <i>Office-package</i>	<i>Cad Software</i> <i>Office-package</i>
Construction	Contractor Sub-contractors	<i>Cad Software</i> <i>Office-package</i>	<i>Cad Software</i> <i>Office-package</i>
Completion and service	Contractor		
User phase and maintenance	Operator Client User		
Demolition	Demolition company		

Table 6: Comparison between software usage in the Netherlands and Germany in different stages of the construction process.

4.2.8. The role of the German architect in the construction process

An important aspect is the influence of different parties on the construction process. Architects in the Netherlands are mainly responsible for designing tasks new buildings. In Germany the role of the architect included more tasks in the construction process until a couple of years ago. The architects were often also the project managers of a project, only since ca. 10 years there has been a shift to independent project managers. This shift has mainly happened for large scale projects. This new project manager is responsible for the tasks of project definition, project organization, project planning, communication, environment management, project management and project documentation.

Figure 21 shows the differences in the scope of work between German architects and architects from the US/UK which existed until ca. 10 years ago and still remains in use for smaller projects. From this figure it is clear that all the architects in Germany have more tasks, not only the pre-design, schematic design, design/development, approval of the planning and construction documents but also play a part in the detailed drawings of a project, the tender documents, bill of quantities, participate in negotiations, being part of the construction management and do the documentation and controlling of a project (BDA, 2011).

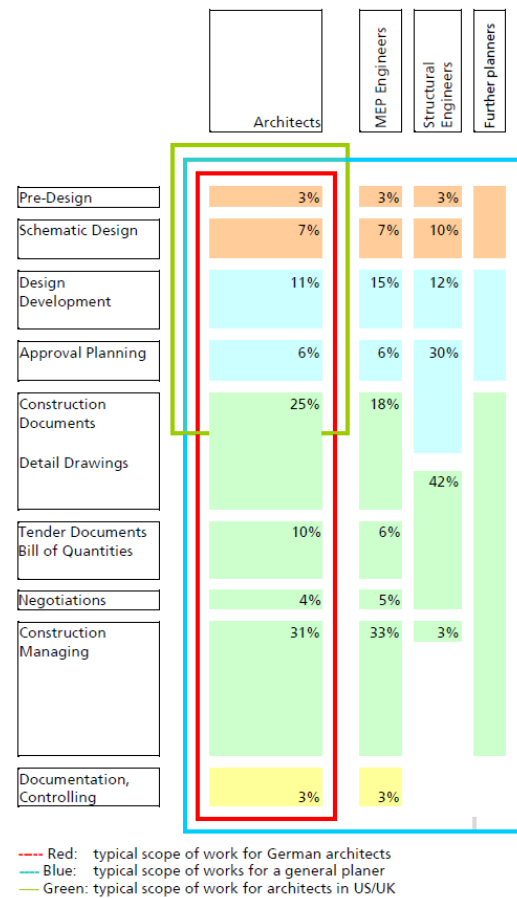


Figure 21: Comparison between the scope of work between German and US/UK architects.

4.3. Implications for the BCB

This chapter will deal with the most important changes that have to be made when implementing the BCB in the German situation.

4.3.1. Bottom-up approach of changes needed for entering the German market.

The current version of the BCB is designed for the Dutch market. This has led to the fact that the whole system is made available in the Dutch language only. As seen in paragraph 4.2.6 it is recommended to serve the information in the BCB in German when wanting to participate in the German market. When a German person tries to find information about the BCB at this moment, all information is only available in Dutch, thus the brochures and the Website need to be accessible in German. When expanding to other countries it is recommended to figure out whether it is profitable to make translations for every country or make the software available in a few languages including English for the international expansion.

Furthermore the BCB software in its current form has been looked through from a German viewpoint to find out the recommended adjustments. The first screen, which is shown when starting up the program, is the welcome screen with the latest news concerning the software and other news concerning the Dutch market. In a German version this information needs to be available in German and should show news focused on the German construction market.

When searching for objects, the search bar shows possible objects for that query, of course these needs to be available in German and the types of objects possibly need to be expanded for specific German construction elements. For example wood-construction in Germany is much more popular than in the Netherlands which leads to the need of more specific object categories.

It is possible to search object by category though an object tree based on the NL-SfB systematics. This system categorizes object to their relation in the total construction, unlike the STABU building specification which categorizes building objects according their types of work. The database of the BCB is not based on this system, but all components have the data concerning their state in the NL-SfB as a property which makes it possible to search by



Figure 22: Welcome screen of BCB.

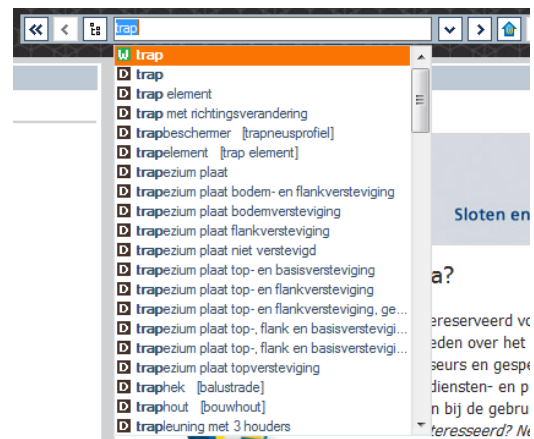


Figure 23: Search screen.



Figure 24: Building specifications according the STABU method.

categories. To implement the same feature for German products it is needed to implement a general German categorization method. There is no German variant of the SfB method but other options are available, more information is shown in paragraph 4.3.3

The window which shows the results of a search query needs to show the information in German which is automatically achieved when filling the library with German construction elements and a translation of the software. These translations are also needed for the abstract objects which are available in the library. The units of the specifications in the German industry are the same as in the Dutch industry namely SI-units which are mostly based on the metric system. The drawings are available through plugins for the most used software packages such as AutoCAD LT, Arkey and the Revit family or by IFC export, this way most of the software market in the AEC is being served. At the time of writing ArchiCAD is one of the most used software packages in Germany, a direct plugin for the library is currently already in the works. The building specifications need to be focused on the German system of STLB-Bau, which show similarities to the Dutch STABU method.

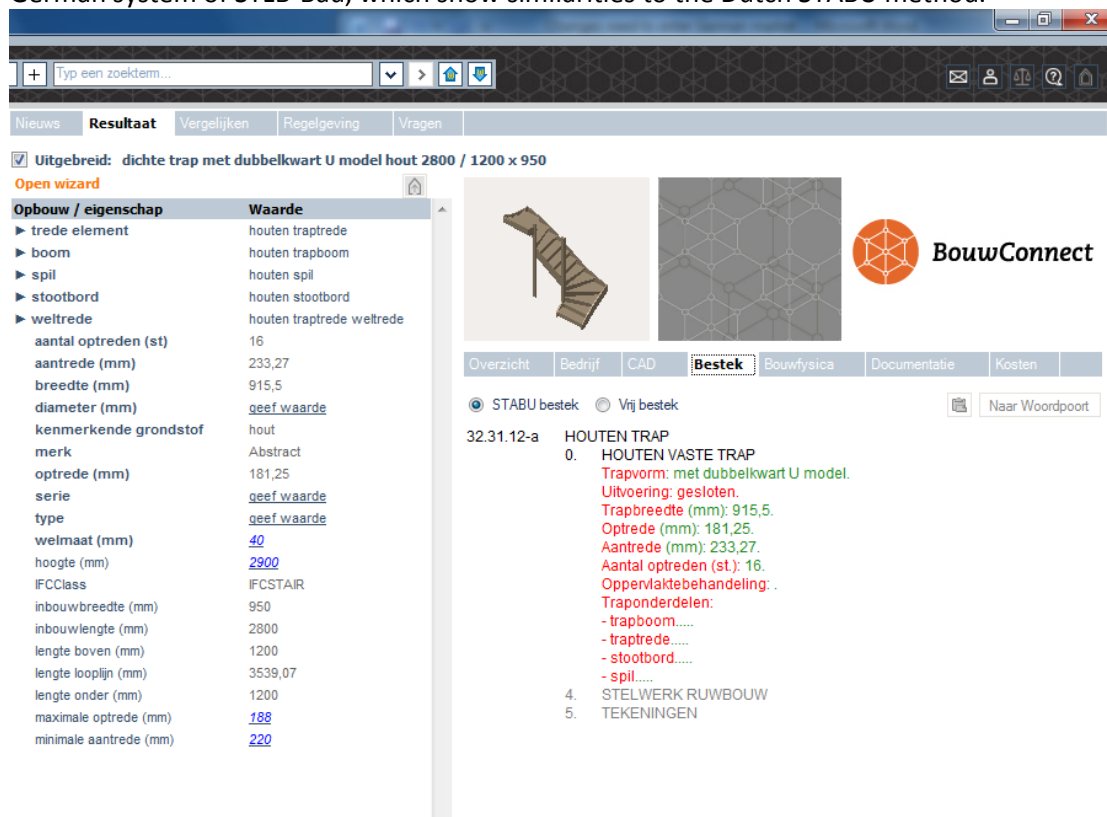


Figure 25: Screenshot of information shown when selecting a stair.

For the building regulations which are shown by some of the objects German regulations are needed according to German regulations such as the DIN-series and the “Landesbauordnung”. The main obstacle of the German construction industry is that every state of Germany has its own “bauordnung” which can differ quite a bit from other states as shown in paragraph 4.2.3. This can be solved by adding an option to select the state someone works in, or by just focusing on 1 state at the time.

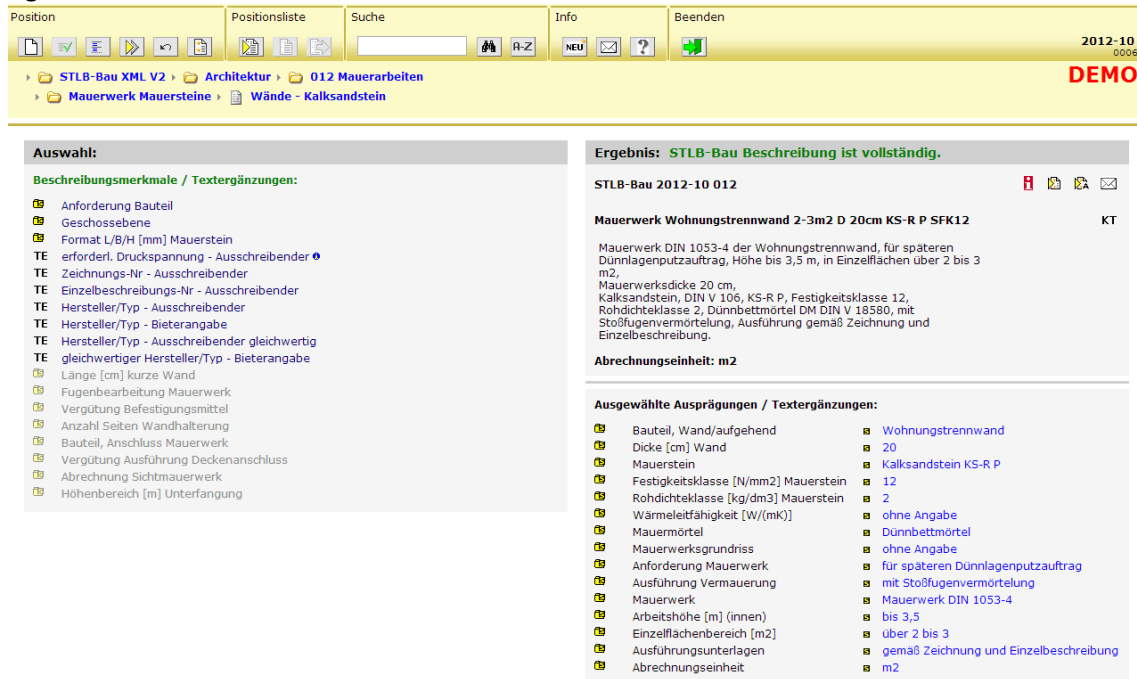
4.3.2. Building specifications

The building specifications in the German construction industry are generated with specially made software. The buildings specifications for the tendering of the works are mostly made with AVA systems, AVA stands for “Prozesse Ausschreibung, Vergabe und Abrechnung”, the data exchange of these bills is done according to GAEB guidelines.

The GAEB also provides an increasingly more important digital platform for the exchange of data. This data exchange is based on the XML file format. Because of the interaction between many parties in the construction process, the GAEB gets in increasingly larger role for streamlining the exchange of data. The exchange of data goes even further than just the plain exchange of files, it also serves as a digital platform to retrieve information like calculation data and unit costs (both will be implemented in the near future).

The “Standardleistungsbuch” is the German equivalent of the “Stabu bestekteksten” in the Netherlands. The first editions have been released in the 1980’s and were named STLB. In 1997 a renewed edition of the STLB has been released under the name STLB-bau. This book has been issued in paper form in the past, but the newest versions are only available online. The specification can be made in a software application and then can be used for the tender phase. The STLB-bau has been divided into 89 different trades, for example 000 for safety equipment and construction equipment, 002 for groundwork, 013 for concrete works, etc.

The online STLB-bau is formed in such a way that it generates the needed information for you. For example when composing a wall you can choose for a lime stone wall, choose the thickness of the wall, type of limestone, strength, etc. For screenshots of this software see Figure 26, Figure 27 and figure 29.



The screenshot shows the software interface with a top navigation bar containing 'Position', 'Positionenliste', 'Suche', 'Info', and 'Beenden'. Below the navigation bar, there are breadcrumb links: 'STLB-Bau XML V2 > Architektur > 012 Mauerarbeiten > Mauerwerk Mauersteine > Wände - Kalksandstein'. A 'DEMO' label is visible in the top right corner.

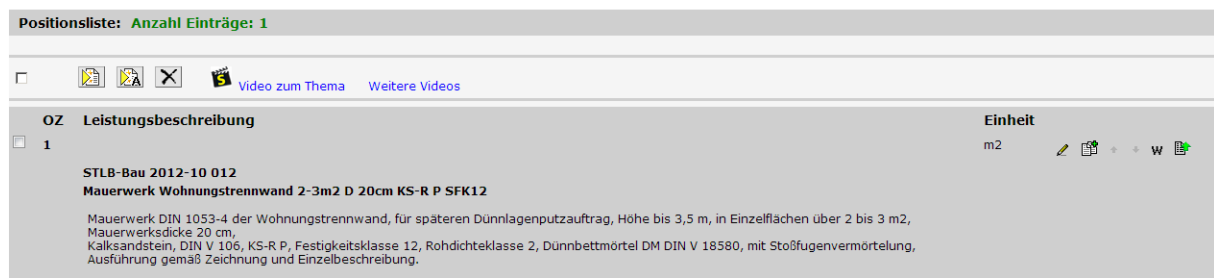
The main content area is divided into two panels:

- Auswahl:** A list of selection options under 'Beschreibungsmerkmale / Textergänzungen:'. Options include 'Anforderung Bauteil', 'Geschossebene', 'Format L/B/H [mm] Mauerstein', 'erforderl. Druckspannung - Ausschreibender', 'Zeichnungs-Nr - Ausschreibender', 'Einzelbeschreibungs-Nr - Ausschreibender', 'Hersteller/Typ - Ausschreibender', 'Hersteller/Typ - Bieterangabe', 'Hersteller/Typ - Ausschreibender gleichwertig', 'gleichwertiger Hersteller/Typ - Bieterangabe', 'Länge [cm] kurze Wand', 'Fugbearbeitung Mauerwerk', 'Vergütung Befestigungsmittel', 'Anzahl Seiten Wandhalterung', 'Bauteil, Anschluss Mauerwerk', 'Vergütung Ausführung Deckenanschluss', 'Abrechnung Sichtmauerwerk', and 'Höhenbereich [m] Unterfangung'.
- Ergebnis: STLB-Bau Beschreibung ist vollständig.** This panel shows the selected item: 'STLB-Bau 2012-10 012' with a 'KT' (Kalksandstein) classification. The description reads: 'Mauerwerk Wohnungstrennwand 2-3m2 D 20cm KS-R P SFK12'. Below this, it specifies: 'Mauerwerk DIN 1053-4 der Wohnungstrennwand, für späteren Dünnlagenputzauftrag, Höhe bis 3,5 m, in Einzelflächen über 2 bis 3 m2, Mauerwerksdicke 20 cm, Kalksandstein, DIN V 106, KS-R P, Festigkeitsklasse 12, Rohdichteklasse 2, Dünnbettmörtel DM DIN V 18580, mit Stoßfugenvermörtelung, Ausführung gemäß Zeichnung und Einzelbeschreibung.' The 'Abrechnungseinheit: m2' is also shown.

A second section, 'Ausgewählte Ausprägungen / Textergänzungen:', lists specific parameters and their values:

- Bauteil, Wand/aufgehend: Wohnungstrennwand
- Dicke [cm] Wand: 20
- Mauerstein: Kalksandstein KS-R P
- Festigkeitsklasse [N/mm²] Mauerstein: 12
- Rohdichteklasse [kg/dm³] Mauerstein: 2
- Wärmeleitfähigkeit [W/(mK)]: ohne Angabe
- Mauermörtel: Dünnbettmörtel
- Mauerwerksgrundriss: ohne Angabe
- Anforderung Mauerwerk: für späteren Dünnlagenputzauftrag
- Ausführung Vermauerung: mit Stoßfugenvermörtelung
- Mauerwerk: Mauerwerk DIN 1053-4
- Arbeitshöhe [m] (innen): bis 3,5
- Einzelflächenbereich [m²]: über 2 bis 3
- Ausführungsunterlagen: gemäß Zeichnung und Einzelbeschreibung
- Abrechnungseinheit: m²

Figure 26: Screen after selection all options.



The screenshot shows the 'Positionenliste' (Bill of Materials) interface. At the top, it says 'Positionenliste: Anzahl Einträge: 1'. Below this, there are icons for 'Video zum Thema' and 'Weitere Videos'.

The main table has the following structure:

OZ	Leistungsbeschreibung	Einheit
1	<p>STLB-Bau 2012-10 012</p> <p>Mauerwerk Wohnungstrennwand 2-3m2 D 20cm KS-R P SFK12</p> <p>Mauerwerk DIN 1053-4 der Wohnungstrennwand, für späteren Dünnlagenputzauftrag, Höhe bis 3,5 m, in Einzelflächen über 2 bis 3 m2, Mauerwerksdicke 20 cm, Kalksandstein, DIN V 106, KS-R P, Festigkeitsklasse 12, Rohdichteklasse 2, Dünnbettmörtel DM DIN V 18580, mit Stoßfugenvermörtelung, Ausführung gemäß Zeichnung und Einzelbeschreibung.</p>	m ²

Figure 27: Specifications ready to put on complete bill of specifications.

There are API's available for the implementation of the STLB-Bau in 3rd party applications. To get access to this API, the vendor needs to be registered as co-distributor, which is free. Then the vendor gets a unique application-ID and a 3 month trial access and a detailed description of the interface. With this information the STLB can be integrated into 3rd party software. The final version of the implementation will be tested and approved after approval of STLB. If the BCB wants to provide building specifications like in the Netherlands, it is recommended to implement data of STLB-Bau in the software.

4.3.3. German variants NL-SfB

In the Netherlands the NL-SfB is being used as a classification method, meant for being used during the design, realization and maintenance of a building project. This method is mostly used to arrange building objects and layers in CAD-systems, to order information from suppliers, to group costs-information, and other appliances.

In this method building components are being ordered to their function in the total structure. The code always exists out of 4 numbers, the first 2 represent the group an object can be classified to, the last 2 numbers stand for the function and the application of an object.

For instance a door gets the code "32.31", as seen in Figure 29. This code is built up from code "32.xx" for inner wall openings, code "32.3x" for inner wall openings filled with doors and "32.31" for inner walls with openings filled with hinged doors.

The NL-SfB is, as its name suggests, a Dutch derivative of a standard called the SfB which has been developed in Sweden in the 1950's. SfB stands for "Samarbestkommittén för Byggnadsfrågor", which can loosely be translated to "Cooperation Committee for Building Issues". In 1976 the Royal Institute of British Architects has expanded the original SfB with more tables, which has been called the CI/SfB. The Dutch version has been in effect since 1977, the year in which the Dutch SfB committee, led by the BNA (Bond van Nederlandse Architecten), has been founded. In a couple of other countries there are also SfB variants in use with varying popularity. For example the before mentioned CI/SfB in the UK, SI/SfB in France, BB/SfB in Belgium and to a lesser extent the BRD/SfB in Germany. All versions are more or less a translation of the original CI/SfB, which makes it easier to cooperate in international settings.

In the Netherlands the SfB systematics is being used widespread throughout the complete construction sector, making it a de facto standardization method. In Germany the use of the SfB systematic is not as widespread as in the Netherlands, in fact it seems that it is not being used at all. The function of the SfB is being taken over by the **DIN 276** for the use of costs estimates, like the SfB fulfills in the Netherlands for small sub-projects in which the extensive method of the STABU isn't needed. The "DIN 276:Kosten im Bauwesen" consists of 2 parts, "teil 1: hochbau"(constructions) and "teil 4: Ingenieurbau" (civil engineering).

Ergebnis: STLB-Bau Beschreibung ist vollständig.

STLB-Bau 2012-10 012

Mauerwerk Wohnungstrennwand 2-3m2 D 20cm KS-R P SFK12 KT

Mauerwerk DIN 1053-4 der Wohnungstrennwand, für späteren Dünnlagenputzauftrag, Höhe bis 3,5 m, in Einzelflächen über 2 bis 3 m², Mauerwerksdicke 20 cm, Kalksandstein, DIN V 106, KS-R P, Festigkeitsklasse 12, Rohdichteklasse 2, Dünnbettmörtel DM DIN V 18580, mit Stoßfugenvermörtelung, Ausführung gemäß Zeichnung und Einzelbeschreibung.

Abrechnungseinheit: m2

Ausgewählte Ausprägungen / Textergänzungen:

<input type="checkbox"/> Bauteil, Wand/aufgehend	<input type="checkbox"/> Wohnungstrennwand
<input type="checkbox"/> Dicke [cm] Wand	<input type="checkbox"/> 20
<input type="checkbox"/> Mauerstein	<input type="checkbox"/> Kalksandstein KS-R P
<input type="checkbox"/> Festigkeitsklasse [N/mm ²] Mauerstein	<input type="checkbox"/> 12
<input type="checkbox"/> Rohdichteklasse [kg/dm ³] Mauerstein	<input type="checkbox"/> 2
<input type="checkbox"/> Wärmeleitfähigkeit [W/(mK)]	<input type="checkbox"/> ohne Angabe
<input type="checkbox"/> Mauermörtel	<input type="checkbox"/> Dünnbettmörtel
<input type="checkbox"/> Mauerwerksgrundriss	<input type="checkbox"/> ohne Angabe
<input type="checkbox"/> Anforderung Mauerwerk	<input type="checkbox"/> für späteren Dünnlagenputzauftrag
<input type="checkbox"/> Ausführung Vermauerung	<input type="checkbox"/> mit Stoßfugenvermörtelung
<input type="checkbox"/> Mauerwerk	<input type="checkbox"/> Mauerwerk DIN 1053-4
<input type="checkbox"/> Arbeitshöhe [m] (innen)	<input type="checkbox"/> bis 3,5
<input type="checkbox"/> Einzelflächenbereich [m ²]	<input type="checkbox"/> über 2 bis 3
<input type="checkbox"/> Ausführungsunterlagen	<input type="checkbox"/> gemäß Zeichnung und Einzelbeschreibung
<input type="checkbox"/> Abrechnungseinheit	<input type="checkbox"/> m2

Figure 28: Compact specification list.



- NL-SfB
 - 11 BODEMVOORZIENINGEN
 - 13 VLOEREN OP GRONDSLAG
 - 16 FUNDERINGSCONSTRUCTIES
 - 17 PAALFUNDERINGEN
 - 21 BUITENWANDEN
 - 22 BINNENWANDEN
 - 23 VLOEREN
 - 24 TRAPPEN EN HELLINGEN
 - 27 DAKEN
 - 28 HOOFDDRAAGCONSTRUCTIES
 - 31 BUITENWANDOPENINGEN
 - 32 BINNENWANDOPENINGEN
 - 32.1 NIET GEVULD
 - 32.2 GEVULD MET RAMEN
 - 32.3 GEVULD MET DEUREN
 - 32.31 DRAAIDEUR
 - 32.32 SCHUIFDEUREN
 - 32.33 TUIMELDEUREN
 - 32.34 TOURNIQUETS
 - 32.4 GEVULD MET PUIEN
 - 33 VLOEROPENINGEN
 - 34 BALUSTRADES EN LEUNINGEN
 - 37 DAKOPENINGEN
 - 38 INBOUWPAKKETTEN
 - 41 BUITENWANDAFWERKINGEN
 - 42 BINNENWANDAFWERKINGEN
 - 43 VLOERAFWERKINGEN

Figure 29: Example of a door in the NL-SfB methodology.

4.3.4. Differences in requirements between the Dutch and German construction industry

The main purpose of this paragraph is to show that there are possible differences between the dimensions of Dutch and German construction products. Because of the number of products in both markets in numerous categories it is impossible to make a review of all of them. Therefore it is chosen to review a number of product categories such as doors and stairways. When there are multiple requirements or specifications available, it will be chosen to use the information based on medium sized one-family dwellings.

Stairs

According to (Meijer, et al., 2003) each country in the EU has its own building regulations for stairs. Due to the ongoing process of introducing new countrywide regulations in Germany, the specifications in the state of Hesse, the focus of the Meijer et al, 2003, research, has been replaced with the DIN 18065. The minimum width of a private stairway in Germany is 0.8m, which is the same as in the Netherlands. The headroom of a stairway in the Netherlands needs to be at least 2.3m, while the German DIN 18065 requires a height of 2.0m.

There are also differences in the rise height, thread depth and the maximum rise of the stairs. In the Netherlands these are 0.22m for the minimum depth of thread depth, 0.185m as the maximum height of the rises and a maximum pitch of 40°. In Germany these are respectively 0.23m, 0.20m, and 41°. In Germany is a general regulation concerning the rise-to-tread ratio of stairs, the optimal ratio is 17/29 and a maximum length of 18 steps without interruptions. The height of the handrail must be at least 90cm above the front of the step.

Accessibility

Every room in a dwelling needs to be accessible through a door opening, which is also bound to certain requirements. In the Netherlands the minimum width of an opening is 0.85m of clear width, while in Germany there is a split in entrances and internal doors. Entrances to the dwelling require a minimum width of 0.9m while 0.8m is enough for internal doors. The Netherlands are unique in the fact of requiring a minimum height of doors, 2.3m, in other countries there are no minimum requirements. According to (Neufert & Neufert, 2002) an internal door has a minimum required width of 80cm for main rooms such as living spaces. Auxiliary rooms such as storage rooms can be equipped with doors with a minimum width of 70 cm.

To elaborate this even further, the general rules for doors and the door frame will be discussed for both the Dutch and German market.

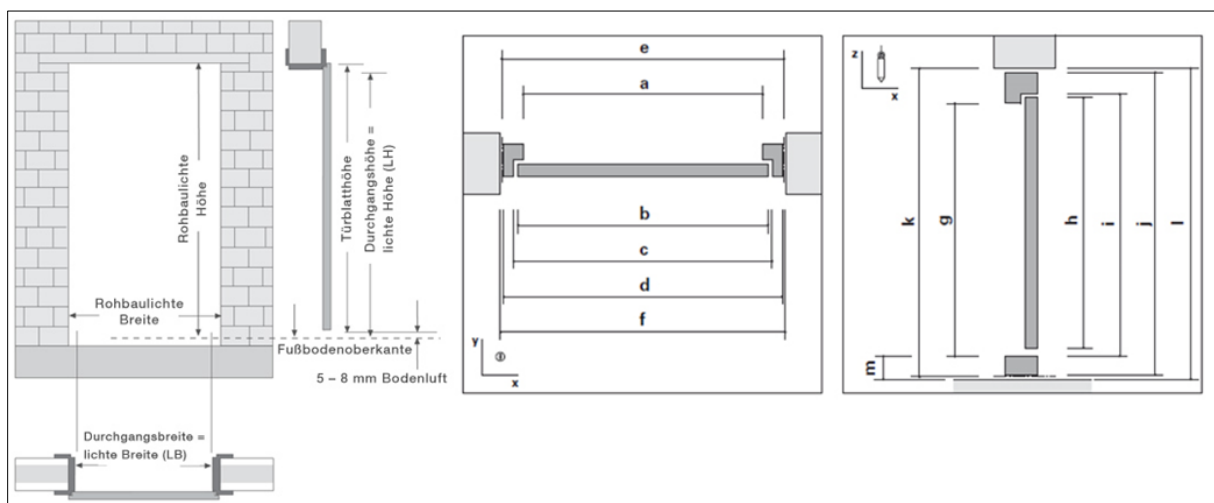


Figure 30: German specific dimensions.

Abbreviation	Meaning	Translation	Dutch version
a/g	lichte Öffnungsbreite/-höhe	Clear opening width / height	Dagmaat / Vrije hoogte
b/h	Flügelbreite/-höhe	Door width / height	Deur breedte / hoogte
c/i	lichte Falzbreite/-höhe	Frame width / height	Vrije doorgang / Vrije doorgangshoogte
d/j	Rahmen/Stockaußenmaßbreite/-höhe	Outside dimensions door frame	Buiten afmeting kozijn
e/k	Baurichtmaß	Basic dimension, wall-wall	Bouwmaat
f/l	lichtes Rohbaumaß (Wandöffnung)	Wall opening	Muuropening
m	Schwelle/Schwellenhöhe	Ramp height	Dorpelhoogte

Table 7: Information accompanying Figure 30.

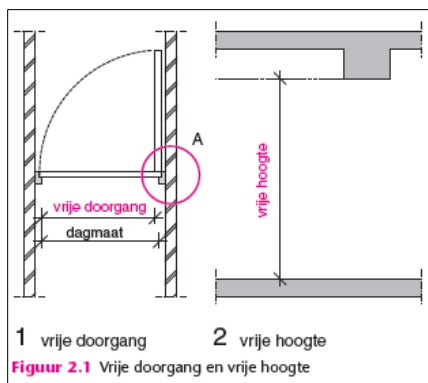


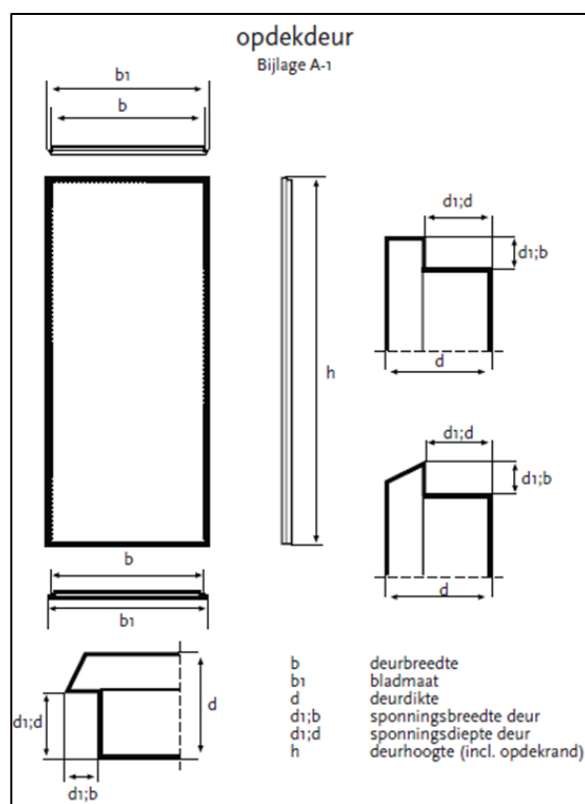
Figure 31: Dutch specific dimensions. ↑ Source: (ter Laan, et al., 2005).

Figure 32: Dutch specific information dimensions. →

The “Durchgangsbreite” is the same as the “dagmaat” in the Netherlands, the width between the bars of the door frame. The “Durchgangshöhe” corresponds with the Dutch “vrije hoogte”. The “Türblatthöhe” is defined at the same way as the “deurhoogte” in the Netherlands, including the rebate of the door in case of a rebated door.

This example shows that for a door and the doorframe the dimensions are called the same after translation, and that they have the same definitions. Of course there are differences in measurements and uses, but there is also a large overlapping area which results in the possibilities to use several components in both the Dutch and German construction sector.

This conclusion does not mean that there are no differences in definitions at all. The construction sector offers a large amount of specific products which makes it nearly impossible to handle them all, which is also beyond the scope of this report. The translation of terms needs to be done by someone who has knowledge of both the Dutch and the German sector to avoid any confusion caused by wrong translations.



In addition the Twee Snoeken has made its own templates based on general rules which are applied in the Netherlands for every building object that gets imported into the library. In appendix H this information is shown for a door.

5. Process analysis current situation and development plan

As seen in the previous chapters the Twee Snoeken and KPN will focus on an entrance to a foreign market, in this case the German market. The Netherlands is a country with a lot of internationally oriented businesses, who often expand to Germany as one of the first countries as the start of their international expansion.

Germany is seen as the most important trading country for the Netherlands. Both countries have a lot in common which makes companies think that they can easily expand their business to Germany. However Germany is located near the Netherlands, it does not mean we know all the ins and outs of country and the differences in language, culture and legislation are quite large. Because of the size of the country the German companies are often less focused on expanding to neighboring countries, which makes it that it is harder for foreign companies to conduct business in Germany.

In this chapter the process of bringing the BCB to the Dutch market will be analyzed, after which conclusions can be made on how to bring the BCB to the German market.

5.1. History of the introduction of the BCB in the Netherlands

The Bouwconnect library is a development from the “digitale huis bibliotheek” which has been developed by the Twee Snoeken and several software developers as part of “het digitale huis” in 2001. In December 2010 the Twee Snoeken has teamed up with KPN to develop a product which has resulted in the current BCB.

The ambition of the 2 parties is that they want to make the construction industry stronger and more sustainable with the use of better products, making qualitative and sustainable buildings, enable an increase in efficiency of operations and place a greater emphasis on the importance of people, planet, profit in the construction industry.

Due to the similarities between the Dutch and German construction industry it is possible to maintain the same ambition for the expansion to Germany. In addition to these mottos it can be said that the BCB will focus on integrating and normalizing the whole European construction industry.

The current version of the BCB is an evolution of the first version introduced. The introduction of the BCB is done in phases in which the focus on different parties in the construction industry changes. The first introduction is done for architects in 2011, and it was expected that in 2012 all parties in the construction process could be served. Due to circumstances in the construction industry caused by the economic turndown this timeframe has not been achieved. The BCB has been introduced in the market for Architects in 2011, and in the market for contractors in 2012. At the moment of writing the company is in process of introducing the BCB in the installation branch by adding installation specific objects in the BCB. The phases used for the Dutch introduction are shown in Figure 33. After the adding of the last sector the majority of the construction industry is covered.

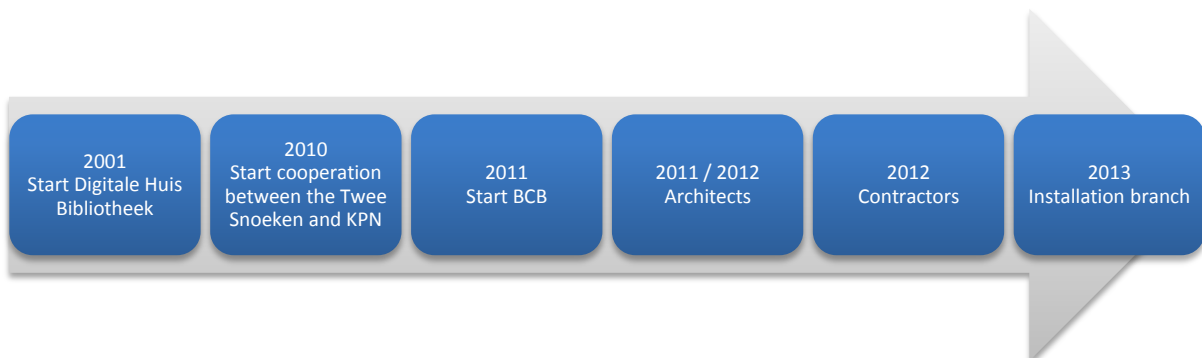


Figure 33: The initial phase-planning of the introduction of the BCB in the Dutch market and phases of the BCB.

5.2. Process analysis new situation

The main question in this paragraph is whether the same phases can and/or need to be used when entering the German market.

A large part of the BCB can be used in the German situation, for example the abstract building parts which are not bound to a certain manufacturer. The first focus will be on the developing contractors since the Twee Snoeken and KPN are already trying to establish contact with these parties. After this initial focus I advise to focus on the architects, mainly because these parties have an overlap in the needed objects. Because almost the same planning is used, everyone is accustomed to this planning, and it ensures that the market is divided from the largest sectors declining to the smallest sectors. This way the initial investments such as translating will be made for entering a large sector.

The first stage will be the orienting on the German market, possibly including a survey with potential customers and suppliers. This way it is ensured that there is a market for a product like the BCB. For the introduction of the product it is recommended to seek partners who can have experience with the way the German construction industry works, for example on the field of legislation and building codes. When there is a proven market and the partners are known, the next phase is the translation of the software and adjustment of parameters where needed. These are the largest steps different to the Dutch market that have to be taken when entering the German market. The initial focus will be on the developing contractors and thereafter the same planning as in the Netherlands will be used.



Figure 34: Phase-planning for the German market.

In the event of entering a new market in which a company has no experience, it is important to make a process analysis in order to find any possible threats and possibilities and how these can be avoided / acted upon. These analyzes will be done with the use of the MKDH model, a SWOT analysis and the 5-forces model of Porter. The MKDH model has been developed to get insight into several important aspects of idea development, the SWOT analysis points out the Strengths, Weaknesses, Opportunities and threats of an idea while the 5 forces model of porter focuses on the 5 main forces of competitiveness. It is important to use these tools in the initiative phases of decision making, to prevent any avoidable problems from happening. A general way of decision making is shown in Figure 35. This report focusses on the delivery of information and providing advice so a well based decision can be made in the future. The choice that has to be made, the entering of a new market, has to be back-upped with further research data which will cover the new market which will be served. Following this stage the company needs to give the authorization on what level the market will be served and how the investments will be made. The last stage is the actual implementation of the BCB product in a new market.

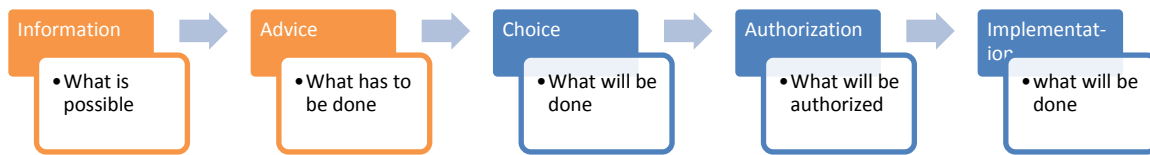


Figure 35: General way of decision making. This report focusses on the first 2 stages. Source: sheets course 7C510.

5.2.1. MKDH model

The MKDH model is developed to get insight into several important aspects of idea development. It clarifies the quality of an idea with the use of the parameters power, strength, feasibility and support. The model is a ranking model in which an initiative is dependent on the support and feasibility which are created by respectively the power of the idea owner and the power of the initiative (Bekkering, et al., 2001). To conduct a proper process of idea development, to manage it and to make proper decisions, it is of importance to distinguish several elements and their coherence. The elements of importance are the Idea owner, the power of the idea owner, strength of the idea, support and feasibility. These elements are shown in Figure 36 and will be further elaborated now. The main principles of this paragraph are based on the book “management van processen” by (Bekkering, et al., 2001).

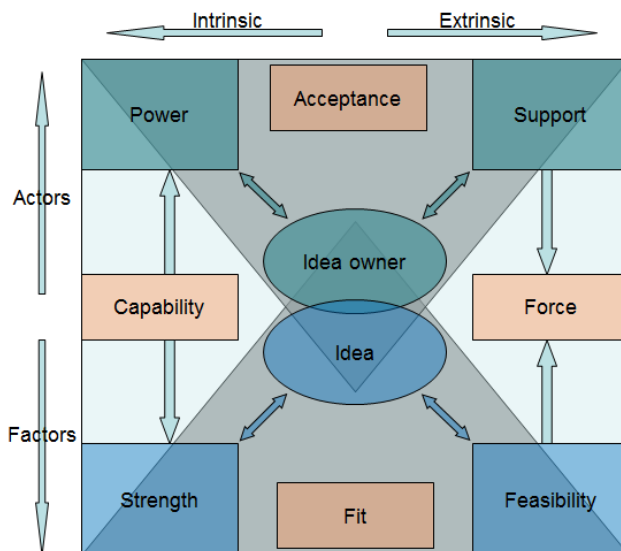


Figure 36: Global MKDH model. Source sheets 7C510.

The idea

The idea itself is an intangible entity, it can't be seen, heard or touched, it only exists in the mind of the idea owner. Some ideas are more innovative than others, to the point that someone cannot make an imagination about the subject. On the other hand there are ideas that use elements of already known objects so someone can make an imagination are called “evidence based” or “proven technology”.

The idea in this case is the expansion of the BouwConnect library to Germany, thus bringing a BIM capable object library to the German construction market. This will be done by integrating German construction objects in the current Dutch BCB database. This is in addition to the products that are already imported in the BCB which are also available in the German market. It is planned to focus at German architects / developing contractors, which will be the entrance for the BCB in the German market before further expansion. Thus the software will stay mainly the same, abstract objects that can be used in the German industry will be used again and Dutch objects that can be delivered in Germany will be used again, after consultation with the manufacturer.

The idea owner

The person who has embraced the idea is called the idea owner. This person does not have to be the same person or entity that has created the idea in the first place. The idea owner and the idea itself form the core of this model.

In the case of expanding the BCB to Germany the “idea owner” consists of 2 entities, the companies the Twee Snoeken and KPN. These 2 companies have founded the BCB in the Netherlands and are now willing to expand their product to other countries.

The elements of the model can be divided into multiple categories, based on the intrinsic/extrinsic (internal/external) properties and factors/actors. The intrinsic factors are factors that are based inside the idea, the power of the idea owner and the strength of the idea. The support and feasibility of the idea are extrinsic factors, external influences. Furthermore there are factors that influence the idea, and stakeholders who influence the idea owner.

Power

Power forms the basis of the possible influence concerning the evolution of the idea. Power can also be explained as authority, position and respect, which shows that the idea has a larger chance of succeeding when there are influential people or parties backing up the idea. During this process the amount of idea owners grows.

In this case the idea owners are the Twee Snoeken and KPN, who both have a large amount of power over the idea. Both have financial and organizational stakes in the project, when one of the idea owners decides to drop his support it will be difficult for the other party to succeed in realizing the idea.

However, also the companies providing products for the BCB have power. Since they have paid to integrate their product in the Dutch BCB, they may choose not to make their products available in the German version. The whole system of the BCB relies on the amount of players that want to cooperate with the BCB to make their products available.

Strength

Just like it's the case with the previous characteristics the strength is strongly connected to the idea owner. The strength of the idea is based on the concreteness of the proof combined with the extent to which the idea appeals (the approach with information and views as basis of the idea). The strength of the idea is also based on the extent of how the idea connects to dominant policy and other basic principles (the “undercurrent” approach).

Information and views as basis of the idea

An idea has a strong basis when it is back-upped with factual data, thus using “evidence based figures”. In this view there is a large difference between information and data, data are the raw numbers and information is the interpretation of this data. Ideas can also be based on views, these ideas are strong because they have appeal and prestige. Most of the strongest ideas are based on both views and information in such a way that the gathered information underpins the views.

Undercurrent

The undercurrent is specified as the prevailing conditions, thought patterns, policy proposals and ambitions. When an idea “follows” this undercurrent it generates more momentum than when it goes against the undercurrent.

The idea of expansion of the BCB is based on the feeling that the current BCB works well in the Dutch market, but the amount of customers and participating companies is on the low side due to the

harsh financial situation of most companies in the Dutch construction sector caused by the financial crisis. This research is meant to seek out the technical difficulties when wanting to expand this Dutch product to the German market, therefore the idea will be underpinned with information in accordance to the current views of the idea owners. The idea itself follows a certain undercurrent which is mainly based on the rapid development and implementation of BIM in Europe, and even European integration and borderless working of companies.

Support and Feasibility

The power of the idea owner and the strength of the idea are the building stones for creating support and feasibility of the idea. The *support* of the idea is an indicator for the extent in which parties want to realize the idea. The *feasibility* is the extent to which it is possible to realize the idea. The support for the idea needs to be measured under stakeholders and will represent the intensity the stakeholders feel connected to the idea. The feasibility is purely based on facts and data.

One of the main tasks of the project manager who guides the realization of an idea is to judge whether key persons/parties are joining or leaving the process of implementing the idea.

The amount of support for an initiative is thus defined as the degree in which parties are willing to support an initiative. This definition supports both actors who support the initiative and those who are against it. The main obstacle with support is that it is hard to gather support in the initiation phase of a project because stakeholders often don't see the use and/or necessity of the initiative. The support of actors can be measured with interviews, meetings, surveys and other methods.

The degree of interest of an actor in the initiative can be categorized into multiple categories:

- Blanco: The actor has no idea of the existence of the initiative and has no opinion;
- Interested: The party is interested in the initiative and will request information about the initiative;
- Concerned: The actor is interested which results in reactions to the provided information and the development of a formulation how he can get involved in the initiative;
- Investing: Actors who invest in the development of an idea provide a substantial support to the development of this initiative;
- Realizing: Realizing actors are the actors who provide an agreed contribution to the realization of the initiative.

The support of the idea needs to be measured with a follow-up survey / questionnaire under potential customers and content deliverers. The feasibility of the idea will be shown in the conclusion chapter of this report.

The 4 main terms used in the MKDH-model are connected with even more parameters, namely acceptance, fit, force and capability which will be elaborated further now. These parameters can only be answered to when there is research available concerning the support of the idea.

Acceptance

The acceptance of the idea is dependent of both the power of the idea and the support. Acceptance of the idea is achieved when the power of the idea owner leads to support from stakeholders. The stakeholders are then, because of the power, convinced that the idea will lead to a profitable end product in which they are willing to participate and support the development of the idea.

Fit

The fit of the idea is dependent on the strength and the feasibility. The idea is fit for use when the strength of the idea leads to a high feasibility. If there is no or low strength of the idea and/or a low

feasibility of the idea, the idea can be classified as a “luchtkasteel”, a dream with no theoretical underpinnings which cannot be taken serious.

Force

Force stands for the amount of possible alternatives or changes without the loss of the most essential parts of the idea. An idea with no support or feasibility is an idea with low force and is not an idea that will find a lot of actors that want to collaborate in realizing the idea. This will probably lead to failure to execute the idea.

Capability

Both the strength of the idea and the power of the idea owner are intrinsic characteristics which determine the possibilities to put the final idea on the market. When the power of the idea owner and the strength of the idea are both low, thus a powerless idea owner and a weak idea, will make it impossible to realize the idea. In this case both a medium to high, this results in a large capability to execute the idea.

5.2.2. SWOT

The SWOT analysis is a model that exposes the internal strengths and weaknesses and external opportunities and threats on which a strategy can be based. It must be pointed out that a SWOT analysis does not only conclude anything about the current situation, but it also focusses on the future. The SWOT analysis can both be used to determine the position of a company and to determine to either make or break decisions. SWOT is furthermore used for planning, marketing, classification of competitors, organization developments, product development research and personal profiling.

The strengths are pointed out as the positive internal characteristics of a company or any of its ideas/products, often in comparison with one of its competitors. The weakness of an idea or company is a negative internal property and is often also the result of a comparison between the item and one of its competitors.

The opportunities show the external positive aspects of a decision, these opportunities show the chances that lie in the market. The threats are the exact opposite, it shows the threats for the item in the market. With all these data available it is possible to make a sound conclusion about the current status of the firm or product or make a rational decision for future planning like expanding to a new market.

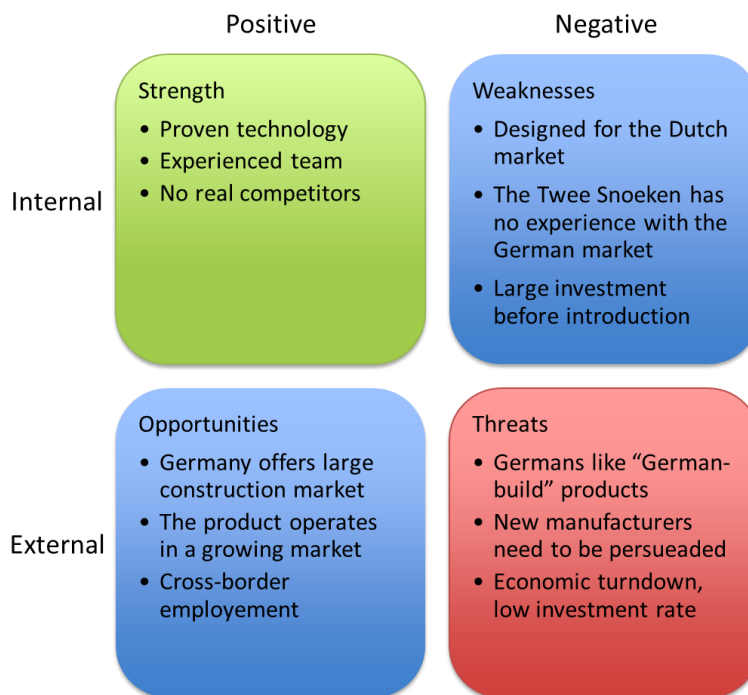


Figure 37: SWOT analysis of the expansion of the BCB to Germany.

Strengths

- Proven technology. The product is up and running in the Dutch construction market. The product is gaining popularity;
- Experienced team for adding components to the library;
- No real competitors who deliver the same amount of detailed information. The analysis of competitors has shown no real competition of the BCB product.

Weaknesses

- The whole product is now build in Dutch and designed for requirements of the Dutch market, when operating internationally this needs to be adjusted to fit the needs from foreign users.
- The company the Twee Snoeken has no experience with the German market whatsoever, however the partner KPN has;
- Before entering the German market, the library has to be filled with German products. This requires a large investment, both money wise and time wise, before the launch of the product.

Opportunities

- The German construction market is the largest construction sector of Europe;
- The product operates in a growing market, at this moment the adoption of BIM is still in mainly adapted by the early adopters, which will be followed the majority of the market;
- Before the financial crisis in 2008 and the following economic downturn, German contractors operating near the Dutch-German border were seeking work in the Netherlands. When they get in contact with the BCB in this way, they may be the first to adopt the German version of the BCB.

Threats

- Germans like “German-Build” products;
- Manufacturers need to be persuaded to join the BCB;
- Due to the current economic downturn companies have reduced their investment rate.

5.2.3. Michael Porter's 5 factors that shape strategy

When entering a new market it is needed to analyze the competition. Often the term "competition" is defined too narrow by managers, who think that only today's direct competition forms a threat. Porter has extended the standard description with 4 other factors namely: Customers, Suppliers, Potential entrants and substitute products. These 5 factors shape the competitive interaction within an industry. Porter states that the strongest competitive force or forces determine the profitability of an industry and become the most important to strategy formulation.

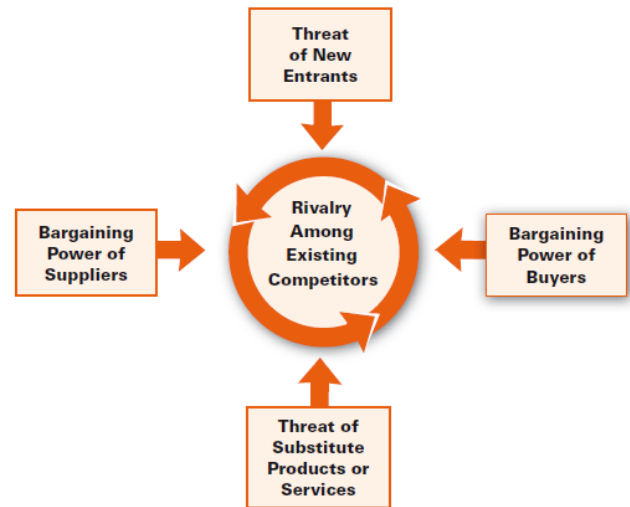


Figure 38: Porter's 5 factors of competitiveness.

The 5 threats by M. Porter (Porter, 2008):

New entrants at the market bring more capacity, and a desire to gain market share will result in pressure on prices, costs and the rate of investment to compete. The most important parties are competitors who are diversifying their markets, since they already have a cash flow and coexisting capabilities to push their products. For example what Pepsi did when entering the bottled water industry and how Apple changed the music distribution process with their products. A large threat of entry results in higher investments or lower prices to stay competitive. Porter specifies 7 barriers to entry, which are shown in Table 8.

#	Barriers to entry	Implications to the BCB
1	Supply-side economies of scale; These economies are recognized by firms who produce at a large scale which results in lower costs of the end product. A result is that the market must be entered on a large scale as well to compete.	At this moment there are no large competitors who offer the same kind of product, thus this point has not to be taken in account. This does not mean that the BCB can enter the market on a small scale, the amount of products offered will be important to attract customers.
2	Demand-side benefits of scale; These benefits are recognized on the effects that arise when a buyer is willing to pay for a product that is made by a company with a larger market share.	See #1;
3	Customer switching costs; These costs arise when customers need to change suppliers. These costs can consist of new hardware to be bought, training for employees, etc.	This is a point that has to be taken into account. Due to the amount of features of the BCB and possible additional software the users have to be trained to get used to the BCB way of working. Additionally the BCB will be adapted to the customer, thus there is no need for new hard- and / or software
4	Capital requirements; The need to invest large financial resources in order to compete with existing companies. These costs consist not only on fixed facilities but for example also for building an inventory.	Due to the lack of real competitors this has not to be taken into account. But as pointed out before the database needs to contain enough objects to attract customers, this will require an investment in draftsman.
5	Incumbency advantages independent of size;	At this moment there are no real comparable services available.

Existing companies have an advantage.

6 Unequal access to distribution channels; A new entrant needs to secure a distribution chain for its product or service.	The product is a digital service the distribution channel will be the internet.
7 Restrictive government policy; The government has the power to aid or hinder new entrants to a certain market with the use of policy making.	The German government does not actively support the adoption of BIM capable tools, neither does she hinder it.

Table 8: 7 Barriers to entry and the implications for the BCB.

Powerful suppliers capture more value for themselves by charging higher prices to their customers, limiting the quality or services.

This is a point to keep in mind. Due to the bad economy in Europe the construction sector cuts on its budget. This results in the fact that these companies have more power in negotiations to lower the price or to cancel a partnership. For companies there is a price to have their products added to the library, it needs to be determined what these companies are willing to pay. When the economy takes an upturn and the BCB gains popularity the Twee Snoeken has a more stable foundation for negotiations.

Powerful customers can capture more value by forcing down prices, demanding better quality of the product or service and playing out different parties against each other. Buyers are powerful when they have negotiation leverage relative to the industry participants, especially in markets with price sensitive products.

The prices for using the BCB are determined and shown on the website, there is no negotiation moment for customers.

Substitute products perform the same or similar function as the product it replaces. An example of threats by substitute products is seen in the photography industry. Kodak and Fuji where the largest manufacturers of photographic film until the rise of digital photography, which has been a major substitute product for the original analog photography.

The market for BIM capable products is still in the phase of adoption and has not yet reached the average customer. Of course the market needs to be monitored for new initiatives and it has to be acted upon the stay competitive.

Also from the past there are books available with hard-copy information of products, people used to this product might want to stick to it. Although it is no secret that this way of working is declining.

Rivalry among existing competitors takes many familiar forms, including price discounting, new product introductions, advertising campaigns and service improvements. High rivalry in a specific market leads to a lower profitability, money is lost in the acting and reacting towards rivals.

For now there are no competitors that offer the same product as the Twee Snoeken. When the product gains popularity other firms probably want to try to make a similar product in order to profit from this market as well. Therefore the developments in the market need to be monitored constantly whether there are new products introduced to the market and what their capabilities are.

5.3. Minimum requirements of the BCB in Germany

At the moment of writing this paper the amount of objects in the Library counts up to a total of 32.500 products of 450 manufacturers and ca. 18.000 abstract models. With this amount of products it is possible to support ca. 70% of the designing and engineering process of a typical Dutch building. It is estimated that the 15-20% of the objects that are available are only specific to the Dutch market, which means that 80-85% is internationally applicable.

Amount of available products	Dutch Specific products	Internationally applicable products
32.500	4.875—6.500	26.000 – 27.625 manufacturer specific models + 18.000 abstract objects

Table 9: Subdivision of objects.

The current estimate of the BouwConnect group is that for an expansion to Germany at least 50-100 German High grade manufacturers need to be added to have a library that is appealing for future users. Currently a manufacturer has ca. 75 objects in the library, this means that the amount of objects that need to be added specifically for the German market is around 3.750-7.500 objects. This brings the amount of products that are needed to bring the BCB to the German market at a total of 29.750 – 35.125 objects. In addition to this number there are more than 18.000 abstract models available.

This is the bare minimum to start in the new market, with these products of high-grade manufacturers it is possible to make name, and then keep expanding the database regularly with new products.

5.4. Costs

This paragraph will give a short, conservative and rough price calculation concerning the costs of entering the German market. It is assumed that 2 plugins are necessary for the most popular software packages, Allplan and ArchiCAD. Other costs are based on average salary costs of 2000€/month/per person, on average 10 people will be working on adding objects, except where noted differently. The costs for negotiating with existing companies to offer their products in Germany are not taken into account in this calculation.

Action	Costs
The software needs to be translated to the German language, since the software does not contain many different words and sentences this is quite easy. It is estimated this will take 2 weeks	€1.000,-
To support the GAEB STLBAU in the software it is necessary to take licenses from the GAEB, which costs €2994.83 for the first license. Every further license costs €1197,93.	€2.994.83
The NL-DFB method needs to be converted to the German variant, the DIN 276. This includes the adding of information to current objects which can be used in the German market. This can be done in a month by 2 persons.	€4.000,-
The plugins for the software packages in Germany take about 3 months to produce by 1 person, this totals at per plugin. It is assumed that 2 plugin are needed to start operating in the market.	€12.000,-
The data needs to be adjusted to the German situation, say that 5% of the data needs to be changed in order to fit the situation. This will cost about €60.000,-. This is based on the fact that it has taken about 3 years to construct the current amount of objects with a team of 10 persons on average. To adjust 5% of the data it will take 10 persons 3 months.	€60.000,-
To start well it is recommended to have objects of at least 50 – 100 high grade German companies. It is assumed that these companies are not yet implemented in the database and that every company delivers 75 objects (average amount of objects	€170.000,-

per current manufacturer). The costs of implementing this will cost around €170.000,-

Changing software and database for filling German products; It is estimated that 2 persons will have a month of work to adjust and test the software before it can be used for the definitive version	€4.000,-
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Total: €253.994.83

This overview only covers the costs concerning the conversion of the current Dutch oriented library before introducing it in the German market. In addition to these costs there are sales and marketing costs which are estimated to range between € 800.000,- and €1.000.000 in the first 2 years of operation.

6. Conclusions and recommendations

This final chapter will deal with the conclusions and recommendations that can be given. This chapter has been made in accordance to the stated research questions. First the research questions will be stated again and paragraphs 6.1 – 6.3 will give answers to these research questions.

1. How can BouwConnect compare itself to national and international developments?
 - 1.1. How unique is the concept of “BouwConnect Bibliotheek”?
 - 1.2. What are the opportunities for BouwConnect?
 - 1.3. What are the threats for BouwConnect?
 - 1.4. How could BouwConnect react to these developments?
2. What is the current added value of the Bouwconnect Bibliotheek for the building sector?
3. What are the changes for international expansion of “BouwConnect” to Germany?

6.1. How can BouwConnect compare itself to national and international developments?

The amount of BIM usage in the Netherlands and other countries is growing. The BCB is able to play a large role in connecting different parties in the building chain to work together and speed up the adoption of BIM in the construction sector. The answering of this question is further elaborated in the following sub-questions.

6.1.1. How unique is the concept of “BouwConnect Bibliotheek”?

The uniqueness of the BCB is mainly researched by finding competitors who offer the same kind of product. This literature review and internet research has shown no real competitors, therefore it can be concluded that the concept of the BCB is unique.

However, there are object libraries available with more objects but these offer a lower level of detail or just simply abstract models that are not linked to an actual product. There are several libraries that do deliver the same level of detail but those only focus on a specific market, for example only escalators. There are no real competitors who specifically focus on the German market.

6.1.2. What are the opportunities for BouwConnect?

Due to the lack of competition, the library has a monopoly when it comes to this kind of product. Customers looking for this type of service will only find the BCB when looking for services to join. The user base is growing, which results in the case that other parties also hear about the BCB and possibly want to try it themselves.

Although the product is now focused on the Dutch market and therefore is customized for CAD products that are mostly used in the Netherlands, it is possible to create new extensions where needed. For example when entering the German market plugins for ArchiCAD and Nemetschek Allplan are needed, because these are the most used CAD packages in Germany.

The database of the BCB is not a barrier for adding new types of information, the main piece of software used to fill the database is the VulProgramma which is also adjustable to fit new information when necessary. The software packages used for constructing the BCB are not connected to each other, and therefore all software packages need to be adjusted when something changes. For example when the definition of the height of a certain object is different between the Dutch and German sector, this can be solved by creating a new “height”, for example “height_de”.

The construction markets in Europe are working more and more cross-border due to changing rules in contracting. When the BCB is offering its services internationally it can be a catalyst in uniting companies from different countries in the same project.

6.1.3. What are the threats for BouwConnect?

The definitions of measurements used in the BCB are based on common used definitions in the Dutch construction sector, and where needed complemented with definitions determined by the Twee Snoeken. Definitions can vary between countries, although the differences between the Netherlands and Germany are quite small.

The creating of new plugins to functions with other software packages is an opportunity because of its flexibility. However the creation of this kind of plugins takes about 2 months work by 2 persons, excluding extensive testing before bringing it to the market. The costs are thus quite high and profitability of making a new plugin depends of the market share of the targeted product.

For customers it takes time and effort to get acquainted with the way of working that comes with the implementation of the BCB. This means that some customers need to buy new hardware, or invest in training of their employees.

6.1.4. How could BouwConnect react to these developments?

In a market in which the BCB operates it is important to react on changes in this market. For example when a new software package or software version is introduced, the linkage needs to be tested on consistency. Also it is important to keep track of the share of individual packages, when a certain package shows a large increase or decrease in market share it is important to react accordingly.

Because of the amount of available features the learning curve of the BCB results in costs for getting acquainted with the package, by improving and simplifying the lay-out this can be reduced. There needs to be found a balance between usability and functions.

6.2. What is the current added value of the Bouwconnect Bibliotheek for the building sector?

The BCB is a library for people who work in the construction industry. The added value of the product is that it reduces design errors, increases productivity and introduces customers to BIM. The way of working introduced with BIM and the BCB allows designers to use pre-designed objects which reduce the time needed to design a whole project. When every party in the building chain uses the BCB, every party has the same information which results in better communication and less errors though interpretation.

The BCB offers objects with a consistent set of data, which cuts down the amount of errors made in a typical object. When the BCB is used it is possible to reduce the failure costs of a project along the whole building chain.

6.3. What are the chances for international expansion of “BouwConnect” to Germany?

The chances of bringing the BCB to the German market have real potential. In the following subparagraphs the results of this study will be presented.

The results of the SWOT analysis show the following:

- Strengths: The product has been up and running in the Netherlands, and is thus proven to work in the construction sector. The team working on the BCB is experienced in adding new objects and adding new functionality. For now there are no real competitors who offer the same experience as the BCB.
- Weaknesses: The current library is constructed for the Dutch construction sector, and thus holds only Dutch products. It will take a large investment to add new objects. Furthermore the Twee Snoeken has no experience in Germany. These 2 items combined will result in a

large investment before the introduction of the product, mainly because of finding partners and adding German objects.

- Opportunities: The German construction sector is the largest of Europe, and the BCB operates in a growing BIM market. The EU promotes cross border employment, the BCB is able to connect the several construction market when the database of products is extended to more countries.
- Threats: The Germans are really found on “German made” products, which may holds back a quick introduction of the BCB in Germany. New manufacturers have to be persuaded to join the BCB, without the objects of these manufacturers the BCB cannot function properly. At this moment there is an economic turndown that has hit the construction sector as well and which will lead to a temporally lower investment rate.

General

It is advised to distribute the product the same way as in the Netherlands. For first time use the software needs to be downloaded from the internet, including all data available at that time. After that there will be small updates pushed from the internet to the software package. The package should contain all objects that are available, selection on country needs to be possible. Once or twice per year a full update will be released with a new database, resulting in a large download. It is advised to look whether it is possible to distribute the software per DVD, for free as extra service of for a small fee, when a customer does not have a fast internet connection available.

For end-users it needs to be possible to subscribe to a part (or the whole) BCB. For instance a designer only works in the Netherlands won't use any German products and is thus not willing to pay for these objects. On the other hand there are companies in the border area who probably work on both sides of the border and thus are willing to subscribe to the entire BCB. This division is also necessary because some suppliers do not deliver the same products in all countries, for example differences in color, measurements, etc.

The BCB is part of the “Digitale Huis” which covers more than only objects, when the BCB international, the other parts will as well. A part of these functions is the legislation concerning objects. The states in Germany have their own legislation and building codes, this information needs to be added per state.

Costs

The introduction of the BCB will be handled quite the same as the introduction in the Netherlands. An exception is that the introduction will start with the developing contractors, followed by the architects, structural engineers and the installation branch. The cost of the introduction of the BCB in Germany is estimated at a minimum of €254.000,-. In addition to these costs there is an estimated cost of minimal €800.000,- for sales and marketing in the first 2 years of operation.

However the regulations in the industry differ, especially the amount of different regulations is higher in Germany. Also because of the far reaching autonomy of the states, the building codes and other rules differ from state to state. Therefore it is advised to cooperate with a company specialized in the Germans building regulation for the adding of specific information.

Additional opportunities

ArchiCAD and Nemetschek Allplan are the largest CAD packages in Germany. The BCB needs extensions for these packages to be successful and to give the full integrated experience that is promised. I advise to make plugins for these 2 software packages, which serve almost 40% of the total CAD-market in Germany.

The use of BIM in Germany has not yet taken off in large numbers, the adoption rate is only 36% including people who only use a lower level of BIM (drawing in 3D and exchanging data files). This brings opportunities for the BCB product, end-users have not yet chosen an object library to use and are therefore not yet acquainted with a certain product. As a new name in the business this shapes opportunities. A large con in investing in the German market is that there is a large amount of home grown software packages that are not used in other countries. It will take a large investment to program new plug-ins especially for those software packages. In the initial stages the users of these packages can use the IFC function, but this limits the integrated experience.

The structure of the German construction market is almost familiar to the Dutch. The construction process follows the same steps which will not form a barrier in adopting a product like the BCB.

Additional Threats

The contracts between the suppliers of the information and the Twee Snoeken have to be evaluated whether it is possible to use objects in the Netherlands as well as in Germany. At this point I assume that the current contracts and subscriptions are only valid for the Dutch market and Dutch products.

Germans like to do business with companies from the country, and especially with companies having experience with the market. This results in the recommendation to seek partners in Germany who are experienced in this market. Since the division of the German states and their own interpretations of legislation, I advise to seek out a party who knows a decent amount of the rules and legislations in the German construction sector. Or even a party who has already experience in running a library of construction information such as the Deutscher-Baukatalog.

Although the structure of the Dutch and German construction market is familiar, the regulations in the industry differ. This mainly applies to the amount of different regulations, which is higher in Germany. Also because of the far reaching autonomy of the states, the building codes and other rules differ from state to state.

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Appendices

A. Use of BIM worldwide

There is a vast amount of information available concerning the use of BIM in the United States, the amount of information about the BIM usage in Europe on the other hand is considerably smaller. The editors of (McGraw-Hill Construction, 2010), have researched the similarities and differences between the implementation of BIM in the United States and a selection of European countries, Germany, France and the United Kingdom. They reported that 36% of the European respondents in the research have adopted BIM. In comparison, 49% of the respondents in the US stated that they had adopted BIM into their working method, see Figure 39.

Source: McGraw-Hill Construction, 2010.

Source: McGraw-Hill Construction, 2010.

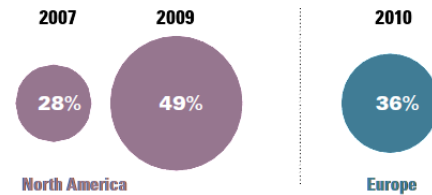


Figure 39: BIM adoption (source: McGraw-Hill Construction, 2010)

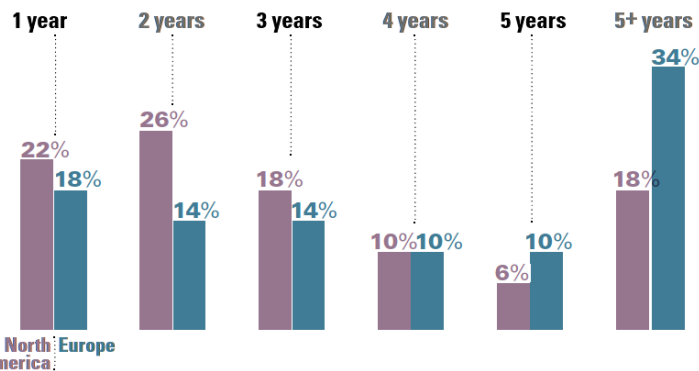


Figure 40: Years of experience with using BIM (source: McGraw-Hill Construction, 2010).

shown in figures of adoption among contractors, in the US 50% of the contractors have experience with BIM compared to just 24% of the European contractors. The adoption rate of BIM in Germany is ca. 36% of the companies surveyed, of which more than 50% sees themselves as advanced or expert users. When watching at the real figures, it is shown that European BIM users have often more years of experience using BIM as shown in Figure 40 and Figure 41.

Source: McGraw-Hill Construction, 2010.

The largest amount of adopters of BIM in the EU can be found at architectural firms (47%), and 45% of the respondents consider themselves experts or advanced users. Almost 75% of the European respondents report a positive perceived return on their investments in BIM. The differences between the embracement of BIM between the US and the EU can be found in differences in types of construction projects. In the US there are more large scale construction projects while in the EU the renovation sector is significantly larger. This is really

	ARCHITECT	ENGINEER	CONTRACTOR	TOTAL
We are not using BIM	54%	63%	77%	64%
We are creating (authoring) models	23%	15%	6%	16%
We are using BIM tools to analyze models but not creating our own models	4%	7%	11%	6%
We are creating and analyzing models	19%	15%	6%	14%

Figure 41: How and which partners use BIM in Europe (source: McGraw-Hill Construction, 2010).

The European respondents of the McGraw-Hill Construction research cited 3 main productivity gains, the reduction in errors and omissions in construction documents, reduced cycle time of

Source: McGraw-Hill Construction, 2010

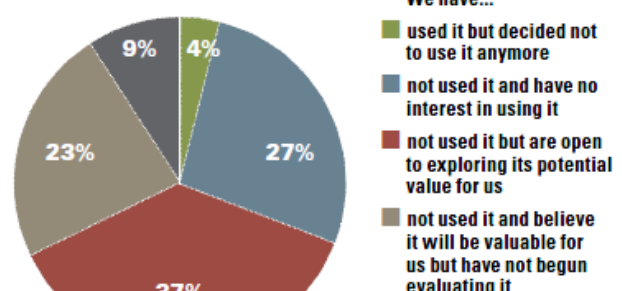


Figure 42: Opinions of non-BIM users (source: McGraw-Hill Construction, 2010).

specific workflows and reduced rework. Furthermore they experience an improved collective understanding of design intent, improved overall project quality and reduced conflicts during the construction.

Of the European respondents who have do not currently use BIM only 4 percent tried working with BIM and has decided to not use it again. 27% is not interested in BIM and have no interest in using it. The remaining 69% who have not yet used BIM are open to trying BIM but are not all convinced of the potential of BIM. Thus most respondents are open-minded in the future possibilities to integrate BIM into their workflow which is shown in Figure 42.

Source: McGraw-Hill Construction, 2010

Focusing more on Germany, the adoption rate is ca. 36%, the adoption is led by architects (43%, than engineers (33%) and contractors (24%). Of the respondents who say they are familiar with BIM, 51% thinks that they are advanced or expert users.

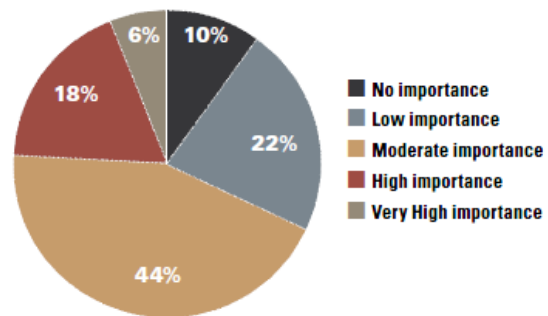


Figure 43 furthermore shows the expected importance in the next 5 years according to the respondents who have no BIM experience at the moment of writing. The figure shows that most, 44%, believe that BIM will have moderate importance in the following 5 years. Only 24% believe it will be highly or very highly important in the next 5 years.

Figure 43: (source: McGraw-Hill Construction, 2010)

The “Rijksgebouwendienst” in the Netherlands has set up instructions in the “RGD BIMnorm” to instruct contractors on how to work with BIM. The partners have the complete freedom to use any kind of BIM application and file format, as long as the information can be extracted to DWG(drawings) or IFC(models) file formats (Rijksgebouwendienst, 2012). They also report that the ongoing development of BIM software and standards is a real threat in the implementation of BIM in daily use, and it is advises to keep close track of ongoing developments. The “Rijksgebouwendienst” also sees a threat in the fact that the building sector is still document centric.

The report “10 truths about BIM” (WSP, -) states the current states of BIM in several European and other countries.

The implementation of BIM in the Scandinavian countries has taken a leap in comparison with other European countries. For instance **Norway** has a small construction industry and government. These regulatory bodies and construction industry are all actively promoting the use of BIM which have made Norway a BIM success story, which has led to the point that BIM-less projects are becoming quite rare. It is now essential for all major infrastructure and government construction projects, and it is even thought in school to new students. The adoption of BIM in **Finland** has been the highest in the world. Finland is also a technological advanced nation with a small construction sector and a long history of open standards. These facts have led to a perfect environment for the development of BIM, currently it is most used in smaller projects. The third Scandinavian country, **Sweden**, is catching up fast with the other Scandinavian countries and is leading in the implementation of BIM in large and complex infrastructure projects such as the Stockholm Bypass and the new City Line in Stockholm. In **Denmark** BIM is required for all construction projects with a price tag of more than €4 million. In comparison to the Scandinavian countries, the construction industry in the **UK** has less enthusiasm for BIM. Just recently the government decided to make BIM part of its procurement policy, which has been received with skepticism from the construction industry. The last European country, **Germany**, is going its own way for now. The “buzzword” BIM is less common in Germany and there are obstacles because of the large amount of home grown software packages. The decentralized political structure has resulted in a more fragmented construction industry which

makes it harder for BIM to be adopted (WSP, -). In Germany the Mefisto (management/Führung/Information/Simulation im Bauwesen) project is initiated by the German office of Education and Research (2009-2012). This project is meant to make it possible to increase the interoperability between parties in the building chain. Although the objectives are roughly the same, this project does not incorporate BIM.

(Liebich, et al., 2011) states that the technological equipment and software in use in most of the European countries is quit the same. Therefore they conclude that most of the used software packages are used internationally and thus cannot account for the main differences in the adoption of BIM between European countries.

The **United States** has a large construction industry which makes it more difficult to implement new technologies such as BIM. BIM will lead to a shift in responsibilities and new collaborative relationships, which is being retained by the American culture of lawsuits and large damage claims. In **Australia** BIM is starting to take off but the government and industry associations need to encourage the use of BIM even more. The Sydney opera house is a famous example of how BIM can be used in the management/operation phase of existing buildings (WSP, -).

Countries like the **United Arab Emirates** have a short history of computer aided design, and are now forerunner in the implementation of BIM in the design of its innovative and boundary-defying constructions. The report of WSP also shows that companies in **India** currently approaching BIM in a way they need to provide models for overseas companies. This expertise combined with the demand of new infrastructure locally will lead to an optimization of BIM usage and expertise for local projects. In **China** there is a large potential for the quick adoption of BIM because of the fast moving construction industry. Combine this with large investments in infrastructure coupled with strong government support this will lead to rapid implementation of new technologies like BIM (WSP, -).

A widely used figure for showing the degree of adoption of a certain product is the adoption curve. Figure 44 illustrates the current position of a couple countries in the adoption curve. It is immediately clear that most countries are still in the pioneering phase of the implementation with only the early adopters using BIM. Only the Scandinavian countries, which are really the forerunners, are in the process of that the early majority has embraced the use of BIM in practice. Germany is a country where only the visionaries use BIM, there is a long way to go before the majority of engineers and architect in Germany will use BIM, thus there is a huge potential for new applications that are BIM-proof and help the implementation.

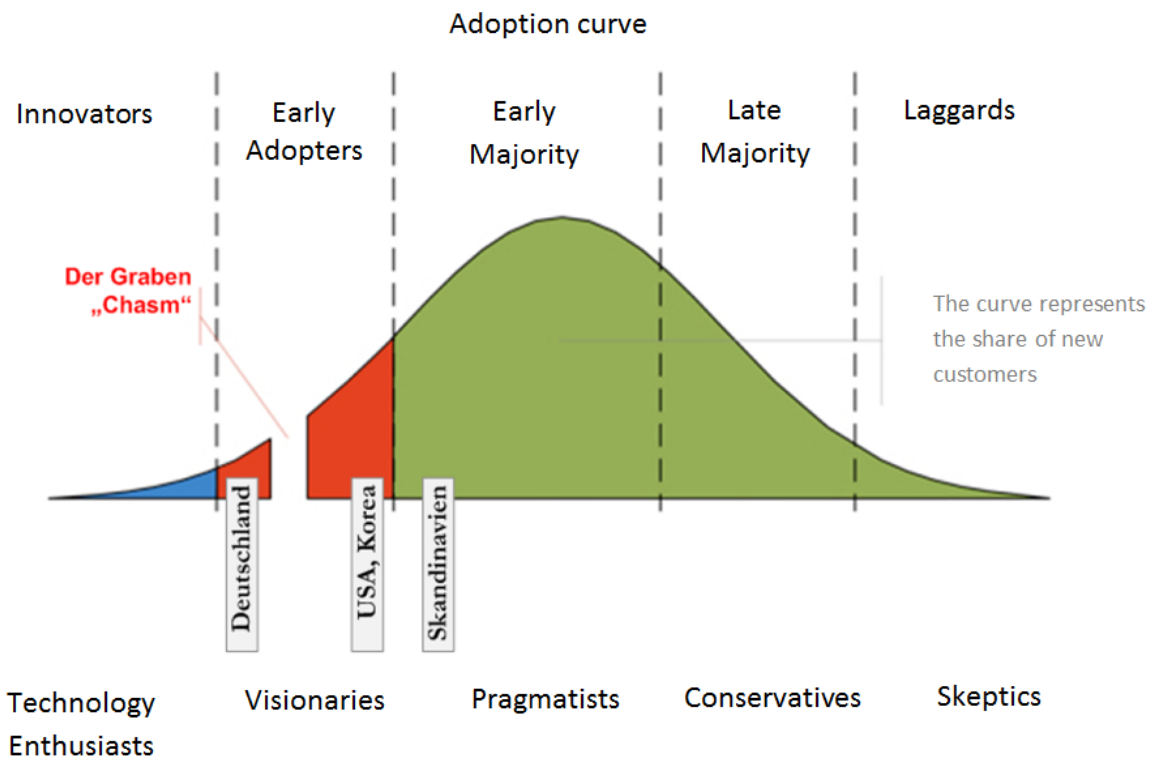


Figure 44: Adoption curve of BIM with the position of Germany, USA, Korea and Scandinavian countries illustrated source: (Leibich, 2012).

B. Obstacles and barriers of implementing BIM

Main obstacles and barriers	Sub-categories
Organizational barriers	Change in contractual relationships between developers, designers, builders and contractors;
	New contract processes and methods in the construction industry;
	The frequently and constantly changing design and construction teams;
	A change in business processes at each participating firm;
	Thinking and working methods conform to the HOAI phases and compensation systematics;
	The transformation to a high density information content at site level works like polishing, manual workers, etc.;
	The building information model needs to be transferred throughout all the project phases, from initiation to demolition.
Technical barriers	Users need to buy and install new software and possibly buy new hardware because of increased hardware requirements of these software;
	Handling the data-exchange between different software systems and large data volumes of the models;
	Data storage and back-up systems need to be organized and available 24/7, 7 days per week;
	The exchange of patented and/or company specific information between multiple companies;
Price technical barriers	Investment in hardware and software, questions about the profitability and payback-times of the investments;
	Current operating costs and costs concerning BIM administration;
	High implementation costs because of the complete or partial change of business processes;
	Training needs, BIM is a new complex way of working, and also the software is more extensive and needs training before usage;
	Long learning curve and possible start-up problems.
Use and acceptance obstacles	Various individual preferences and dislikes of persons who come in contact with the new way of working;
	Different motivations and beliefs;
	The complexity and possibilities of the programs require new specializations;
Legal barriers	New and changing requirements for those involved.
	Contracts concerning design and risk-taking between the parties;
	Legally binding status concerning the provision of information;
	Data security and the protection of trade secrets;
	The compliance with the requirements of the current procurement procedures.

C. List of Competitors

Name	Website	Targeted software	Area of Focus	User added content	Number of objects	Price ¹	Level of Detail ²	Comments
BouwConnect Library	http://www.bouwconnect.nl/	Plugins: - Autodesk Revit - Autodesk AutoCAD (LT) - Arkey-ASD - ArchiCAD (not yet available) Alternatives - IFC export	Netherlands	No	Ca. 32.500 objects of 450 manufactures, and over 18.000 abstract objects	View and search: free Student licenses: free Entry Costs: €95 - €695 Yearly fee: €300 - €1048,50 depending on the implemented plugins	High, including object related information	Prices are based on yearly contracts.
Autodesk Seek	http://seek.autodesk.com/	Direct links from: - Autodesk Revit - Autodesk AutoCAD	United States / International	No	Ca. 65.000 objects of over 1000 manufactures	Free of charge	-	This database is hosted by the company Autodesk, the maker of Revit and AutoCAD. Data is not available in the IFC format.
Revit City	http://www.revitcity.com/index.php	Focusses on Revit, offering: - Family objects (.RFA) - Project files (.RVT) - Groups (.RVG) - Templates (.RTE) - Fill patterns (.PAT) - Material libraries (.MLI)	United States / International	Yes	Ca. 13.500 objects	Free of charge	Some drawings contain extra information, mostly just geometrical	The objects are mainly composed by users and are available in Revit compatible formats.

CADCells	http://cadcells.com/3d_architectural.htm	Plugins: - Bentley Microstation - AutoCAD 3D	United States / No International	Thousands of 3D objects, 10's of thousands of 2D drawings (exact numbers unknown)	2D packages ranging between \$59 - \$399 3D packages ranging between \$159 - \$499	Just geometrical	CADCells provides a smaller amount of 3D objects and a large amount of 2D drawings. The objects are divided into several groups which have to be bought separately. Objects are not certified.
FormFonts	http://formfonts.com/	- Google SketchUP - Autodesk AutoCAD - FBX - Autodesk Revit	United States / Yes, partially International	Ca. 50.000 objects and 2D models	\$199 / year	Just geometrical	Seems to be more oriented on interior and exterior design, seems to be lacking constructional objects like walls however these categories are implemented in the website they show no results.
SmartBIM	http://smartbim.com	Autodesk Revit	United States / No International	Ca. 45.000 generic and manufacturer specific BIM families and types of ca. 120 clients representing 160 brands	Free of charge	Offers additional information such as instructions and specifications	The library hosts items of 120 clients with 160 brands, and all items are manufacturer-approved. The focus of this library is on the US market. The components are available in DWF, XML and RFA formats. Does not contain any German

								or Dutch specific objects and information is provided in imperial system formats.
BIM object	http://bimobject.com/	- Autodesk Revit - ArchiCAD - Others	Scandinavian / International	No	Ca. 1520 objects of 142 manufacturers	Free of charge	-	Files are downloadable in IFC-format and other vendor specific formats. The website states that the models are checked and approved by their vendors. This library contains objects for construction markets, concentrating on Western Europe.
Revit Content	http://www.revit-content.com	Autodesk Revit	International	No	Number of objects is unknown, there are 20 sub categories with several objects	Pay-per-download, Ranging from \$25 - \$99.99	Just geometrical	This library offers a small amount of products, which are certified for use. For now they offer models escalators, elevators, doors, windows (including framing), garage doors, and several interior items.

BIMstop	http://www.bimstop.com	<p>Plugins:</p> <ul style="list-style-type: none"> • Autodesk Revit family • ArchiCAD • Vectorworks <p>Some files are available for the following software packages:</p> <ul style="list-style-type: none"> • Bentley Microstation • IFC • SketchUP 	International	Yes	Ca. 1.000 objects, both manufacture specific and user inputted objects.	Free	-	The object origin from all over the world, including 114 for the German market and 10 for the Dutch market.
SweetsBIM-Collection	http://www.construction.com/bim/	Downloads are available for Autodesk Revit. File formats offered are .RFA, .DWG, .DWF and .DXF	International	No	Unknown	Unknown	-	<p>The website is hosted by McGraw-Hill Construction and is part of the “sweets network” website.</p> <p>The main site shows a list of manufacturers from which data is available. The objects are offered by the manufacturer.</p>
Smartrevit	http://www.smartrevit.nl/	Autodesk Revit	Netherlands	Yes	Unknown	Unknown	Geometrical data only	It is a part of a whole working method which has to be purchased from SmartRevit, the library is just a smaller part of the total package.

BimSlim	http://www.bimslim.nl/	Autodesk Revit	Netherlands	Unknown	Unknown	Free	-	This library is a part of a whole working method which have to be purchased
ArchiCAD BIMcomponents	https://bimcomponents.com/	ArchiCAD	Germany / International	Yes	Unknown, site states "thousands of objects"	Free of charge	-	Integrated into the ArchiCAD software package and also accessible with a web browser.
MuM Praxispaket Bau	http://www.mum.de/DE/Bau_Architektur_MuM_Praxispaket_BAU.CAD?ActiveID=7049	Revit	Germany	No	Unknown	€821,10	-	The library is part of a larger working method, in which the library is included. For MEP, and bauplan LT, additional packages are available.

¹ All prices are based on single user licenses when available, prices per year. Prices are based on information available in February 2013

² The level of detail is determined on the basis of information available on the website, when a level of detail is noted with "-" no information is available or only available after getting a subscription to the product.

D. Drawing specifications of a brick (example)

afbeeldings editor (project N:\HD\HDData-goe\De-enige-echte)

werken Beeld Invoegen Instellingen Help

[bamboe]

Kijk wijze				Bouw status				
2D inside	2D Aanzicht	3D inside	3D Aanzicht	Normaal	Renovatie	Stop	Bestaand	Vrij
	✓			✓	✓	✓	✓	✓
✓		✓	✓	✓	✓	✓	✓	✓
✓				✓	✓	✓	✓	✓

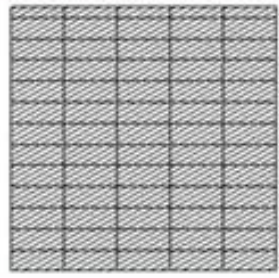
Viewer

Instellingen

- Arcering
- Texture
- Kleur
- Omlijnig

Schaal

1:1



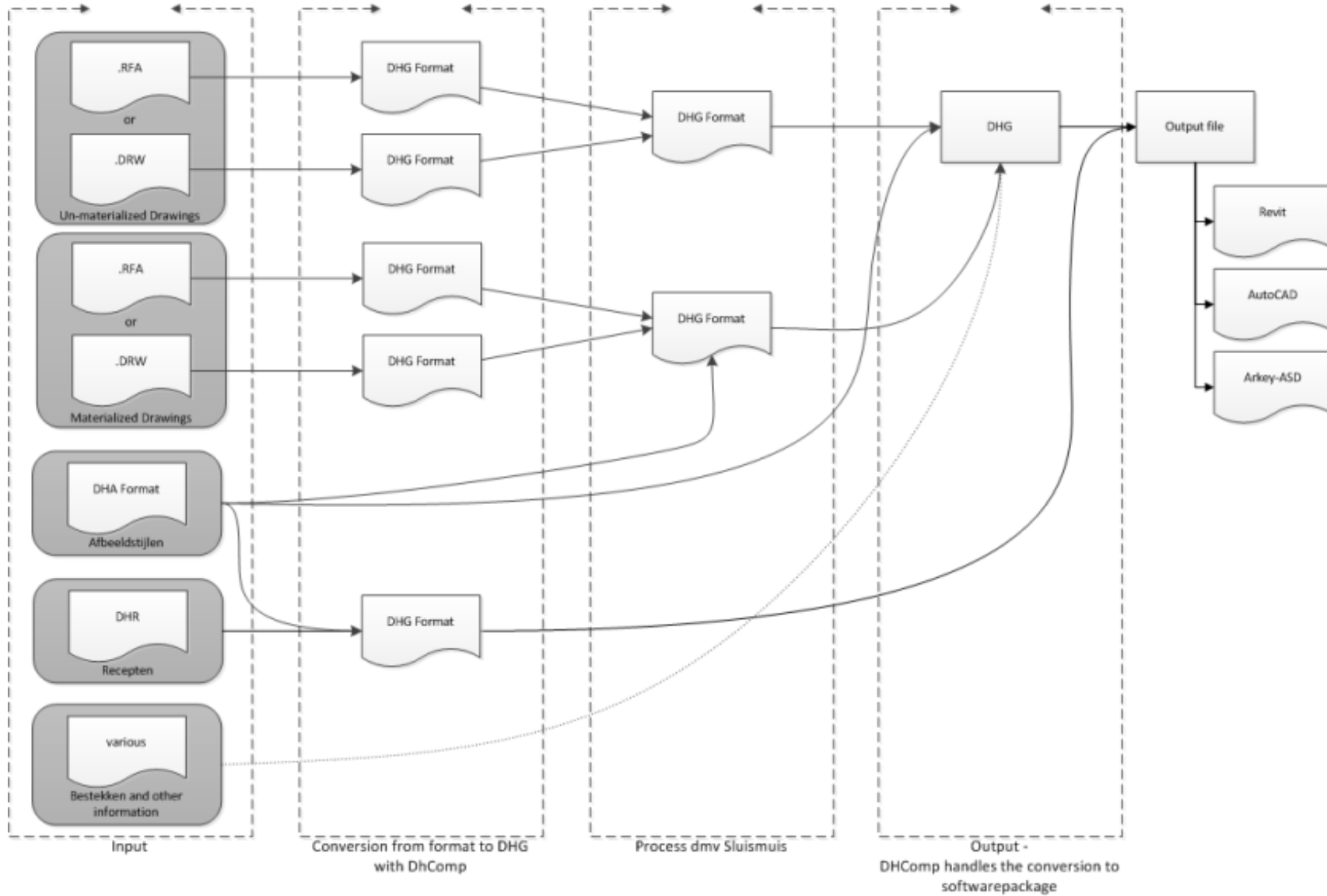
Kleur	Lijntype	1:1	1:2	1:5	1:10	1:20	1:50	1:100	1:200	1:500	1:1000	1:2000	1:5000	1:10000
Kleur														
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Kleur														

rt	uu	Start X	Start Y	Repeteer parallel	Repeteer loodrecht	Afh. Absoluut	Dikte	Kleur	Lijn type	1:1	1:2	1:5	1:10	1:20	1:50	1:100	1:200	1:500	1:1000	1:2000	1:5000	1:10000	
		0	0	0	15	✓	0,25	Kleur															
		0	0	0	6	✓	0,18	Kleur															
		0	0	0	1	✓	0,1	Kleur															
		0	0	0	20	✓	0,25	Kleur															
		0	0	0	8	✓	0,35	Kleur															

Bitmap Eigenschap	Schaalfactor X	Schaal X Eigenschap	Schaalfactor Y	Schaal Y Eigenschap	Hoek (°)	Offset X	Offset Y	1:1	1:2	1:5	1:10	1:20	1:50	1:100	1:200	1:500	1:1000	1:2000	1:5000	1:10000	
	1		1		0	0	0														
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	1		1		0	0	0														
	1		1		0	0	0														

Kleur	Eigenschap Naam	1:1	1:2	1:5	1:10	1:20	1:50	1:100	1:200	1:500	1:1000	1:2000	1:5000	1:10000
Kleur														
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Kleur														

E. Scheme of process in the BCB



F. Properties of objects

BouwConnect - VulProgramma (4.0.0.39)


Opslaan N:\VHDH\Data-goed\De-enige-echte | Open database | Instellingen | Onderdeel

radiator | Nieuw(e) Onderdeel | Lijst

ledenradiator 5-koloms 300mm hoog; 500mm hoog; 750mm hoog; 450mm hoog; 600mm hoog; 1000mm hoog; 400mm hoog;
 ledenradiator 5-koloms Brugman Radiatorenfabriek - Classic Line DIN-ledenradiator
 ledenradiator 6-koloms Solar Nederland - Thermrad Deco 566mm hoog; 966mm hoog; 416mm hoog; 266mm hoog
 ledenradiator Vasco - Primula
 Mechaheat - plaatradiator; vloerverwarming; convectorput
 Novellini Diffusion - douchecabine; radiator
 Partner In Zaken - radiator; haard; cv ketel; rookgasafvoer; zonnepaneel
 plaatradiator Brugman Radiatorenfabriek - Piano Line
 plaatradiator Brugman Radiatorenfabriek - Piano Line Piano-Verti; Piano-Uni
 plaatradiator radiator Brugman Radiatorenfabriek - Casual Line Mini; Piano Universeel
 plaatradiator radiator Brugman Radiatorenfabriek - Casual Line Verti
 plaatradiator type 10 Brugman Radiatorenfabriek - Casual Line Standaard
 plaatradiator type 10 Brugman Radiatorenfabriek - Casual Line Standaard
 plaatradiator type 11 900mm hoog; 700mm hoog; 400mm hoog; 300mm hoog; 500mm hoog; 600mm hoog
 plaatradiator type 11 Brugman Radiatorenfabriek - Casual Line Standaard
plaatradiator type 11 Solar Nederland - Thermrad Compact-4 Plus 500mm hoog; 400mm hoog; 600mm hoog; 900mm hoog; 700mm hoog
 plaatradiator type 11 Solar Nederland - Thermrad Super-8 Compact 300mm hoog; 600mm hoog; 500mm hoog; 400mm hoog;
 plaatradiator type 11 Solar Nederland - Thermrad Super-8 Plateau 600mm hoog; 700mm hoog; 500mm hoog; 400mm hoog; 900mm hoog;
 plaatradiator type 20 400mm hoog; 300mm hoog; 900mm hoog; 500mm hoog; 700mm hoog; 600mm hoog
 plaatradiator type 20 Brugman Radiatorenfabriek - Casual Line Universeelkompakt; Kompakt-4; Standaard

Kenmerk	element	voorplaat	T eenheid	T aansluiting	afbeeldingen produc	breedte	brongeometrie
Alle	Meerdere waarden	Meerdere waarden	st	A C A in [11, 18, 32]	Meerdere waarden	1000	Meerdere waard
300mm hoog	KNIPFILTER (radiator plaat)	geprofileerde voorplaat So	st	A C A in [11, 18, 32]		1000	M
400mm hoog	KNIPFILTER (radiator plaat)	geprofileerde voorplaat So	st	A C A in [11, 18, 32]		1000	M
500mm hoog	KNIPFILTER (radiator plaat)	geprofileerde voorplaat So	st	A C A in [11, 18, 32]		1000	M
600mm hoog	KNIPFILTER (radiator plaat)	geprofileerde voorplaat So	st	A C A in [11, 18, 32]		1000	M
700mm hoog	KNIPFILTER (radiator plaat)	geprofileerde voorplaat So	st	A C A in [11, 18, 32]		1000	M
900mm hoog	KNIPFILTER (radiator plaat)	geprofileerde voorplaat So	st	A C A in [11, 18, 32]		1000	M
Toevoegen			st	A C A in [11, 18, 32]		1000	
Dupliceer	KNIPFILTER (radiator plaat)	geprofileerde voorplaat So	st	A C A in [11, 18, 32]		1000	M

Soort: plaatradiator | Opbouw: 1-plaats met 1 conve | Patroon: <<Leeg>> | Merk serie: Solar Nederland - Th | Kenmerk: 300mm hoog, 400mm hoog, 500mm hoog, 600mm hoog

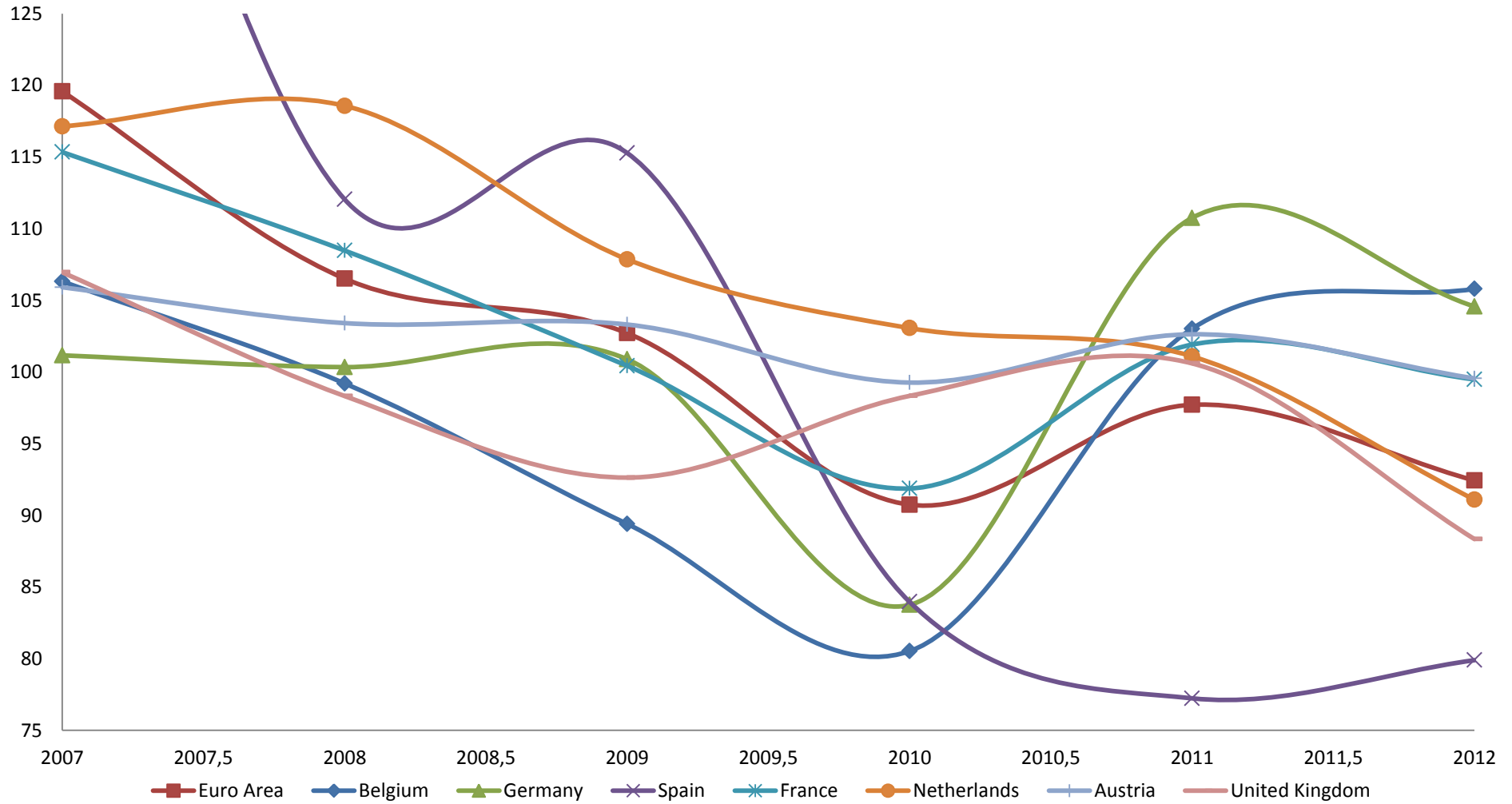
brongeometrie fabrikant: 2D 3D | bestekpost: 60.41.11-a | afbeeldingen product:  | product omschrijving: Compact-4 plus

60.41.11-a RADIATOR
 0. PLAATRADIATOR
 Fabrikaat: Solar Nederland.
 Type: 11.
 Thermrad Compact-4 Plus.
 Hoogte (mm): 900.
 Diepte (mm): 70.
 Vermogen (W): 1312.
 Materiaal: metaal.
 Toebehoren: - bevestigingsmid delen.
 4. MONTAGE VERWARMINGSLI

product omschrijving
Compact-4 plus
 U kiest voor de Compact-4 plus indien geen onderaansluiting is gewenst. Deze radiator is voorzien van sierlijsten op boven- en zijkanalen.

Technische gegevens Compact-4 plus
 • 4 zij-aansluitingen 18,2".
 • Aangelaste ophangstripen t.b.v. wandbevestiging.
 • Inclusief L-console met bouten en pluggen.
 • Inclusief blind- en ontlichtingstop.
 • Bouwhoogten in mm 300, 400, 500, 600, 700, 900.
 • Bouwdiepten in mm 70 (type 11), 73 (type 21), 106 (type 22), 165 (type 33).
 • Bouwafstanden in mm van 400 t/m 3000.

G. Graph of Construction output between 2007 and 2012



H. Templates for importing and drawing a door and framing

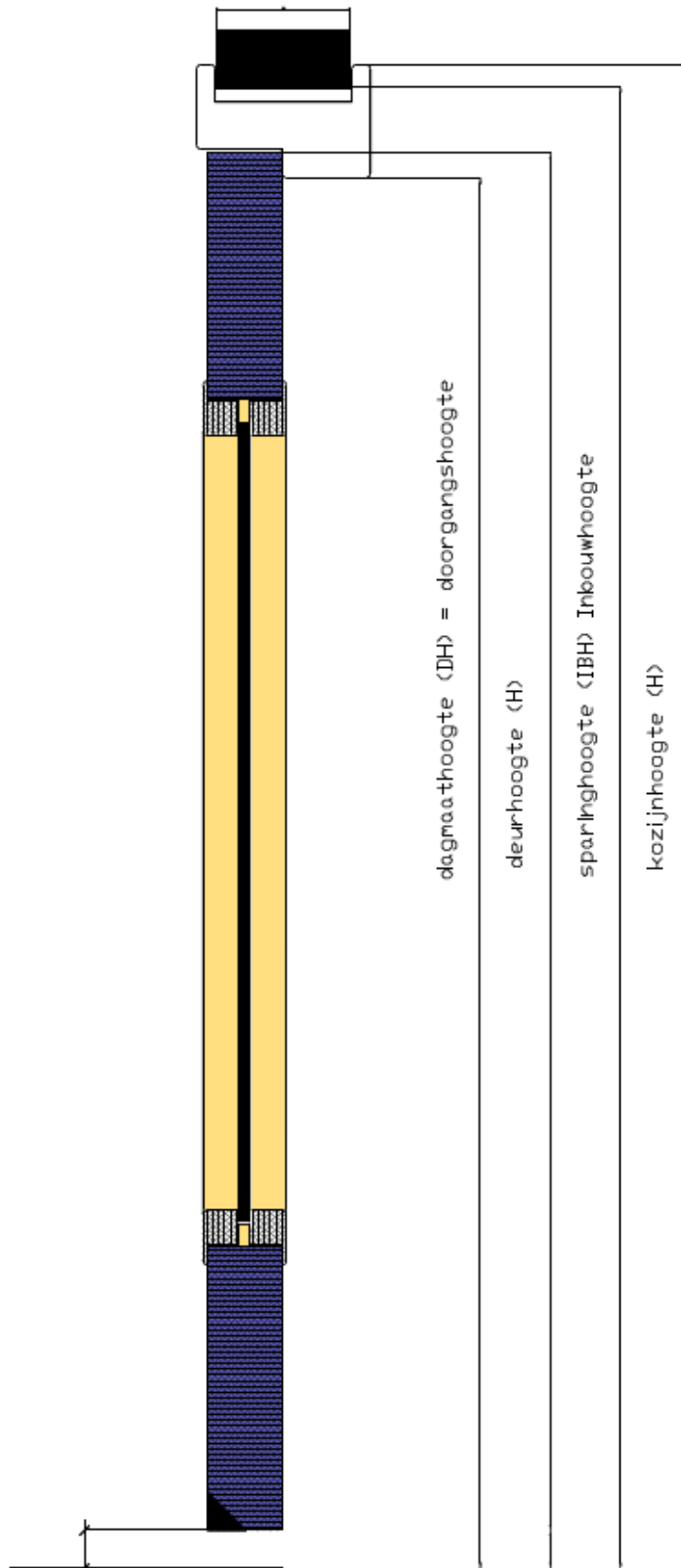


Figure 45: Cross section on height of the door

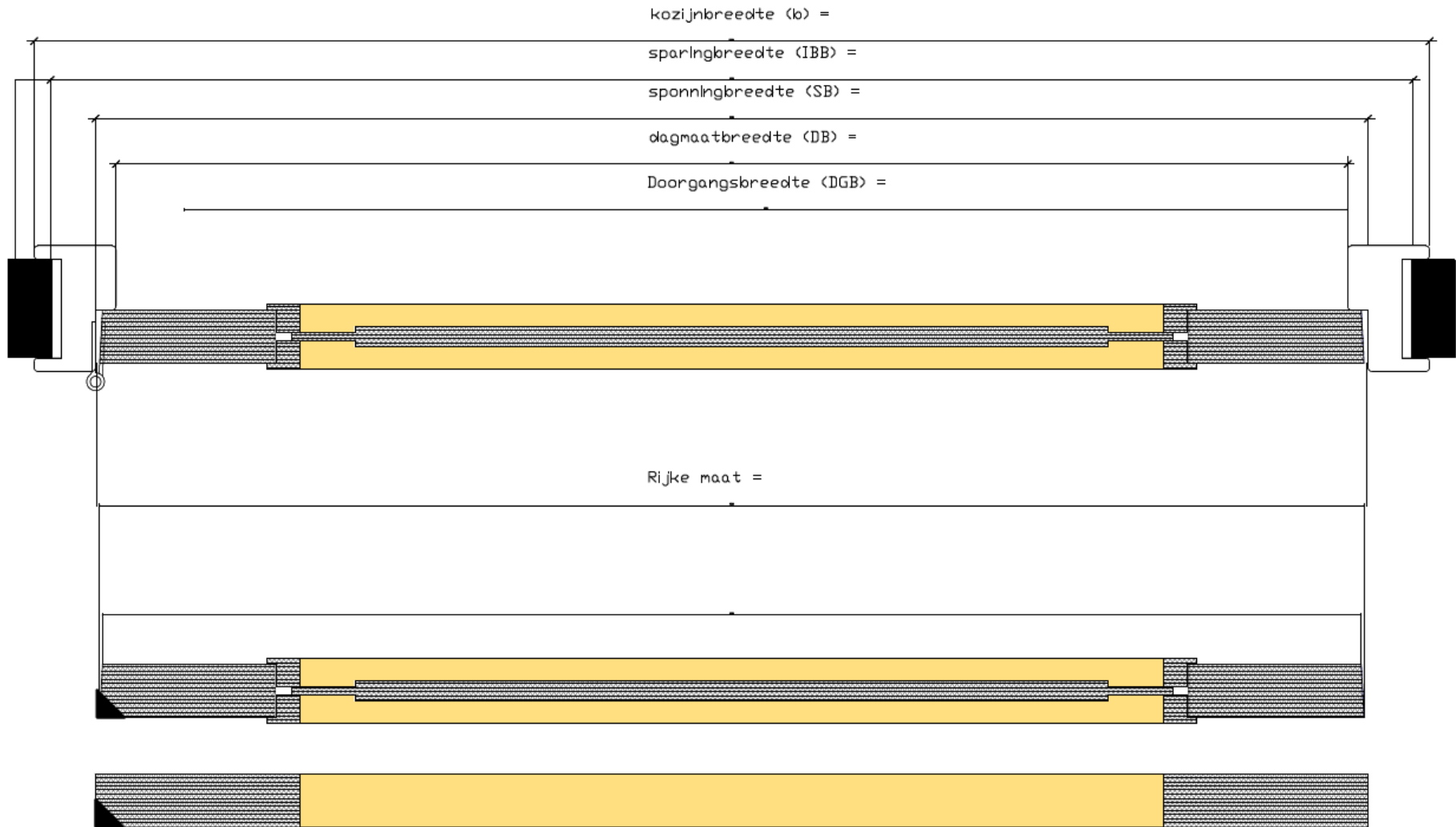


Figure 46: Cross section on width of the door

I. Summary

INTERNATIONAL OPPORTUNITIES BOUWCONNECT LIBRARY

Threats and opportunities for expansion of BouwConnect to the German construction market

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21-08-2013

ABSTRACT

This paper contains the most important findings and conclusions of the research for the international opportunities for the BouwConnect Library (BCB). With the use of expert interviews, literature and internet research the technical background of the BCB has been described. This information is used to make a sound conclusion whether it is possible to offer the BCB product in the German construction market. The most important conclusion is that it is possible to enter the German market, although with some remarks.

Keywords: BIM, Object library, International Deployment, Process Analysis, Rework

INTRODUCTION

Because of the document centric and the multidisciplinary nature of the construction industry, Isikdag et al, 2010, projects face unforeseen costs. Documents are outdated when send around, and face the problem of interpretation. his information is often digitally available, but it is still treated as a document. Because of this document-centric nature of the construction industry and the insufficient integration and interoperability between software applications has resulted in problems in communication and coordination between involved parties. Mistakes made because of these interpretation and errors in drawings result in rework, rework accounts for a large portion of unforeseen cost in the construction sector. To tackle this problem a 3D Building Information Model can be used, also called BIM. BIM is a way of working that can unite all actors in the construction process and concentrating all the data of all actors into one model. Just like with the introduction of the 2D cad models, there is a need for object libraries through which the time lost in drawing an object multiple times, in different projects, can be reduced. The BouwConnect Library offers this product, and is quite successful in the Netherlands and is willing to expand to Germany.

THEORETICAL BACKGROUND

Rework

According to (Isaac & Navon, 2013) design changes often have a major impact on the client objectives in construction projects, and even in successful construction projects the costs associated with post award design changes typically amount to 5-8% of the contract value.

They furthermore note that design changes include any modification of existing design data, which alters previous decisions made by the project team and other actors. Causes of such changes may include the following:

- Change in orders: For example, changes originating from the client, due to omissions in the requirements, changes in the clients' activities, or a better understanding of client needs.
- Rework: For example, changes originating with the project team, due to errors or solutions which emerge during the development of the design and planning, and the actual construction.
- Changes originating with suppliers, due to changes in technology or the inability to meet the original planning targets.
- External causes, such as new regulations.

In the history of construction a lot of projects have seen unforeseen costs and delays due to miscommunication between several parties. The main reason which causes cost overruns and delays has been identified as rework. Love, 2002, defines rework as “the unnecessary effort of redoing a process or task that was incorrectly implemented the first time”. Rework contributes to 52% of total cost overruns and can increase the schedule overrun by 22% (Han, et al., 2011). Han et al, 2011, also state that design errors are a major contributor to the problem of rework.

Fragmentation is an important aspect of the construction industry structure and client base, because of the traditional nature of the industry involves bringing together multidiscipline in a one of a kind project (Isikdag & Underwood, 2010). Furthermore Isikdag et al, 2010, notes that the construction industry is extremely “document-centric” of nature with construction project information being captured mainly in documents. At present day this information is often digitally available, but it is still treated as a document. This document-centric nature of the construction industry and the insufficient integration and interoperability between software applications has resulted in problems in communication and coordination between involved parties. To tackle this problem a Building Information Model can be used, also called BIM which is a field of research that has become more actively in recent years

BIM

According to Linderoth, 2010, the first reports of the potential of Building Information Models in the AEC industry emerged in the late 1980's and early 1990's, but it took almost 15 years before positive outcomes appeared from the development of BIM in the AEC industry. But already in the 1970's there were several prototype integrated systems developed which attempted to integrate building descriptions.

Using BIM results in some benefits compared to other pre-BIM methods. Manning & Messner, 2008, have identified 6 primary benefits, rapid visualization, better decision support upstream in the project development process, rapid and accurate updating of changes, reduction of man-hours required to establish reliable space programs, increased communications across the total project development team, and increased confidence in completeness of the scope. Using BIM results in a faster and more cost-effective project delivery process, and creates higher quality buildings that perform at reduced costs (Eastman, et al., 2008). The study of Sacks et al, 2008, shows that the use of BIM in a project

can offer an increased productivity ranging from 21% to 61% in drawing production activities of a firm. According to Sacks et al, 2008, drawing production activities account for 68% of the hours spent on a typical construction work. The research of Kaner et al, 2008, has shown that there is a steep learning curve when introducing BIM to a project.

Barriers encountered when implementing BIM

Because BIM is a new way of working, new users have to get acquainted with the method. Naumann, -, states that the implementation of BIM in the German market knows some difficulties because of the differences in the supply and demand of BIM bases products. The factors are also applicable to other markets than Germany. Software developers try to push the implementation of BIM capable products while the supposed users are surrounded by obstacles and barriers which hold back the implementation of BIM in the German practice. The main obstacles and barriers are:

- Organizational barriers;
- Technical barriers;
- Price technical barriers;
- Use and acceptance obstacles;
- Legal barriers.

BOUWCONNECT LIBRARY

Because of the document-centric nature of the construction industry and the short partnerships which change per project, actors want a system in which information is available at a level that everyone knows what to do with this information and which can only be interpreted one way. BIM is a way of working that can unite all actors in the construction process and concentrating all the data of all actors into one model. Just like with the introduction of the 2D cad models, there is a need for object libraries through which the time lost in drawing an object multiple times, in different projects, can be reduced.

BouwConnect is a cooperation between the architects of “De Twee Snoeken” and communication specialist “KPN” (BouwConnect, -). BouwConnect provides a platform independent database as universal information source for an integral solution for information supply and communication in the building sector.

The information which is specified for each element goes as far as CAD information, building physics, costs and information to compile the “bestek” (building specifications) of a project. The software also houses several configurators to compose walls, stairs, windows frames, escalators, elevators, etc. With the use of these configurators it is possible to compose custom larger multi-object based objects with all the information available. The library contains both abstract and manufacturer specific models, the abstract models can be used in the start of the design phase, and can later on be replaced by manufacturer specific models. This way the whole decision making process is covered with the BCB.

Every element that is included in the BCB has a unique “WUID”, Warehouse Unique Identifier, which can be seen as the DNA of a building component. Every object that is included in the BCB, or made with one of the configurators, gets this unique ID code. This WUID is always 100% unique for every generated building component and is 100% reproducible. As a result it is not necessary to share the entire models with each other but

just the WUID, when importing the WUID into the BCB the user will get the building component and accompanying information he needs. The WUID is not based on the UUID or GUID which are incorporated in the IFC/IFD standard and which is promoted by the BuildingSMART platform. Although it is not based on the UUID or GUID of BuildingSMART, it shares the same objectives namely providing a unique key for exchanging data between parties in the construction sector.

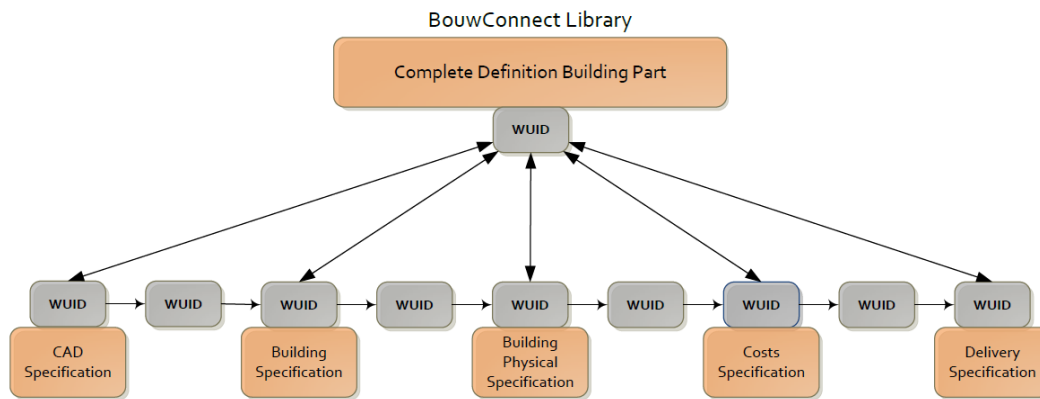


Figure 47: Working of the WUID.

UNIQUENESS OF THE BCB

The uniqueness of the BCB product is investigated with the use of a literature review and internet research. The uniqueness of the product in this context is linked to the amount and kind of competitors who operate in the same market.

According to (Gu & London, 2010) the main problem with existing object based libraries for BIM capable tools is that there are interoperability issues across different commercial software packages. This is mainly caused by the use of different file formats and a different focus of the software on the use of a model. They furthermore state that most product libraries target specific commercial applications with a wide market base. Furthermore there is not only a need for a standard format for data exchange, there is even a greater need for standard vocabulary for the consistency of data when exporting data from one package to another (Gu & London, 2010).

From the research it becomes almost immediately clear that most of the object libraries are focusing on the US market or offer international products without the focus for just one specific country.

The research also shows that most object libraries are focusing on 1 particular software package, in particular the Revit software family of AutoDesk, just like (Gu & London, 2010) stated in their research. A lot of libraries contain user generated content which is not validated by manufactures or are just abstract models, not specifically assigned to a certain product. Furthermore it has become clear that most of the libraries that can be found on the internet are offering just geometrical models, and are thus lacking the information richness which is integrated in the objects that are available in the BCB library.

ADDING OBJECTS TO THE LIBRARY

In this paragraph the process of adding objects to the library is briefly explained.

The models in the library have been drawn with either Revit Architecture or Arkey-ASD which results in geometrical drawings in multiple file formats such as .RFA and .DRW. The geometrical data used in the library is stored in a file with a .DHG format, which is a custom made format called the DigitaleHuisGeometrie format. The transition of the geometrical data from .RFA and .DRW to .DHG is done with the custom made application called the DHcomp. After the phase of transforming the geometrical data, the possibly 2 new .DHG files will be joined together in 1 .DHG file with the use of an application called “sluismuis”. This is both done for materialized and non-materialized drawings.

From this point the data concerning the drawing properties can be added to the geometrical data. This data contains all the information concerning the way a material is drawn, for example the hatching of an object, the contours, colors and bitmaps. The data for materialized drawings is added in the first DHcomp conversion, while the data for unmaterialized CAD drawings is added in a later step. Furthermore the data belonging to the objects can be imported with the use of the VulProgramma.

After this step the DHComp software takes care of exporting the .DHG data to data that can be extracted to CAD packages such as Revit, AutoCAD and Arkey and adds all the information that a model can hold, including the unique WUID of an object. In this step it is also possible to extract data to an IFC file with all the needed parameters.

The main purpose of the VulProgramma is the filling of properties of BouwObjecten. BouwObjecten are the essential foundations of a model, a whole building can be divided into these BouwObjecten. These BouwObjecten are the cornerstones of the digital model, an example of the importance of this division is that for example a living room is a completely other object than a steel HEA-beam. The division is not only done for structuring purposes but also for the possibility to connect different elements together. These BouwObjecten are placed in different BouwObjectTypes, furthermore it exists out of 1 or more DeelObjecten.

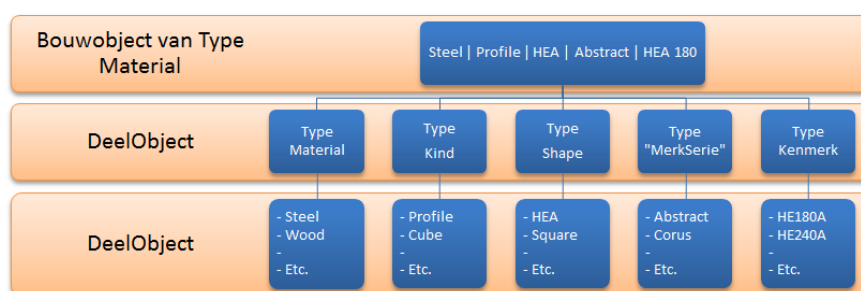


Figure 48: Decomposition of a BouwObject.

There are a couple of special BouwObjecten and DeelObjecten. For example the fictive DeelObject which contains all the properties of a DeelObjectType can be defined as an item container, for users a kind of bowl which contains all properties. There is also a “Toegewijd(dedicated) BouwObject” which is only used exclusively for the creation of larger models and will never be used solely. Furthermore there are the “kenmerk” DeelObjecten which is a special DeelObject which does not contain properties but is used to store property values, these are specific for a certain “kenmerk”

When adding new objects with the use of the VulProgramma it is possible to give all the measurements their own reach. This is for example,

- Category A: absolute reach, which is physically possible,
- Category B: structural reach, the measurements of objects the manufacturer can deliver in addition to the common measurements and
- Category C: common reach, the common objects a manufacturer provides.

These measurements are thus dependent on the kind of products a manufacturer can deliver. These measurements are all based on the used templates of the Twee Snoeken.

DATABASE OF THE BCB

To get a more detailed insight in how the data in the BCB is stored, a conceptual class diagram of the database behind the BCB is made. This is shown in figure 4.

The database of the BouwConnect library is constructed in such a way that the database itself is not a barrier for adding new types of information. For example when there is a difference in the definition of the height of a door between the Dutch and the German construction industry, this does not matter for the structure of the database. Of course there is a difference, but this information needs to be imported by the people working for the “vulploeg”, the people who build the models and who enter all the relevant information of a specific object. Thus that is where the changes need to be made when necessary.

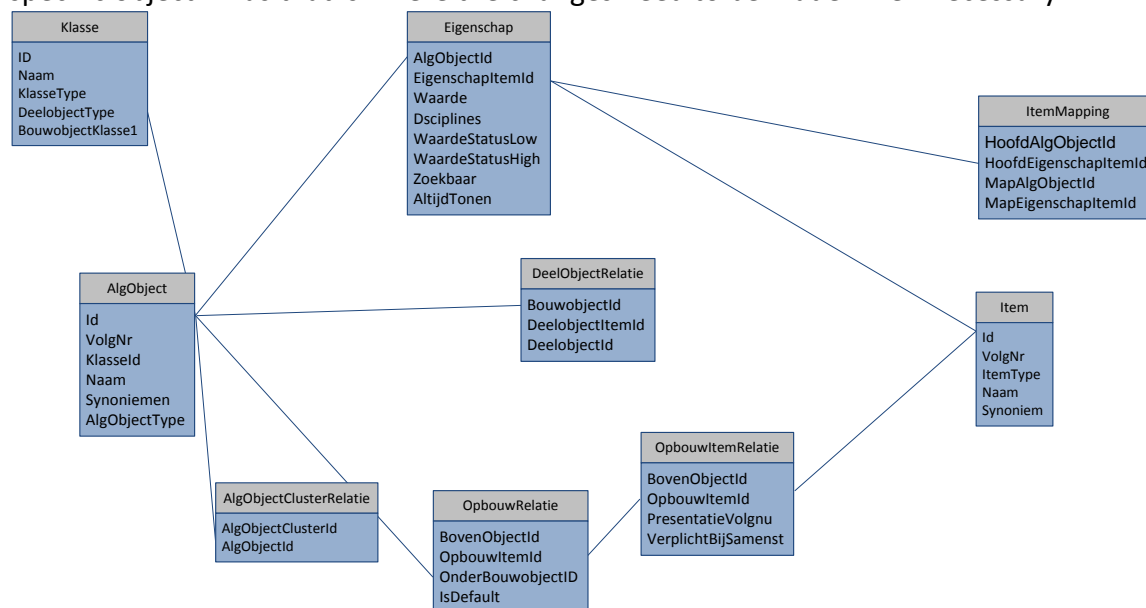


Figure 49: Conceptual class diagram of the BCB.

EXPANSION TO THE GERMANY

The world economy finds itself in one of the most destructive crises in modern history, which started in 2007 in the United States. Since then the complete economy has suffered from this crisis, and in particularly the construction sector. Before the crisis in 2007 the European market showed its 13th year in a row of uninterrupted growth (Gluch, 2007).

Arch-Vision has produced a report (Arch-Vision, 2012) in which they conclude that the construction industry in the European countries that are examined are showing the first signs of recovery, but that real growth is not expected before 2015. Germany, together with the UK, are the only countries which show a quarter-quarter increase in their order book

development. As seen in figure 5 it is forecasted that the European market in total will show a decrease in the coming years, at least 'till 2014. Germany is the only country listed that is believed to show opposite figures, the market is expected to grow until 2013/2014 slowly, and after that the growth will increase.

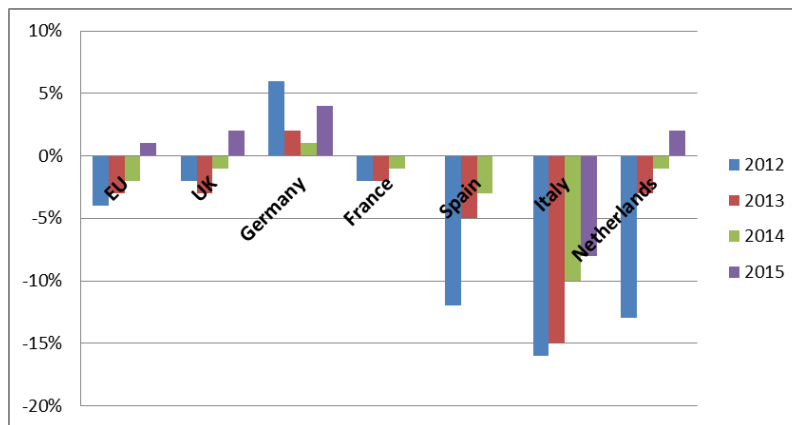


Figure 50: Expected construction output 2012-2015 in Europe.

Further research in the German construction market showed that it is viable to focus at this market. But before entering the market it is important to know the differences between the current Dutch market and the German market.

The German construction market is shaped almost the same as in the Netherlands, the structure of the market is thus not a barrier for

introducing the BCB in the German market.

A large difference in the market is that Germany knows a lot of different regulations. Every one of the 16 states has its own “bauordnung”, and other regulations are way more extensive than known in other countries. This is a point to keep in mind before entering the German market with the BCB product.

The software usage between the Netherlands and Germany differs significantly. This is mainly caused by the fact that German companies often use home-grown products while in the Dutch construction mainly international software packages are used. In the following table the main differences are shown. Because the BCB offers plugins for the most used software packages in the Netherlands, German products are not yet served. For an successful expansion the main software packages in Germany need their own plugins.

Netherlands	Germany	United Kingdom	France	Spain	Italy
AutoCAD 27%	ArchiCAD Nemetschek Allplan 18% (both)	/ AutoCAD 50%	AutoCAD 34%	AutoCAD 64%	AutoCAD 61%
ARKEY 18%	AutoCAD 16%	ArchiCAD 10%	ArchiCAD 22%	Allplan 8%	ArchiCAD 10%
Revit 13%	Vectorworks 10%	Vectorworks 7%	Allplan 13%		
Other known 35%	Other / not known 38%	Other / not known 33%	Other / not known 31%	Other / not known 28%	Other / not known 29%

Figure 51: Comparison of software usage.

Of course the product needs to be altered to fit the German needs. This means that the software needs to be translated, but there is more. Other implications are such as the integration of the STABU, which is only valid in the Netherlands. The German counterpart will be the STL-Bau. The classification of the NL-Sfb will be translated to the DIN 276.

Furthermore there are small differences in naming of distances etc, this needs to be incorporated in the software. The software and its backbone at this moment does not form a barrier for incorporating the needed changes.

PROCESS ANALYSIS

The introduction of the BCB started in 2001 with the start of the “Digitale Huis Bibliotheek”. In 2010 the cooperation between the Twee Snoeken and KPN started which resulted in the BCB in 2011. This first phase focused mainly on the architects, than contractors and now the they are focusing on adding new objects for the installation branch.

For an introduction in Germany I suggest an similar approach, with the main difference that the contractors are approached earlier. This is mainly because this group has appeared to be more important than expected. This makes the following planning for the German introduction of the BCB.



Figure 52: Phase-planning for entering the German Market.

Form the different methods, Michael Porter’s 5 factors that shape strategy, SWOT analysis and the MKDH model, used for investigating the feasibility of the idea, the SWOT analysis will be highlighted.

Strengths: The product has been up and running in the Netherlands, and is thus proven to work in the construction sector. The team working on the BCB is experienced in adding new objects and adding new functionality. For now there are no real competitors who offer the same experience as the BCB.

Weaknesses: The current library is constructed for the Dutch construction sector, and thus holds only Dutch products. It will take a large investment to add new objects. Furthermore the Twee Snoeken has no experience in Germany. These 2 items combined will result in a large investment before the introduction of the product, mainly because of finding partners and adding German objects.

Opportunities: The German construction sector is the largest of Europe, and the BCB operates in a growing BIM market. The EU promotes cross border employment, the BCB is able to connect the several construction market when the database of products is extended to more countries.

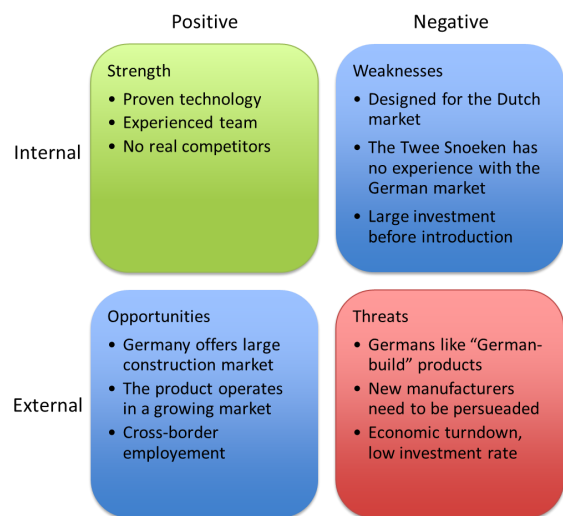


Figure 53: SWOT.

Threats: The Germans are really found on “German made” products, which may hold back a quick introduction of the BCB in Germany. New manufacturers have to be persuaded to join the BCB, without the objects of these manufacturers the BCB cannot function properly. At this moment there is an economic downturn that has hit the construction sector as well and which will lead to a temporarily lower investment rate.

CONCLUSIONS & RECOMMENDATIONS

The amount of BIM usage in the Netherlands and other countries is growing. The BCB is able to play a large role in connecting different parties in the building chain to work together and speed up the adoption of BIM in the construction sector. The uniqueness of the BCB is mainly researched by finding competitors who offer the same kind of product. The literature review and internet research has shown no real competitors, therefore it can be concluded that the concept of the BCB is unique. Due to the lack of competition, the library has a monopoly when it comes to this kind of product. Customers looking for this type of service will only find the BCB when looking for services to join. The user base is growing, which results in the case that other parties also hear about the BCB and possibly want to try it themselves.

The database of the BCB is not a barrier for adding new types of information, the main piece of software used to fill the database is the VulProgramma which is also adjustable to fit new information when necessary. The software packages used for constructing the BCB are not connected to each other, and therefore all software packages need to be adjusted when something changes.

The definitions of measurements used in the BCB are based on common used definitions in the Dutch construction sector, and where needed complemented with definitions determined by the Twee Snoeken. Definitions can vary between countries, although the differences between the Netherlands and Germany are quite small.

Although the product is now focused on the Dutch market and therefore is customized for CAD products that are mostly used in the Netherlands, it is possible to create new extensions where needed. For example when entering the German market plugins for ArchiCAD and Nemetschek Allplan are needed, because these are the most used, together 40% marketshare, CAD packages in Germany.

However the regulations in the industry differ, especially the amount of different regulations is higher in Germany. Also because of the far reaching autonomy of the states, the building codes and other rules differ from state to state. Therefore it is advised to cooperate with a company specialized in the Germans building regulation for the adding of specific information.

The construction markets in Europe are working more and more cross-border due to changing rules in contracting. When the BCB is offering its services internationally it can be a catalyst in uniting companies from different countries in the same project.

For future customers it needs to be possible to subscribe to a part (i.e. the Netherlands), or the whole (the Netherlands and Germany) BCB. This division is also necessary because some

suppliers do not deliver the same products in all countries, for example differences in color, measurements, etc.. It is advised to distribute the product the same way as in the Netherlands. For first time use the software needs to be downloaded from the internet, including all data available at that time.

The introduction of the BCB will be handled quite the same as the introduction in the Netherlands. An exception is that the introduction will start with the developing contractors, followed by the architects, structural engineers and the installation branch. The cost of the introduction of the BCB in Germany is estimated at a minimum of €254.000,-. In addition to these costs there is an estimated cost of minimal €800.000,- for sales and marketing in the first 2 years of operation.

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During the master Construction Management and Construction the author chose to write his thesis in cooperation with the Twee Snoeken, an architectural firm with a strong focus on automation. The graduation research was very interesting and has resulted in the gaining of knowledge, and I hope my research will contribute to the understanding of the technical background of the BCB and the international possibilities of the product.

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