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The use of certification systems

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Declaration of Authorship

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Abstract

This thesis aims to analyse the effect that certification systems can have on sustainable construction, and its development in the Danish building industry. An analysis was made to determine, how the DGNB certification system can be become a dominant design in the industry, and if this can result, in a more widespread use of innovative sustainable construction. By viewing the DGNB certification system as a platform, it was possible to analyse how the mechanisms surrounding the system, affected the growth and development of Green Building Council Denmark. A case study of before-mentioned organisation was made in order to establish, how the network of stakeholders affected the DGNB system and the organisation itself. Through interviews with experts and stakeholders within the Danish sustainable building industry, it was established to have a substantial impact on the use of sustainable building. Along with interviews, several research studies were incorporated to show what effect, the DGNB certification system could have on the sustainable building industry. The research made in this thesis found, that the pursuit of making the DGNB system a dominant design in the sustainable industry, could be a feasible strategy in order to spread the use of innovative sustainable building, throughout the country. The pursuit towards a dominant design the industry could, however, be challenged by the lack of acknowledgement of the DGNB system worldwide. This is due to international clients and investors having a stronger familiarity with other certification systems.

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1. Introduction

We are living in a world, where natural resources are becoming increasingly scarce, which means that nations and companies are looking towards innovative and sustainable ideas that can secure a bright future. Sustainability has become widely known and accepted, as the way forward in order to both save resources in the production of materials, and later in the recyclability of these materials or management of the waste. Sustainable buildings are good for the environment, as they are developed with a broader perspective than earlier. These buildings are made, so that they are cheaper to maintain in terms of energy consumption and running costs but also creates a healthier living space for its inhabitants. Sustainability is not only about creating a cheap-to-maintain building, but also thinking about the materials used and the lifecycle cost of these. By using materials that are produced in a sustainable way, and at the same are easy to recycle at the end of use, it also decreases the total amount of energy consumed in the construction of new buildings. As mentioned in a report from the EU commission in 2008, there are a substantial potential for energy savings in the building sector:

> *"The buildings sector – i.e. residential and commercial buildings - is the largest user of energy and CO2 emitter in the EU and is responsible for about 40% of the EU's total final energy consumption and CO2 emissions. The sector has significant untapped potential for cost-effective energy savings, which, if realized, would mean that in 2020 the EU would consume 11% less final energy. This in turn translates to a number of benefits, such as reduced energy needs, reduced import dependency and impact on climate, reduced energy bills, an increase in jobs and the encouragement of local development."* - (COD/2008/0223, 2008)

In general, the increased attention for sustainable buildings stemmed from recognising the high-energy consumption in many buildings (Berardi, 2011). However, energy savings in the construction industry is only one part of the sustainability aspect. In recent years, there has been a development in the construction of sustainable buildings, but also how to categorise the sustainability of these buildings (DK-GBC, 2015). Both in Denmark and in the EU, an in-

creased focus has been on updating regulations, that support and follow a more sustainable way of building.

In addition to having a minimised effect on the environment, sustainable building can also have potential economic and social upsides, which may have led actors in the industry to pursue a 'greener' approach to construction (Ahn, Pearce, & Ku, 2011). Worldwide there has been a vast development of different certification systems, to categorise sustainable buildings by, which have resulted in a very divided "market" for these systems. While all the systems focus on sustainability of buildings, the difference is found in the criteria for sustainability in each system (Hamedani & Huber, 2012). Most of these systems are developed by state functions or NGO's and are mostly non-profit organisations. The systems are developed in different countries around the world, which means the recognition and acknowledgment varies a lot from country to country.

In 2010, Green Building Council Denmark was established and chose DGNB as the primary certification system as the result intensive research and testing (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010). The system was adapted and changed, in order to function in compliance with guidelines and regulations within the Danish building industry. The certification system was ready a couple of years later, and started being used in the beginning of 2012. Green Building Council Denmark consists of actors from the Danish building industry from a whole range of functions. The members are from different parts of the industry, but mostly from the private sector and thereby consist of developers, architects, engineering companies, and contractors. However, governmental agencies and non-governmental organisations are also part of Green Building Council Denmark.

1.1. Problem Statement

With the increase of sustainable buildings, many countries have chosen to update their national regulations for buildings, in order to follow a more eco-friendly and sustainable approach to building materials, and in general, the building process (Bygningsstyrelsen, 2015). This has meant that many countries are supporting NGO's that have adapted different forms of certification systems, in order to classify new buildings as sustainable and thereby categorise them as sustainable on different levels. In Denmark, an adaptation of the German DGNB has ben developed and has already seen the first new buildings officially being classified and categorised as sustainable according to this specific certification system. DGNB is not the only system present in Denmark, as other certification systems are also being used to certify sustainable buildings. The use of many different certification systems in the Danish building industry might have a positive effect, on the amount sustainable building being constructed. It might also create a lack of transparency in the sustainable building industry.

In general, the development of certification systems have concretised sustainability, and made it somewhat easier to understand the sustainability of buildings. Along with the development of certification systems, the industry has seen increased interest from many industry actors, which may have different incentives for choosing a 'greener' path (Ahn, Pearce, & Ku, 2011).

Green Building Council Denmark has a role in the sustainable building industry, but as of now, we do not know how that role will evolve over time. As the organisation has many members it is also important to take into account the intentions of these different members, and how they might change over time. So the question now is, how Green Building Council Denmark, with its many members, can affect the direction and evolvement, of the Danish sustainable building industry over time.

1.1.1. Research Question

From the problem statement above, we can derive the research question, which will be the foundation of this thesis. Therefore, this thesis will aim to answer the following research question:

> *Under what conditions is the strive for developing the DGNB system as a dominant design a feasible strategy, for Green Building Council Denmark to achieve more widespread use, of innovative sustainable construction by building industry actors?*

In order to itemize the research question, a set of sub-questions will be created later on. Firstly, the methodology and theoretical foundation of this thesis will be described in chapter 2 and 3 to better understand how to approach the research question.

1.2. Delimitation and general structure

This thesis is delimited to only exploring and describing a few of the many certification systems available within sustainable building. Besides the DGNB system, other certification systems described are limited to BREEAM and LEED, as these are some of the more recognised systems worldwide.

Throughout the thesis, Green Building Council Denmark will be mentioned extensively and therefore the reference will be made a bit shorter and simpler. The abbreviation GBC-DK will be used for Green Building Council Denmark in the entirety of this thesis. The official abbreviations for the various certification systems described will also used. The GBC-DK organisation is Danish and only focuses on the sustainable building industry in Denmark. Therefore, this thesis will delimit itself, to only analysing the Danish sustainable building industry.

2. Methodology

In this chapter, the methods used collect data will be described along with a description of how the research philosophy, approach, and design has been structured. We start by looking into the research philosophy of this thesis.

2.1. Research Philosophy

This thesis aims to find the objective truth to the research question asked, and will therefore use a realistic philosophy to answer the before-mentioned question. An ontological approach to the collection of data has taken place in order to establish the most valid information in this area (Saunders, Lewis, & Thornhill, 2009).

2.2. Research Approach

This thesis uses an abductive reasoning approach to answer the research question stated above. This is done, as the outcome might not come down to a single definitive explanation. Hence, many possible explanations to the question might arise making the abductive approach the best and most reasonable to use in this case.

2.3. Research Design

An explanatory study is made throughout this thesis, to analyse the relationship between the DGNB system as a possible dominant design in the industry, and the possible increase in innovative sustainable building in Denmark (Saunders, Lewis, & Thornhill, 2009). The research strategy used to answer the research question is a single holistic case study. This has been chosen due to the fact, that this thesis will look at GBC-DK and the DGNB system as a whole, and analyse the importance of this organisation in the sustainable building industry. The design created is based primarily on collected qualitative data and therefore uses a mono method collection technique. The research created in this thesis is a cross-sectional study which aims to give a 'snapshot' of the impact of GBC-DK and the DGNB system on the development of sustainable building in Denmark (Saunders, Lewis, & Thornhill, 2009).

2.4. Data collection

The data collected to answer the research question has been a mixture of primary and secondary data, which has been necessary in order to shine light on the problem, researched in this thesis. The data collected will be explained below.

2.4.1. Primary Data

The primary data created in this research has been qualitative interviews with both actors in the Danish building industry and experts in the area of certification systems for sustainable building. In total, four one-to-one interviews was conducted in a non-standardised way, but with the same themes covered in all four interviews. The interviews conducted can be classified as respondent interviews as the conversations were directed by the questions asked by the interviewer. As this thesis is based on an explanatory study of the research questions stated earlier, the semi-structured form of interviews were chosen to better understand the relation between the different variables in the research question.

The first interview was with Klaus Hansen, a former researcher at SBi (Statens Byggeforskningsinstitut). As Klaus was one of the people researching the different certification systems when the GBC-DK first was created, it made sense to talk to him about the decisions and challenges during this process. The second interview was with Thomas Fænø Mondrup, an employee at MT Højgaard A/S working in their sustainability department. This interview was conducted to get a better understanding of the mechanisms and processes around GBC-DK and the DGNB system in general. The third interview was conducted with Lone Hedegaard Mortensen, a current researcher at SBi. In order to better understand the function and importance of certification systems in sustainable building, an interview was set up with Lone, who has co-authored the Danish DGNB manuals. The fourth and last interview was conducted to figure out, what role and incentive investors/developers have within the sustainable building industry in Denmark. The interview was with Karsten Withington Brink who is the Vice President of the Real Estate Development department within PensionDanmark.

Summaries of these interviews have been attached in the annex and will be shown in appendix 1 through 4. No audio was recorded during the interviews and these summaries will

therefore act as the main source of the primary data collected. All four interviews were conducted in Danish, as this was the native language of all interviewees. In order to not misunderstand or misinterpret any information through these interviews they were completed in the native language of both the interviewer and interviewee. This means that the summaries attached is also in Danish.

Reliability, Bias, & Validity of interviews

In general, the quality of the primary data collected is high, however there are factors that have decreased the quality, which will be discussed here. The interviews were conducted in a semi-structured manner and therefore it automatically decreases the reliability of the data collected. As the interviews were not fully structured, the use of follow-up questions were present and used to make the interviewees elaborate on certain topics, that might have had a high relevance to the research (Saunders, Lewis, & Thornhill, 2009).

There was bias present in the interviews both from the interviewer but in some cases also from the interviewee. The interviewer bias stems from the fact that pre-determined views and thoughts might have come to light in the interviews, which may have altered the answers of the interviewees, but still to a small degree. Interviewee bias may have been present in the interviews conducted with the people from the private industry. Thomas from MT Højgaard A/S specifically mentioned in the interview, that he was a supporter of the DGNB system, which might have had an impact on his answers. Karsten from PensionDanmark might have had a small degree of bias as he is on the board of GBC-DK and therefore might see the organisation in a more positive light than other actors in the industry.

The validity of the primary data collected through the before-mentioned interviews can be considered to be very high. The people interviewed have great experience in the field of sustainable building and the use of certification systems, each in their own areas. Therefore, these sources of primary data can be considered trustworthy (Saunders, Lewis, & Thornhill, 2009).

2.4.2. Secondary Data

In the research of this topic, multiple types of secondary data have been used to describe, and analyse the problems faced. Documentary data in the form of information from websites has been used to describe certain aspects of the topic. Multiple source data has been gathered from area-based and time-series based publications and journals (Saunders, Lewis, & Thornhill, 2009). Lastly, secondary data from ad hoc surveys have been used to a small degree.

Reliability, Bias, & Validity of secondary data

The reliability of the secondary data collected and used in this thesis is relatively high, due to the fact that it comes mostly from well known publishers, and is in general easy accessible. As most of the secondary data is collected from articles in well-established journals it helps the trustworthiness of the information (Saunders, Lewis, & Thornhill, 2009).

At the same time, it also confirms the validity of these data as very high as they are not directly influenced by unknown factors. The data collected directly from GBC-DK is publically available through their website, and contains little-to-none bias. From the secondary data collected it seems that deliberate distortion of the data has not occurred and therefore should not be of further concern (Saunders, Lewis, & Thornhill, 2009).

3. Theoretical underpinnings

In this chapter, the theories and frameworks used to analyse the different aspects in this thesis will be explained. An argumentation will be made, for why these theories and frameworks have been chosen, and also how they will be used in the thesis.

3.1. Innovation in the sustainable building industry

To better understand how innovation in general is happening in the construction industry, but also how the aspect of sustainability plays into this, an analysis of construction innovation through the lenses of GBC-DK and the DGNB system is made. The key influences on innovation within the construction industry are down to a variety of factors (Blayse & Manley, 2004) and to understand this in the case of GBC-DK, we look towards the theory of open innovation (Chesbrough, 2003). This is relevant, as it helps outline which things are important to focus on, when dealing with innovation within the building industry. In total, there are six key influences on innovation within the building industry (Blayse & Manley, 2004). Firstly, clients and manufacturing firms are an influence on the innovation in construction. Clients are constantly pushing the boundaries by being more demanding in projects, and at the same time being able to identify specific novel requirements, that are to be supplied by developers, suppliers etc. Manufacturing firms operate in a more stable research & development environment and are constantly able to provide new innovative products to the industry, due to more consistent R&D programmes internally in the organisations. The second influence area is the structure of production. As Blayse and Manley explain, the building industry calls for tried and tested techniques, in order to assure a certain level of quality in the finished product. At the same time, the longevity of buildings puts pressure on manufacturers and suppliers of building materials to keep the products used in stock, and thereby limiting these producers to innovate and create new product ranges. The third influence is the industry relationships that can both inhibit and encourage innovation. The relationships can encourage innovation through projects, when experimental behaviour towards problem solving is being used. At the same time, learnings are rarely 'codified' and organisations are constantly changing to accommodate future projects, which result in the innovation that come from these relation-

ships, to be little-to-none. Innovation brokers are often present in many industries, and act as a broker of knowledge between industry participants. The fourth influence is procurement systems that traditionally have put a premium on factors that are injurious to innovation such as speed, urgency, and competition on price alone. The fifth influence comes from regulations and standards that if not used correctly, can have a negative effect on innovation. The paper explains that the prescriptive approach to regulations can hamper the innovative environment that is being regulated. This has seen an emergence of the performance-based regulations, which only specifies the final regulatory goal, and not how it should be met. Regulators can force industries to be innovative by imposing regulations that are too strict for the current generation of technology. The sixth and last influence is the organisational resources that combine a lot of different things. An organisation must have, an innovative culture, be absorptive of innovation not developed in-house, key individuals who excel with innovation, processes that codifies the acquired knowledge, and an innovation strategy. These influences will be used in this thesis, to identify how stakeholders in the Danish building industry can work together, towards building a more innovative industry, where sustainability is at the forefront.

The study made by Nidumolu, Prahalad, and Rangaswami (2009) determines what incentives there are for companies and organisations to become sustainable, and in this case to join GBC-DK and thereby support a more sustainable approach to building. Through the study, the researchers found that sustainability has become the key driver of innovation and from this perspective they created a five-stage framework for companies and organisations to become more sustainable. The first stage is for companies to view compliance as an opportunity instead of a problem. By being proactive instead of reactive, companies and organisations can gain advantages in the industry, by going beyond compliance. The second stage towards sustainability is to look at the value chain of a company/organisation and assess what can be done better, in order to become more sustainable. This stage focuses mostly on creating efficiency within manufacturing and offices, and later along the value chain through sustainability. The third stage revolves around companies starting to be innovative, in more sustainable ways. By going beyond compliance in terms of environmental regulations and designing products, that are sustainable both in raw materials used and through the entire

life cycle, could potentially yield first-mover advantages for these companies. The fourth stage is concentrated on the fact, that companies must continue to innovative, to stay competitive in the market. The innovation must also extend to the business model of companies, as this might be necessary if competition becomes too intense, and you are forced to compete on other parameters. Companies and organisations should also think in terms of sustainability, when developing new business models. The fifth and last stage in the pursuit of becoming a more sustainable company/organisation, is to create next-practice platforms that challenge existing paradigms. The view and approach towards sustainability from Nidumolu, Prahalad, and Rangaswami (2009), is used in this thesis to show and determine the positive outcomes that can come from taking a more sustainable approach to business. An analysis will be made of how GBC-DK and its stakeholders can use the DGNB certification system, as way to become sustainable throughout their organisation. The use of this theory on sustainability will be delimited to four of the five stages, as the fourth part about business model innovation is not very relevant and applicable, to the analysis of the DGNB system.

To see the views on innovation in construction and sustainability through the theory of open innovation theory from Chesbrough (2003), we can analyse how sustainable innovation in the building industry is created throughout the industry. This also describes the environment that the GBC-DK, the DGNB system, and its members are operating in when it comes to innovation. The theory talks about four different types of organisations that generate innovation.

1. Innovation explorers
2. Innovation merchants
3. Innovation architects
4. Innovation missionaries

The analysis is delimited to the last two types known as *Innovation Architects* and *Innovation Missionaries*, as they are most relevant to the case of GBC-DK and DGNB. Innovation Architects can be described as organisations that develop architectures that enable other companies to provide pieces of the final system or product. Chesbrough (2003) explains the challenge ahead of innovation architects in the following way:

> *"To be successful, innovation architects must establish their systems solution, communicate it, persuade others to support it and develop it in the future."* - (Chesbrough, 2003)

The other type, are the innovation missionaries who work for the cause and not for the profits like some of the other types, as explained below:

> *"Innovation missionaries consist of people and organisations that create and advance technologies to serve a cause. Unlike the innovation merchants and architects, they do not seek financial profits from their work. Instead, the mission it what motivates them. This is characteristic for many community-based non-profits (…)."* - (Chesbrough, 2003)

These two types of innovation generators can describe the 'community' that is GBC-DK and its members, but also the way the DGNB system is responsible for generating innovation in the industry.

3.2. Industry unification

To understand how industry unification can happen and what the possible effects of this could be, we look at the adaptation of certain systems and processes within the sustainable building industry. The theory of dominant designs in connection with the theory of standards wars in industries outlines the mechanisms that can increase collaboration, due to the streamlined use of products, processes, or systems. The theory of dominant designs describes how products, processes, and systems compete in markets to become the favourite, and thereby a dominant design. This situation applies to that of certification systems in Denmark and the 'battle' that takes place in this market, to become a de facto standard. Utterback and Abernathy introduced the theory as a concept back in 1975, however this thesis will use the newer definitions and explanations made by Schilling (2013) as these are more relevant. Schilling gives the following definition of a dominant design:

> *"A single product or process architecture that dominates a product category – usually 50% or more of the market. A dominant design is a "de facto standard," meaning that while it may not be officially enforced or acknowledged, it has become a standard for the industry."* - (Schilling, 2013)

This definition will be used to analyse the opportunities and challenges of a market selecting a dominant design, and how the DGNB certification system plays a role in this. Competition in a market can be good for a lot of things, but the theory of dominant designs will in this thesis analyse how the unity behind a single system like DGNB can enhance collaboration and create a more innovative environment for all actors in the industry:

> *"A technology that is adopted usually generates revenue that can be used to further develop and refine the technology. Furthermore, as the technology is used, greater knowledge and understanding of the accrue, which may then enable improvements both in the technology itself and in its applications."* - (Schilling, 2013)

As explained by Schilling above, actors in the industry can focus their attention towards improving and innovating upon the adopted system, instead of developing separate systems or processes. This thinking will be transferred to the case of GBC-DK and the DGNB system, and an analysis of how GBC-DK can approach the fight towards becoming a dominant design will be made. In extension of dominant designs the thesis will use the theory of 'standards wars' by Shapiro & Varian (1999). This approach goes along with the theory of dominant designs and is a good way to explain the challenges that GBC-DK face with the growth of the DGNB certification system in Denmark. The theory of 'standards wars' explains how companies and organisations should approach the market with their product or process in order to gain market dominance. The paper by Shapiro & Varian (1999) focuses mainly on the factors that are important for a company/organisation to have, whilst competing to become the dominant player in the industry. They mention seven key assets that a company must attain and own, in order to successfully wage a standard war against competitors:

1. Control over an installed base of users
2. Intellectual property rights
3. Ability to innovate
4. First-mover advantages
5. Manufacturing capabilities
6. Strength in complements

7. Brand name and reputation

These seven key assets will be used to analyse how GBC-DK stands in the market of certification systems and what areas they need to improve, in order to win this 'standard war' against other certification systems. By looking at each one of these assets, we can determine how the DGNB system fairs in the market of sustainable certification systems, and what approach GBC-DK should take in order to grow the organisation. The analysis of these assets, have been limited to only contain six out of the seven, as the manufacturing capabilities in this case is not relevant. This is mostly applicable when the firm in question e.g. manufacturer of products, and thereby needs strong capabilities in this area. This case revolves around GBC-DK and its members, and the analysis of this asset is therefore excluded.

3.3. Industry network and platform mechanisms

In the analysis of the industry network in the Danish building industry, we can look towards theory of mechanisms within the sustainable building industry. This is to understand how the network of actors in the building industry operates when it comes to cooperation behind a single system (Struben & Sterman, 2008). To continue along this line, we look at how a single certification system like DGNB can be considered a platform (Gawer & Cusumano, 2012) and thereby also consider the effects that happen with the actors, on both sides of this platform (Eisenmann, Parker, & Van Alstyne, 2006). The case and theory from Struben & Sterman (2008) who have researched the challenges with a shift to alternative fuel vehicles have been chosen, as the examination of transitional challenges in an industry is very relevant to the case of GBC-DK and DGNB. In this case, they analysed the challenges of adopting new transportation systems/methods. The theory from Struben & Sterman (2008) revolves around three aspects that are used to explain what companies and organisation need to be aware of, as they are trying to grow and expand. The first one is 'marketing', second one is 'word-of-mouth from participants' of the project, and lastly it is 'word-of-mouth of non-participants'. The first aspect explains how an organisation can and should use marketing to increase awareness within an industry, and gain the positive attention of possible supporters. The second and third aspect revolves around the participants and non-participants of a project, and explains the positive/negative effects word-of-mouth can have within an industry. The positive word-

of-mouth from participants can help attract non-participants and thereby grow the support of the product/process or system. The last aspect of word-of-mouth from non-participants is only relevant, if there are people or organisations actively speaking out against the product or process.

Later in this thesis an analysis will be made of how each of these three factors can affect the further growth of the DGNB system in Denmark, and at the same time how these factors affect the acknowledgement of DGNB system as the dominant design within the industry. This theory will explain how GBC-DK can use its network and members, to expand the support for the system in the sustainable building industry.

The theory of platforms from Gawer & Cusumano (2012) is relevant to the analysis, as it explains the environment around platforms where collaboration is a major factor towards becoming a successful platform. The following definition of platforms is made by Gawer & Cusumano:

> *"We have defined external or industry platforms, (…), as products, services or technologies developed by one or more firms, and which serve as foundations upon which a larger number of firms can build further complementary innovations, in the form of specific products, related services or component technologies."* - (Gawer & Cusumano, 2012)

The framework goes on to explain four steps companies and organisations need to take to gain and keep an effective platform leadership.

1. Develop a vision of how a product, technology or service could become an essential part of a larger business ecosystem.
2. Build the right technical architecture and 'connectors'.
3. Build a coalition around the platform: Share the vision and rally complementors into co-creating a vibrant ecosystem together.
4. Evolve the platform while maintaining a central position and improving the ecosystem's vibrancy.

First, an argumentation will be made for why the DGNB system can be considered as a platform, and in continuation of this, the framework will be used to analyse the steps to take, in order to gain an effective platform leadership for the DGNB certification system.

'Two-sided networks' is a theory introduced by Eisenmann, Parker, and Van Alstyne (2006) and is used to explain the effects that a platform has on its users. In our case, it is used to explain what the potential positive effects could be of using a certification like DGNB. Stated below is a definition of 'two-sided networks':

> *"Products and services that bring together groups of users in two-sided networks are platforms. They provide infrastructure and rules that facilitate the two groups' transactions and can take many guises."* - (Eisenmann, Parker, & Van Alstyne, 2006)

These groups of users, that is brought together by platforms and the network effects hereof, are explained by Eisenmann, Parker, and Van Alstyne in the following way:

> *"Typically, two-sided networks have a "subsidy side," that is, a group of users who, when attracted in volume, are highly valued by the "money side," the other user group. Because the number of subsidy-side users is crucial to developing strong network effects, (…)."* - (Eisenmann, Parker, & Van Alstyne, 2006)

To explain this effect, we can use the example of a newspaper and the advertisements herein. The readers of the newspaper represent the 'subsidy side' of this network, whereas the advertisers represent the 'money side'. If the readers increase in numbers, it will create a 'cross-side' effect, as advertisers will pay more to reach these users. Reversely, the same can happen if more attractive 'money-side' users join, it will push more 'subsidy-side' users towards the platform, as explained below:

> *"The goal is to generate "cross-side" network effects: If the platform provider can attract enough subsidy-side users, money-side users will pay handsomely to reach them. Cross-side network effects also work in the reverse direction. The presence of money-side users makes the platform more attractive to subsidy-side users, so they will sign up in greater numbers."* - (Eisenmann, Parker, & Van Alstyne, 2006)

The "same-side" effects are explained by the fact, that as more users join, the platform will become more attractive for users on the same side of the network.
In the analysis later in the thesis, an argument will be made for why the DGNB system can be considered a platform, and in perpetuation of this, an argument will also be made for why

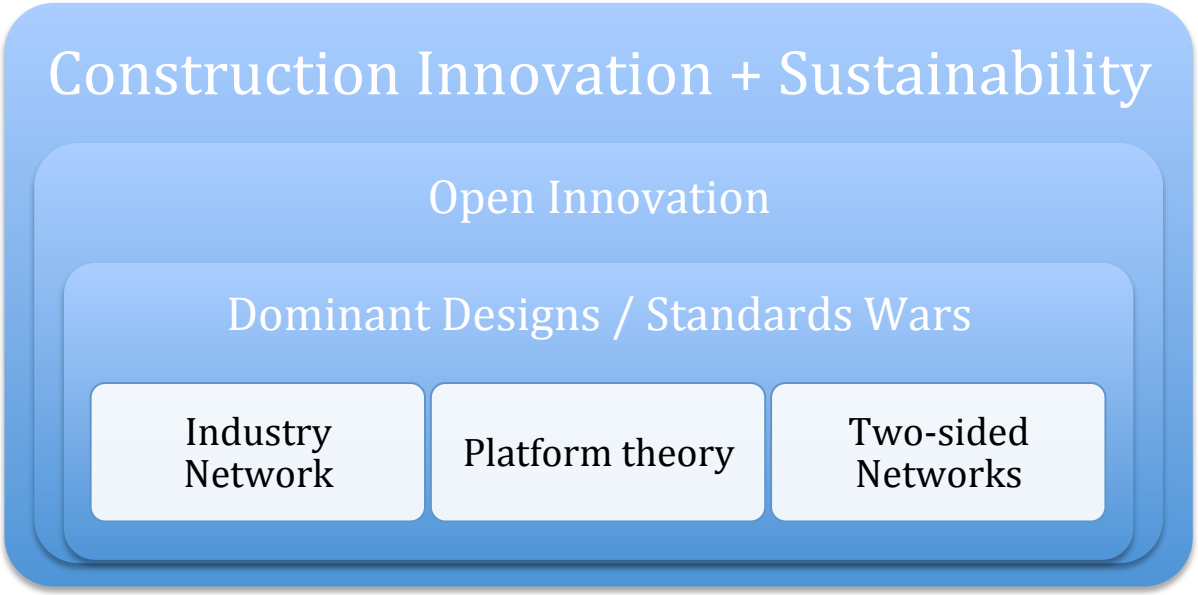
there are two-sided network effects connected to the DGNB system, and its user groups. By doing this, we are able to establish the benefits for actors in the industry to become a member of GBC-DK and support the DGNB system.

3.4. A different type of certification system

Research from Mangiarotti & Riillo (2014) and Terziovski & Power (2007) have been used to describe and analyse the case of the ISO 9000 certification system in the manufacturing industry. The first paper analyses the connection between the ISO 9000 certification system, and innovation produced in these manufacturing firms. The second paper analyses the motivation behind seeking an ISO 9000 certification, and the perceived benefits that comes along, with a certification like this. The research will be applied in this thesis to describe the similarities between the ISO 9000 and the DGNB system. Simultaneously, an analysis will be made to see how the effects that have stemmed from the ISO 9000 certification system in the manufacturing industry, could affect the sustainable building industry.

3.5. Connection of theories

To further explain how the theories will be used in this thesis, the figure shown below gives and overview of the connection between each of these. The thesis will use two general aspects, to describe the background and factors in the Danish building industry. These two aspects consist of innovation in construction and sustainability, and will lay the groundwork for how to describe GBC-DK, and the DGNB certification system in Denmark. We start with exploring which factors are important to innovation in construction, because the ability to innovate in the building process is important to becoming more sustainable. However, the general building process is still seen as hampering innovation due to the strict processes around building (Blayse & Manley, 2004). In continuation of the first layer, there will be focus on the option to become sustainable and the benefits of adopting a more sustainable strategy in firms and organisations. In general, it focuses on why companies should be more sustainable and consider sustainability as a beneficial challenge instead of a prevention of competitive advantages. The second layer is based upon the thoughts from open innovation, where a network of actors contributes with knowledge, to create innovation.



With this network of actors in mind, we can look at how the theories and studies shown above interconnect with each other to describe the scenario in the Danish building industry. The case about ISO 9000 is relevant here, as it describes how the use of certification systems can affect industries as well as the ability to innovate. The case shows which factors are in play when industries choose to adapt a certification system that is not publicly regulated and thereby a voluntary system to abide by. However, the inner workings of industries and the pressure that is put on manufacturers to provide products of consistent quality, makes it not so much an optional choice as a mandatory certification. The case is not used as a fundamental theory but rather to make a comparative analysis against the DGNB system.

The theories of dominant designs and standards wars are used as an interconnected way of showing, how the Danish building industry can benefit from adapting a single sustainable certification system, and how the 'war' between these systems unfolds within the industry. To go a step further, the theories of platforms, industry and 'two-sided networks' are brought into play to demonstrate, how the DGNB certification system can be viewed as a platform and at the same time, act as network with different types of actors and stakeholders.

3.5.1. Overview

To round off this theory chapter and turn our eyes towards the analysis of the research question, it makes sense to itemize and specify how the analytic approach would take form in the

coming chapters. To do this, a series of sub-questions has been formulated to break down the research question and give a clearer idea of how the analysis will take shape, throughout the rest of this thesis.

Sub-questions

- *How can sustainable construction be defined and what kind of regulations and guidelines are being used to classify buildings as sustainable in Denmark?*
- *How can the DGNB certification system be perceived as a dominant design and what are the consequences of it becoming a de facto standard in the industry?*
- *Which factors are working against a dominant design being accepted in the sustainable building industry and how can these be affected?*

These sub-questions will be answered in a structured manner in the coming chapters, and is composed in the following way. The first sub-questions will be answered in chapter 4 and will describe how sustainability fits into the world of construction and what certification systems are being used in Denmark. In chapter 5 and 6, the second sub-question will be answered and will entail an analysis of how the DGNB system can be perceived as a dominant design in the sustainable building industry, along with a look into the industry mechanisms that takes place. In chapter 7, a discussion will take place on the research created in the chapters 5 and 6, but will also contain a discussion of the theories used throughout the thesis.

4. Sustainability in Construction

Compared to the regular thinking in construction projects, sustainable building is a multidimensional approach. Two very important concepts within sustainable building are LCA and LCC also know as Life-Cycle Assessment, and Life-Cycle Cost (Analysis). These concepts are used to analyse and assess buildings and projects over a long-term period instead of the regular, more short-term approach. The LCA takes a holistic approach to the entire life cycle of the building, and focuses on how to dispose and maybe recycle the materials used, in a proper way. Whereas the LCA covers the environmental aspect, the LCC covers the economic aspect of the project. In the regular planning and construction process, focus is on minimizing the cost of the materials and building, while the operating expenses of the building over the following years, is seen as second priority. By following a life cycle approach to the construction process, an assessment will be made of the cost of building, running, and maintaining the building over a period of 50 years.

Sustainable building focuses on three aspects when approaching a new project, with an equal weight on all three (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013). These aspects are explained below:

Environment

The environmental aspect is about the process of continuously analysing and optimising the use of energy, materials, and resources throughout the life cycle of the building. The sustainable approach also focuses on the reduction or complete omission of dangerous chemicals (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013). This aspect, as mentioned above, is the Life-Cycle Analysis of a project.

Economy

The economic aspect revolves around the LCC analysis of a project. The project must have stability in value once finished, secured by high quality and flexibility. Lastly, the project must have an optimised use of areas within the building.

Social

The social aspect is focused on the people that will use the building throughout the entire life cycle. This means that sustainable buildings are focused on health and comfort by providing a good indoor climate. This is secured through thermal comfort, air quality, acoustics, and visual comfort inside the building. Focus will be on safety and access for all, while maintaining good architecture and outdoor facilities.

The last part of the social aspect is a big differentiator compared to regular building projects. It focuses on the placement of buildings, so that it supports the use of sustainable forms of transportation.

4.1. Sustainable building in Denmark and the EU

In recent years, an increase has been seen in the construction of sustainable buildings in Denmark, as stakeholders in the industry become aware of the movement and its possibilities. The table below shows the accumulated amount of certified buildings in Europe as of 2015, with all of the different certification systems combined (DK-GBC, 2015).

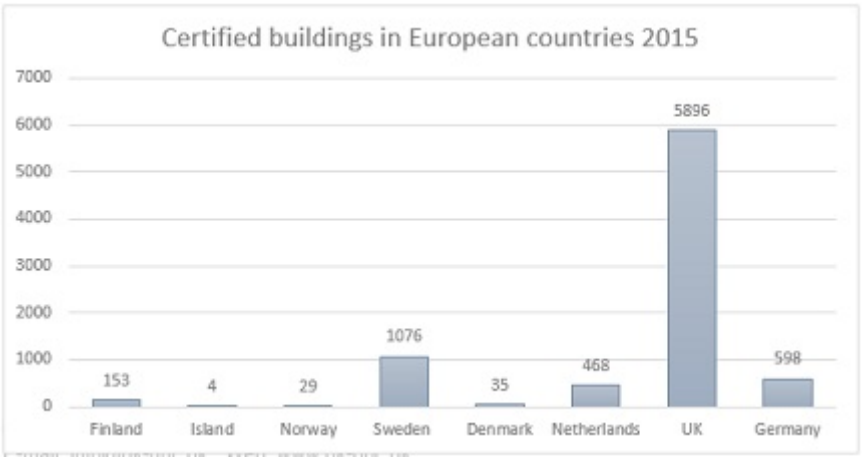


Figure 1 (DK-GBC, 2015)

The table shown above gives an overview of how Denmark compares to other European countries, in terms of the number of certified buildings. To give a more precise overview, a comparison to both the size and population of each country is shown below:

	Area (km^2)	Population[1]	Area/Buildings	Population/Buildings
Finland	338,424	5,488,543	2,211.92	35,872.83
Iceland	102,775	332,529	25,693.75	83,132.25
Norway	385,178	5,214,900	13,282.00	179,824.14
Sweden	450,295	9,858,794	418.49	9,162.45
Denmark	42,925	5,707,251	1,226.43	163,064.31
Netherlands	41,543	17,000,059	88.77	36,324.91
UK	242,495	64,716,000	41.13	10,976.26
Germany	357,168	81,459,000	597.27	136,219.06

As we can see from the table above, the UK leads the race in terms of most buildings compared to the size of the country with 1 certified building per 41.13 km^2 of land. In terms of most sustainable buildings per citizen, Sweden leads this statistic with 1 certified building per 9,162 people.

In Denmark the Danish Green Building Council are working towards getting as many buildings certified by the DGNB certification system in order to increase awareness but also to guide the country towards a greener future. The DGNB certification system is not only able be used to assess buildings, but also urban areas in bigger cities. An example of this, is the project known as *Carlsberg Byen*, which is a construction project located in central Copenhagen. In 2013 the project was awarded *silver* in a pre-certification, which will last 5 years until the project is at least 75% complete, in order for the final certification to take place (Carlsberg Byen, 2013). The project will see approximately 3000 new apartments being built, which all will be classified as low-energy housing, as well as the materials for the public areas will be of a sustainable nature (Carlsberg Byen, 2013).

4.1.1. Building regulations in Denmark

In Denmark, the building regulations support four different energy classes. These classes have been developed over time, and is a result of long-term planning to make Denmark a more energy-efficient and sustainable country. The four classes are divided each by their re-

[1] The population numbers are estimates from 2015 and 2016 (from Wikipedia)

quirements for the technical specifications but focuses mainly on the total energy consumption of the house. The new building regulations *BR15*, which will become fully active on the 1st of July 2016, will see the requirements for insulation and other materials that support lower energy consumption, being exacerbated for the construction of new buildings. With the new regulations, the *BR15* sets the minimum requirements for new construction at the same level as the one set for 'low-energy housing' in the now succeeded building regulations *BR10* (Bygningsstyrelsen, 2015). The exacerbation of the requirements for the energy consumption of new houses is part of a plan to increasingly raise the requirements to meet the expectation, that Denmark will be completely free from the use of fossil fuels, and reliant on sustainable energy instead in 2050 (Energistyrelsen, 2015).

In the following sections it is described how the insulation requirements for new houses will be laid out in the coming building regulations.

BR10

The building regulations, which is set to be succeeded by the *BR15*, called *BR10*, had requirements for most of the same thing that the *BR15* will have, just not as strict. The specifications of the energy frame for new houses sets the following requirements:

The flooring will have to have insulation of 300 to 400 mm. The walls will require at least 300 mm of insulation for light constructions whereas the minimum is 300 mm for heavy constructions with cavity walls. The ceiling or roof will require at least 400 to 500 mm of insulation to live up to the requirements of the energy frame in the *BR10* (GreenMatch, 2014).

BR15

The *BR15*, which is becoming fully active on the 1st of July 2016, has been exacerbated in terms of the insulation demands compared to the *BR10*. This means that the insulation requirements for new houses will be as follows:

The insulation for flooring will need to be 400 to 500 mm whereas for walls in light construction will have to be at least 350 mm. For cavity walls in heavy constructions the requirements will be a minimum of 300 mm and for the ceiling/roof the minimum insulation have been specified to be at least 500 mm (GreenMatch, 2014).

BR20

The *BR20* is the set of regulations, which will replace the *BR15* around the year 2020, and further exacerbate the requirements for insulation. Flooring will need insulation of minimum 400 mm while walls in both light and heavy constructions will have to have at least 400 mm as well. For the insulation of either ceiling or roof, the requirements for insulation have been set at a minimum of 500 mm.

In the table below, the requirements for all three sets of building regulations have been entered in a comparable manner. From this table, it is easy to see that the requirements will slowly be exacerbated over the next years.

	BR10	BR15	BR20
Floor	300-400 mm	400-500 mm	400 mm
Wall, light construction	300 mm	350 mm	400 mm
Cavity wall, heavy construction	250 mm	300 mm	400 mm
Ceiling/Roof	400-500 mm	500 mm	500 mm

Energy Labelling

In Denmark, according to the current *BR10* building regulation, all buildings must undergo an inspection in order to determine the "energy level" of the building at some point in time, mostly in connection with a sale of the house. From this inspection a building will acquire a grade determined by the level of energy use the building has, which will show how much energy is required to 'live' in the house. At the same time, the inspector will give recommendations as to where the building can be optimised in terms of energy use.

The energy scale starts with the highest grade of *A* and ends with the lowest grade *G*. With the update of the building regulations and the introduction of the *BR15* and *BR20,* the energy labelling scale has also been updated. This means that the grade *A* has been divided into three parts consisting of *A2020*, *A2015*, and *A2010* with *A2020* being the best and most energy saving grade on the scale (Energistyrelsen, 2015).

From the *BR* regulations and the *Energy Labelling* certification some aspects of sustainability are being regulated through laws. We can see that the increased use of certification both in Denmark and in the EU leads to a more regulated building industry. However the energy aspect in the *BR* and *Energy Labelling* is only one piece of the combined sustainability puzzle.

4.1.2. Building regulations in the EU

The European Union is working towards harmonizing laws and regulations across its member countries. This also applies to the building industries, and in this case, several initiatives have been started to harmonize test methods across the union. Some of these have resulted in applicable regulations.

CPR

The CPR, abbreviation for *Construction Product Regulation*, is a regulation made to harmonize test methods, rules for attestation of building materials, declaration performance of building materials, and the requirements for CE marking. The operative parts of the CPR was put in full effect as a regulation in July of 2013, which means that the requirements in the regulation became mandatory for all member states in the European union. The regulation has earlier been a directive in the EU and therefore not mandatory for the member states (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013). The result of this meant, that the directive was interpreted and thereby implemented very differently in the individual countries. By changing the directive to a regulation, the EU have initiated the process of harmonizing the rules and thereby creating transparency across the European market of building materials. The CPR has been adopted in the EU to ensure reliable and accurate information on the performance of building materials. The focal point of the regulation, is still the approximately 450 harmonized product standards, and thus, the biggest change is that now, manufacturers of building materials must document their CE marking when using the *Declaration of Performance* (DoP). The DoP is a key concept in the new *Construction Product Regulation*, but also in the CE marking of construction products, because of the increased awareness on sustainability (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013).

Along with the implementation of the regulative, a number of sustainability requirements were introduced in the list of the basic requirements for new constructions. These requirements are applicable throughout the life cycle of the construction and all the materials used (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013).

CE marking

With the implementation of the CPR, it became mandatory for all manufacturers to use the CE mark on all products covered by a European harmonised standard or technical assessment. This is a significant change compared to the earlier directive, in which it was not obligatory to use the CE marking in some EU countries, e.g. Great Britain. All actors within the construction industry that delivers products to the market must ensure no product reaches the market without the CE mark and at the same time meets the requirements of European harmonised standards. In connection with this, companies/organisations must know the local rules and regulations of the markets to which they are delivering products and materials (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013).

The *Declaration of Performance* allow manufacturers to provide information and essential properties on the building materials they are selling in the market. The manufacturer is then required to draw up a DoP when a product is launched in a new market and covered by a European harmonized standard or technical assessment. The manufacturer assumes full responsible for the DoP produced along with the product. The common technical language used in the harmonised standards and assessment documents used by manufacturers and authorities in the EU countries, has created transparency across the line. For users such as architects and engineers, this has also eased the process of considering products for projects, as rules and methods have been aligned across countries (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013).

The CEN/TC350 'Sustainability of construction works' are standards revolving around indicators of sustainability in the area of building materials. It can help strengthen the coordination and harmonization of the many EU initiatives in the area of environmental labeling of buildings and guides when investing in sustainable buildings (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013).

4.1.3. The market for sustainable building in Denmark

To see how big the market for sustainable building is in Denmark we can look at how many buildings there have been from 2011 to 2016 compared to the number of DGNB certified in the same period. Since the introduction of GBC-DK and the DGNB system in Denmark there has been a total of 30 certified buildings either completed or still under construction (GBC-DK, 2016). We can compare this number to the number of buildings in the same categories as the DGNB system is certifying in Denmark today.

Buildings by region, use and time

	2011	2012	2013	2014	2015	2016
All Denmark						
Terraced, linked or semi-detached houses	234 653	236 029	238 148	240 215	242 019	244 169
Multi-dwelling houses	89 480	89 717	90 147	90 561	90 833	91 214
Office, trade, inventory, incl. public administration	75 671	75 682	75 673	75 727	75 569	75 353
Building for hospital, home, maternity home etc.	2 326	2 337	2 335	2 324	2 322	2 302

The numbers shown in the table above are the amount of buildings in Denmark in the specified categories shown by year (Danmarks Statistik, 2016). These numbers show the accumulated amount of buildings in Denmark per year in each category, and are limited in the sense that they do not show the number of new constructions per year. However by calculating the accumulated increase in buildings in this period, which is from the introduction of GBC-DK and the DGNB system in Denmark up till present time, we can see how these numbers compare. As shown in the numbers, two of the categories have actually been decreasing in numbers which shows that both new constructions have been build as well as old buildings have been torn down, or renovated so as they fall into other categories.

	2011	2016	Increase/Decrease
Terraced houses etc.	234,653	244,169	+9,516
Multi-dwelling houses	89,480	91,214	+1,734
Offices, administration etc.	75,671	75,353	-318
Hospital buildings etc.	2,326	2,302	-24
Accumulated number of building over the period			+10,908

As shown in the table above, there has been an accumulated increase of 10,908 buildings in the specified categories from 2011 to 2016. This number is not the best and most precise

number to use, but it gives an overview of how big the market for sustainable certification of buildings is in Denmark. In the period from 2011 to 2016 there has been 30 certified DGNB projects and in the same period the regular building market has seen an accumulated increase of around 11,000 buildings. These numbers gives an idea of the size of the market for sustainable certification of buildings in Denmark.

Type of market for sustainable certification

The market for certification of sustainable buildings is still a small segment of the accumulated market for construction in Denmark, but still growing. The product that GBC-DK and the DGNB certification system are offering is essentially a service that results in a final certification of having a sustainable building. The service of certifying the completed construction is not done by GBC-DK but actually by independent auditors and consultants who have been educated and certified by GBC-DK to do this job cf. interview with Thomas Fænø Mondrup. The market for certification of buildings is a very small and specific market, as it is still a choice for investors to decide whether or not to get a certified building in the end. It is possible to have two completely similar buildings where one is DGNB certified and the other is not. The only difference is essentially the documentation of the decisions made during the construction process. At this point in time, the decision to certify a building is more about branding and having the documentation on the sustainability of the building, for companies to have a more green profile in the bigger picture.

4.2. Different aspects of sustainability

There are a lot of factors relevant in the debate over climate change and the movement towards greener solutions for the environment. As shown earlier in this thesis, the requirements for insulation in new houses will increase as we come closer to 2020 but also 2050 where Denmark aims to be completely free from the use of fossil fuels (Energistyrelsen, 2015). From this standpoint it is clear to see, that the government wishes to move forward on a more sustainable path. However the Danish government have not issued an official standpoint on the discussion of certification systems, which has made stakeholders in the industry create the

GBC-DK and thereby start a movement to increase the use of DGNB certifications in the Danish building industry cf. interview with Klaus Hansen.

The scarcity of raw materials but also pollution from production and manufacturing of products have caused companies worldwide to focus on becoming more environmentally aware (Haanaes, et al., 2011). This factor actually overlaps the political factor in the sense that pollution and carbon footprint is both a political and environmental factor in this case. The environmental factor also coincides with socio-cultural factors because of the increasing demands from consumers. More and more consumers are requiring that the products and materials they buy are sourced ethically and produced in a sustainable way. This fact requires companies to focus their attention towards their supply chains in order to ensure ethical sustainability all the way around. From suppliers to partners, companies will have to do in-depth due diligence on the companies they form partnerships with, in order to keep a strict approach to ethical challenges and sustainability in general.

The economic factors behind the use of DGNB and certification systems in general are most likely the key driver, but actors in the industry might have different incentives cf. interview with Lone Hedegaard Mortensen (Ahn, Pearce, & Ku, 2011). As certification systems within sustainable building are still a fairly new idea, it is hard to determine the full effect already. It will most likely become a great factor when looking at green and sustainable building in the future. As mentioned above, there are several different certification systems available in the world right now, which are all used and accepted in different parts of the world. A problem with having different certification systems is that they are difficult to compare without having a great deal of knowledge of the certification processes behind each system. Still, having a certification system with a grading scale makes it easier for outsiders to see how sustainable a green building really is and thereby compare it to other similar buildings. This approach also makes it easier to put a price on the sustainability in the sense that it can be hard to market these buildings to consumers without indications of how sustainable the building really is. By having a certification system that allows the seller to clearly show the sustainability of a building or project, it makes it easier to sell and maybe even at an increased price, due to increased savings on living expenses in the house. The incentive to having a building or pro-

ject graded through one of these certification systems increases along with the awareness of the systems cf. interview with Karsten Withington Brink.

In recent years, there has been an increased focus on sustainability from companies and consumers (Haanaes, et al., 2011). Along with this, there has also been an increased focus on being green and looking out for the environment. In general, a shift has emerged in the way people and companies look at the concept of being green and sustainable. People are now increasingly focused on being healthy and making better choices in their lives in order to be healthier and in the end live longer. This trend extends into houses and the living areas for these people, as they are now also focused on the fact that their home is a healthy place to live and spend time. Consumers have started to focus more on how the products, materials etc. that they are buying, are produced. This consciousness about the genesis of products and materials has forced many companies to think more green and sustainable. In addition to this, many new companies have been created on the premise of being 'green'.

The technological landscape changes quickly and that is also true for the technology within sustainable construction and building. This technological change can be shown through several different factors. Companies can find new innovative and more sustainable ways of making and producing products, which in the end makes a more green building. With the development of new technologies it will become easier to design and manufacture buildings that generally are more green and sustainable. This refers to the products and materials being used in the building but there are also the processes around the construction of a building, which can evolve over time. These processes can evolve through new ways of transporting and delivering goods and materials to the building site that could lead to a more smooth and easy process. Not only the delivering part, but also the processes around the actual building and assembling part of the construction have already and can develop further over time. This makes way for processes that will ease the job of constructing and assembling buildings in the future.

The legal factors are a combination of many things, however the most relevant ones in this case, is the importance of health and safety. Besides this, there is also the discussion about product labelling and the legal factors associated with that. When it comes to health and safety, the DGNB certification system puts health in the front seat by focusing on the socio-

cultural and functional qualities of a building. This means that it is not health in the general sense, but health in the form of psychological benefits of living in a bright, open space, which in the end can affect the general health of people cf. interview with Karsten Withington Brink.

Through a DGNB certification of a building, an argumentation could be made for the building to have health benefits whether it is for the employees in an office space or for the owners of a family house. It is here that the legal factors come into play in the sense that the research must be in place, for a building to claim to have health benefits for the users. At the same time, "product" labelling comes into play, because of the DGNB certification. As soon as a DGNB auditor has certified a building, the building becomes labelled as a DGNB building. This label comes with certain promises of quality and functions, which stakeholders must make sure lives up to the certain standards that it has promised to deliver.

This means that stakeholders within DGNB must make quality checks, in order to ensure that the certification of DGNB does not fail due to diminishing standards. A high standard of quality must be maintained for the certification system as a whole to be considered a success cf. interview with Thomas Fænø Mondrup.

4.3. Sustainability certification systems

Some of the most influential guidelines and certification systems of sustainable buildings in the world and the EU are LEED, DGNB and BREEAM. These systems all emphasise on some of the same measurements but differ in some other areas. In this section, a comparative review of the three systems will take place with focus on how the systems are different and which ones currently are being used in the Danish building industry.

4.3.1. BREEAM

BREEAM is a certification system developed by *Building Research Establishment* in the United Kingdom and stands for *Building Research Establishment Environmental Assessment Method for Communities* (Hamedani & Huber, 2012). The BREEAM certification system operates with 8 main criteria groups consisting of the following; Climate & Energy, Resources, Place Shaping, Transport & Movement, Community, Ecology & Biodiversity, Business & Economy, & Buildings. The weight of each criterion differs in the total sum, with Place Shaping being the most influential criteria weighing 24% of the total sum. After this, Transport & Movement is the second most important criteria with a weight 21% of the total sum. Climate & Energy is also a big part of this certification system with a weight of 18% and thereby being the third most important criteria in this system. The grading scale of the BREEAM system consists of 5 grades varying from *Pass* to *Outstanding*. In the middle, the grades consists of *Good, Very Good, and Excellent*. The certification phases in the BREEAM system consists of an optional Interim Certificate, which will take place during the planning stage of the project. The Final Certificate will be awarded in the post construction stage of the project, where the final grade of the project will be revealed (Hamedani & Huber, 2012).

4.3.2. DGNB

DGNB is a German sustainable certification system developed by the *German Sustainable Building Council* and was released in 2007. The abbreviation DGNG stands for *Deutsche Gesellschaft für Nachhaltiges Bauen – Neubau Stadtquartiere*. The DGNB certification system has 5 main criteria groups with 4 of the groups weighing 22,5% with the last criteria having a weight of 10%. The criteria groups consist of the following: Ecological Quality, Economical

Quality, Sociocultural & Functional Quality, Technical Quality, and Process Quality. As explained above, the first 4 criteria groups has a weight of 22,5% and the last criteria, meaning Process Quality having a weight of 10%.

The grading scale of the DGNB system is, with only three grades, the most simple of the three systems. Consisting of the lowest grade of Bronze, middle grade of Silver and the best grade of Gold. The grading scale was modified in 2015 in Denmark, by only changing the names of each grade. The lowest grade in the Danish DGNB system is now Silver, the middle grade is Gold and the top grade is Platinum The certification grading of DGNB, consists of three stages where the first one, the Pre-Certificate, will be awarded in the planning stages of the project. The Pre-Certificate will have a validity of 3 years. Next, a Certificate can be awarded during the Exploitation/Construction stage of the project. This Certificate has a validity of 5 years, which means the Final Certificate will have to be given within this timeframe. Lastly, the Final Certificate can be awarded as soon as the project is at least 75% finished (Hamedani & Huber, 2012).

4.3.3. LEED

LEED, which stands for Leadership in Energy and Environment Design – Neighbourhood Development, is a certification system that has its origin in the United States of America. The system was released in 2009 and was developed by the U.S. Green Building Council (USGBC). The certification system has 5 main criteria groups all with a different weight in the total sum of the system. The first criterion is Neighbourhoods Pattern & Design and is the biggest criteria with a weight of 40%. The second biggest criterion is Green Infrastructure & Buildings and has a weight of 26% of the total sum. The third criterion is called Smart Location & Linkage and has a weight of 25%. The two last criteria are Innovation & Design Process and Regional Priority Credits and are the smallest of the five with a weight of 5% and 4%, respectively. The grading scale of the LEED certification system has four different ratings starting from Bronze being the lowest, the second lowest being Silver. The second best rating of the system is a Gold grade whereas the best grade being awarded is Platinum.

The certification within LEED has three phases where the first one is a Conditional Approval of Plan. The second phase within this system is a Pre-Certificate, which will be awarded dur-

ing the construction stage of the project. The last and final Certificate will be awarded in the post construction phase of the project (Hamedani & Huber, 2012).

4.3.4. Comparison of criteria

The three certification systems explained above, are all focused on sustainability in their own way, and therefore has distinguishing features that sets them apart. The certification systems are in general very similar in the fact, that projects are handled in the same way in all three systems. A project is registered with the corresponding certification institute with all the relevant documents being submitted and from here the process of getting the project certified begins. From here on the systems are mostly set apart by the main groups of criteria from which a project is rated and certified by the trained auditor within each system. The grading scale of each system differs as mentioned above. In Figure 2, we can see the grading scales of the systems compared, which shows that BREEAM is the system that has the lowest passing grade of only 25% of the criteria passed. On the other end, DGNB is the toughest system to get a certification, which is shown by the fact that a project will need to pass at least 50% of the criteria in order to get the lowest grade of Bronze.

Figure 2 - (Hamedani & Huber, 2012)

In the middle we have LEED, where a project will have to pass on 40% of the criteria to get a certification of the lowest grade, which is similar to the Bronze grade of the DGNB system.

When comparing the three certification systems we have to look at the main criteria groups to see how the systems differs in the rating of each component of a project. In overall, BREEAM focuses mainly on the environmental conditions and characteristics of each project and is therefore most dependent on these factors. DGNB pays the most attention to the cohesion of several sustainable factors of a project and therefore focuses a lot on the environmental, economic, social aspects of each project. Lastly, LEED looks towards the "greenness" of each project in order to establish how the building fits into a neighbourhood and in general the urban planning.

In Denmark, the *Denmark Green Building Council* has been established and has chosen to use the DGNB standard of certification. This thesis will therefore look to analyse how this certification fits into the Danish building and construction landscape as well as the many other factors that are relevant when dealing with establishing new standards.

4.4. Part-Conclusion

In this chapter, a description of the different aspects of sustainability was made. From that we found that there are three general aspects of sustainability, which are environment, economy, and social. In Denmark, an increased focus has been on making regulations more sustainable, at least in terms of energy savings. Building regulations will therefore see the requirements for insulation being exacerbated up until the *BR20*. The energy labelling system has also ben updated to harmonise with the increase in requirements. European standards have been introduced and updated, to harmonise test methods in terms of construction products. These standards should create transparency in terms of the performance of construction products across the European Union. A description of BREEAM, LEED, and DGNB was made, as these are some of the most popular certification systems being used in Denmark. Apart from the environmental upsides that surround these certification systems, the economic and social/health factors was also described in this chapter.

5. The landscape in the sustainable building industry

Through innovation theory, the DGNB certification system can be viewed as an open innovation system in the case that it creates a system, which stakeholders create innovative solutions in order to fulfil the requirements of the certification system. In that way, the system forces stakeholders to stay innovative and keep looking towards creative solutions. From open innovation theory, GBC-DK and the DGNB certification system can be viewed as a combination of two types of innovation generators. First, the DGNB system can be considered as an *Innovation Architect* in the form that even though the system is not being run through a private company but a non-profit organisation, the certification system creates an environment for new and green technologies to cohere together in innovative ways (Chesbrough, 2003). In general the DGNB system and its stakeholders in Denmark can be considered as an open innovation system as the stakeholders come up with innovative solutions through the DGNB system in order to stay relevant and competitive. In new DGNB certified construction projects, new products and building materials are often used in new ways and combinations, which makes the DGNB system an *Innovation Architect* as mentioned above cf. interview with Thomas Fænø Mondrup.

Secondly, GBC-DK can be considered as an *Innovation Missionary* due to the fact that it is created to advance the sustainable building industry cf. interview with Klaus Hansen. This is in the sense, that GBC-DK was started to promote sustainable building, and if we can consider the DGNB system as an *Innovation Architect* that connects already existing products and materials in new innovative ways, we can see GBC-DK as a *Innovation Missionary* that works to promote this cause.

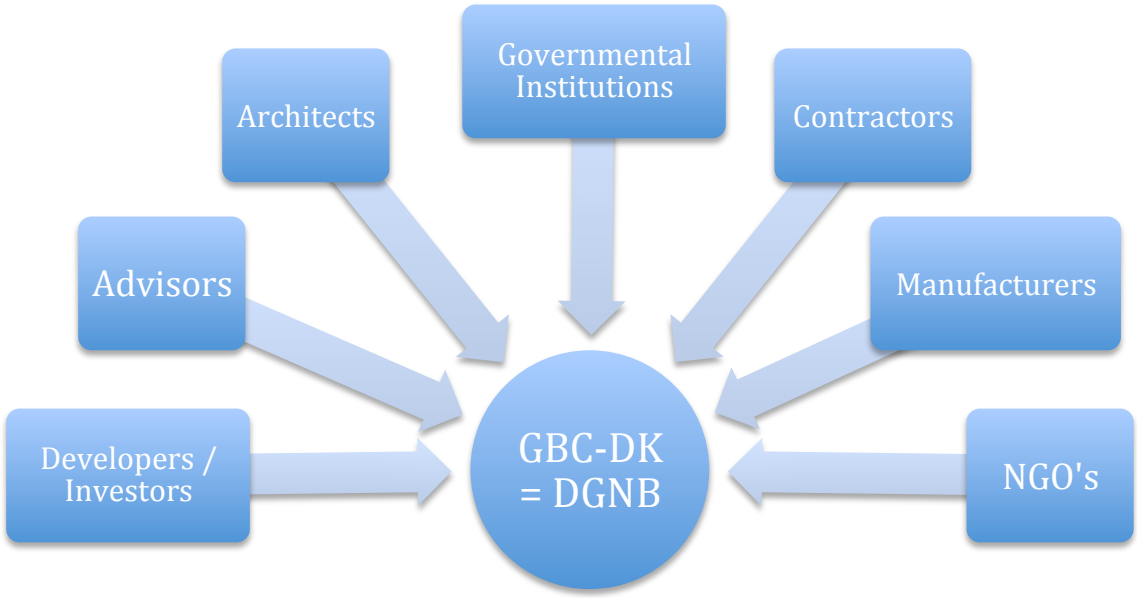
At the same time, it should be said, that many of the members of GBC-DK might not have the same intent as the organisation itself cf. interview with Lone Hedegaard Mortensen. Many of the members are privately owned companies who most likely have an equal interest in creating profit. The incentive to become a member of GBC-DK might vary from member to member but generally firms and organisations become members because they want to follow and promote the sustainable building development in Denmark cf. interview with

Karsten Withington Brink. On the other hand, there might be members who are equally interested in seeing the development progress as slowly as possible, in order for these companies to keep up with possible regulations and standards cf. interview with Lone Hedegaard Mortensen.

The application of open innovation shines light on the collaboration that revolves around GBC-DK and the development of sustainable building in general. In this section, an analysis will be made of how this collaboration takes place and will also give an overview of the stakeholders surrounding the DGNB certification system in Denmark.

5.1. Stakeholders in GBC-DK

In order to identify the stakeholders relevant to the certification system that is DGNB in Denmark but also GBC-DK an overview has been created below.



Shown above are the stakeholders relevant for the use of DGNB in Denmark, which shows that a lot of different stakeholders have an interest in the system. First of all, there is the DGNB certification system as a separate entity. The GBC-DK is a non-profit organisation that has chosen this system as the main certification system in Denmark. Other stakeholders can then choose to become a member of GBC-DK and thereby show their support for DGNB. Besides the GBC-DK, there are all the other stakeholders that are relevant for the use and implementation of DGNB in Denmark. Developers are stakeholders to DGNB as most inves-

tors interested in developing real estate are also interested in creating highest value of property when finished, and could therefore see value in getting the project DGNB certified. An example of a developer/investor could be *PensionDanmark* (PD) who is one of the biggest real estate investors in Denmark. Advisors, mostly in the field of engineering, are members of GBC-DK as they follow up on how the technical requirements in the DGNB system evolve and change over time. Architects are stakeholders to the DGNB system in the sense that the architects in charge must know and understand the certification system in order to fulfil its requirements and get a high score for the final project. An example of architects in Denmark using the DGNB certification system is *Arkitema Architects*. Governmental Institutions are also stakeholders to both the DGNB and the GBC-DK, as the system is implemented in Denmark to support the Danish building regulations and building law. The government agencies most involved in the development of sustainable construction are *Bygge-* and *Energistyrelsen*. Contractors are also stakeholders to the DGNB certification system as they are responsible for overseeing the project to completion and keeping the correct processes around the building site in order to fulfil what is expected from certification system. An example of a contractor could be MT Højgaard A/S, which is one of the leading contracting companies within the Nordic countries. Lastly, building material suppliers can also be considered as stakeholders when it comes to the increased use of sustainability certification systems in Denmark. Companies such as Rockwool International A/S and VELUX Danmark A/S have an interest in the positive development of certification systems such as DGNB as it would see the need for e.g. insulation to rise and thereby an increased demand for insulation materials. Non-Governmental Organisations are also a big part of GBC-DK, as these organisations have high interest in following the sustainable development in the Danish building industry.

5.2. Innovation in construction

The building industry has often been seen as an industry where the old ways of things ruled, and innovation was not welcomed cf. interview with Klaus Hansen. However this is often not the case, as innovation happens continuously in the construction industry may it be in prod-

ucts, processes or systems (Blayse & Manley, 2004). In the following part, the key influences on innovation within the building industry will be analysed.

Clients and manufacturing firms

In the sustainable building industry clients and manufacturing firms are highly influential on the way that the industry is moving. Firstly, if clients, who could be investors, start making demands to buildings that require a higher level of sustainability it would push the industry in that direction. If investors started investing only in DGNB certified projects, this would push the industry towards a more sustainable standard. A demand for sustainable products will happen, which could force manufacturers of building materials to focus their research & development towards more sustainable products. But as it is in many other markets and industries, the customer/client holds most of the power. That is the same here. It is the client's choice whether a project is to be sustainable or not. And at the same time, also what certification system is to be used, if the project will be of a sustainable nature and later certified cf. interview with Thomas Fænø Mondrup.

Structure of production

The process of constructing a building is in the general sense, not a very flexible and innovative process. When working with the DGNB system on the construction site, many builders choose to have made, a very explicit guidance report in order to know what requirements are required to fulfil a DGNB certification in the end cf. interview with Lone Hedegaard Mortensen. The use of reusable products and materials give a higher score in the DGNB system, which might give incentives to builders to use materials that can later be recycled and used in other projects or disposed in sustainable manner. As traditional constructions are made with longevity in mind, it puts pressure on manufacturers and suppliers to keep old product ranges in stock, if parts need to be replaced. By using module products and materials of a recyclable manner, it eases the pressure on manufacturers and suppliers and can lead to innovation in the production of construction materials cf. interview with Thomas Fænø Mondrup.

Industry relationships

The coalitions of firms and individuals that happens on a temporary basis in construction projects, tends to lose the acquired knowledge and innovation when the projects are done, due to absence of processes that can codify the information. When firms are using the DGNB system during a construction phase of a project, the GBC-DK act almost as a broker of information/innovation both between the firm and the organisation but also between the firm and others firms in the industry. GBC-DK is aware of the challenges that firms go through when trying to complete a DGNB certified project, and helps out in whatever way they can. This means answering questions directly to the firm, but at times, they link together firms in the industry that have gone through the same challenges so these firms can share experiences and results and help the system grow cf. interview with Thomas Fænø Mondrup.

Procurement systems

Innovation in construction usually comes from trying out new products and processes, however most traditional procurement systems in construction discourage the adoption of new products and processes. By using DGNB in construction projects, there might be a higher incentive to use innovative products as these products might be reflected in the score and thereby result in a higher grade on the DGNB scale once the project is done. Partnering across boundaries tends to improve innovation in construction because integration between teams will be established (Blayse & Manley, 2004). In DGNB projects, information across teams is essential because documentation of procedures on the construction site is very important. In that manner, integration between many teams across organisations is established and helps to create and improve innovation in construction. At the same time, there is constant communication between the client and the construction firm as even the smallest of changes to design and material choices ends up affecting the criteria in the DGNB system, which then requires cooperation between many functions throughout both organisations cf. interview with Thomas Fænø Mondrup.

Regulations and standards

The criteria in the DGNB system are very performance related, and do not specifically mention which materials to use in the construction of projects. When specifying how to accomplish individual goals in the construction of projects, regulators tend to hamper innovation, as the freedom to accomplish these goals is very limited (Blayse & Manley, 2004). By relying more on the functionality in the construction than the specifics, regulators can encourage innovation in the construction phase, while still achieving the end goal of having sustainable building with a high longevity cf. interview with Lone Hedegaard Mortensen.

Organisational resources

An organisation working with DGNB must have a culture of innovation and collaboration, as all decisions regarding a construction project reflects in the final DGNB-score. This means that knowledge boundaries must be low in order for collaboration and information flows to happen smoothly. The absorptive capacity of firms working with the DGNB certification system must be high in order for the firm to interpret and codify the learning that comes from the individual projects and challenges. These firms must also have the right people employed to work with certification systems like DGNB, as these systems tend to meet resistance in the beginning due to new or different ways of doing things in the construction phase. These employees must be able to challenge the resistance to innovation that could come from many places throughout the organisation in all stages of a project cf. interview with Thomas Fænø Mondrup. When a firm has the above-mentioned resources in place, a decision can be made on how to create a strategy on how to codify the knowledge acquired from working with the individual DGNB projects. The information and knowledge gathered in these projects is crucial both internally in the firm but also to outsiders who might encounter the same challenges in the future. Exchanging this knowledge with other actors within the industry can help push for more sustainable building.

5.3. Sustainability as a way forward

To see the DGNB system and its stakeholders through open innovation theory, we are also able to analyze how stakeholders related to GBC-DK can improve their behavior towards

innovation. In many cases, sustainability is seen as an obstacle when being in the innovation process of bringing new products/services to the market. In the analysis of this behavior and the possible opportunities ahead, we can look towards the sustainability research from Nidumolu, Prahalad, and Rangaswami (2009).

In this part, we will analyze how this theory can affect the various stakeholders related to GBC-DK and the DGNB certification system in Denmark.

We can split the stakeholders into three groups with architects, developers, and contractors being in the first group. This group is already familiar with the DGNB certification system, as they stay updated on the initiatives within the industry and try to incorporate as much as possible into their own processes cf. interview with Klaus Hansen. These stakeholders realised that with the initiation of GBC-DK, the DGNB system became an integral part of the Danish sustainable building industry. This means, that these stakeholders have already implemented and are using the DGNB system when working on various projects. By doing this, they are ensuring that they stay compliant on this area and are ready if governmental agencies start making new rules and regulations.

The second group consists of government and authorities within the sustainable building industry. From a national level, the government must make decisions on how to approach this area in the future. Whether the right way is to regulate sustainable building industry and thereby the certification systems present in the market, or let the industry choose and roam freely cf. interview with Lone Hedegaard Mortensen. If the government chooses to regulate the industry with laws and regulations, the easier choice would be to adhere to the lowest environmental standards as possible (Nidumolu, Prahalad, & Rangaswami, 2009). However, if more strict regulations are to be set in motion, government agencies in Denmark must consider the option of aiming higher in order to set a higher standard. If the EU chooses to implement laws within the sustainable building industry, Danish government would benefit from already being compliant with a more stringent set of regulations (Nidumolu, Prahalad, & Rangaswami, 2009).

The third and last group in this stage is the building material suppliers, which are in the same situation as above-mentioned. If these manufacturers are to deliver products and materials

to a market increasingly monitored by sustainability systems and indicators, they must adhere to the most stringent set of rules and regulations. By aiming higher in terms of sustainability, manufacturers can improve efficiency in production, improve sustainability, and still stay compliant with regulations in Denmark. By choosing this approach, companies in this industry can yield first-mover advantages by always staying on top of regulations and fostering innovation (Nidumolu, Prahalad, & Rangaswami, 2009).

In the next stage about making value chains sustainable, it would make most sense to split the stakeholders into two groups, as this step is focused on the value chains within companies/organisations, that bring products or services to the market. The first group contains Developers, Architects, Advisors, Government, and Contractors, as they are not directly concerned with the manufacturing of building materials. These stakeholders are therefore able to focus their attention towards other agendas and making more green sustainable choices. This could mean making a more sustainable office environment, or the more important task, to choose the right building materials and services for the projects they are handling for clients. This leads us two the second group, which actually only contains the Building Material Suppliers and therefore the manufactures of construction products. In the step towards becoming a more sustainable company these firms must concentrate on every step in their value chain and cooperate with other suppliers to develop eco-friendly raw material to use in the further production (Nidumolu, Prahalad, & Rangaswami, 2009). If the stakeholders in the first group (e.g. Architects, Developers) start making commitments towards GBC-DK and the DGNB certification system, this puts pressure on the manufactures of building materials, as they are forced to make innovative and more sustainable products in order to keep up with the growing demands and also exacerbated regulations cf. interview with Thomas Fænø Mondrup. This could put pressure on e.g. *Rockwool International A/S* to start innovating and produce products with a more sustainable performance.

If more actors in the sustainable building industry start committing to the DGNB certification system it would create a demand for products with a higher degree of sustainability. In the start, these products might come at a higher price due to the need for better and more sustainable raw materials throughout the production (Nidumolu, Prahalad, & Rangaswami, 2009).

However, the sooner manufacturers start focusing on the processes revolved around manufacturing more green and sustainable products, the sooner learning effects will happen. Eventually these learning effects will increase and result in higher efficiencies in production, which could lead to a more acceptable price level for the products and thereby attract other stakeholders such as Architects when developing projects (Nidumolu, Prahalad, & Rangaswami, 2009). In general, the sustainable building industry must develop an environment that makes it attractive for companies to start innovating and manufacturing products with a high sustainability profile. This could be done by committing to an industry-wide certification system of sustainable buildings as these systems makes participants think about the choices made in the building process cf. interview with Thomas Fænø Mondrup. If these choices result in choosing more products with a high sustainability profile, it could be the right way to go.

In the sustainable building industry in Denmark, the closest we come to this, is the collaboration around GBC-DK and the DGNB certification system. The collaboration around choosing a certification system showed that actors in the industry were willing to work together in this field cf. interview with Klaus Hansen. The introduction and implementation of the DGNB system in Denmark could have similarities towards a next-practice platform, as it is a new way to measure and certify sustainable buildings. At the same time it is a system that brings together actors in the industry to think differently in terms of sustainable innovation. Whether it is new innovative and sustainable products or new processes that would increase efficiencies (Nidumolu, Prahalad, & Rangaswami, 2009).

From the study, Nidumolu, Prahalad, and Rangaswami found that companies and organisations are increasingly turning towards sustainability when creating innovation. This trend shines trough to many other areas other than private businesses. Danish building law and regulations have been adjusted to incorporate a more green and sustainable approach to construction cf. interview with Klaus Hansen. The coming building regulations over the next few years will see the requirements towards energy saving exacerbated (GreenMatch, 2014).

5.4. The case of ISO 9000 and innovation

In order to better understand how the connection between innovation and standards fits together we look towards the case of the ISO 9000 certification standard. Mangiarotti and Riillo (2014) explains how the relationship between the two can be defined:

> *"Innovation and standards are often perceived as antithetic because innovation is the realization of something new while standards are meant to hold things the same. Innovation, in a broad sense, is the destruction of previous standards and the establishment of new ones. However, this relationship is complex and not fully understood."* - (Mangiarotti & Riillo, 2014)

Mangiarotti and Riillo (2014) have researched this connection in the case of ISO 9000, which was first introduced in 1987 by the International Organisation for Standardisation and has been updated many times since then. These sets of standards are used as quality management and helps companies and organisations ensure that the products and processes they deliver meet the requirements of their customers, while continuously improving the quality (ISO, 2016).

The ISO 9000 and the DGNB systems share similarities as companies can use both systems voluntarily. In the case of ISO 9000 it would be to assess quality in the production and in the case of DGNB it would be to document processes in the construction phase. Both systems are free to use but an official certification would cost money, and this is where the challenge lies. Without an official certification manufacturers would have no way to prove that they indeed are making quality assessments through ISO 9000, and the same is the case with DGNB. Developers can easily build a project using DGNB, but without the official documentation and certification it is rather useless.

In the manufacturing industry there is an immense pressure from customers and competitors for firms to be certified in the ISO 9000 standards, in order to show a guaranteed level of quality. And with the certification a great amount of external opportunities arise as manufacturing firms become more internationally recognised with an ISO 9000 certification and are able to bid on/accept more jobs (Terziovski & Power, 2007). An ISO 9000 certification is not required by public regulation, and therefore the pressure to get certified comes exclusively

from internally in the industry. It also makes it easier for customers when they engage in business with new manufacturers and want to have a certain level of quality assurance, to go straight to ISO 9000 certified manufacturers, as they get this a high degree of assurance.

To compare the ISO 9000 certification system to GBC-DK and the DGNB, we can see that many factors are applicable. The ISO 9000 certification is seen as a Total Quality Management system and the same can be said for the DGNB system. The first one focuses on quality within manufacturing whereas the latter focuses on constructing buildings of a higher quality. From analysing the case of ISO 9000 and its effect on the manufacturing industry, it would suggest that the sustainable building industry could benefit from the same results. This in the sense, that the internal industry pressure towards following a certain certification system might be for the betterment of the entire industry, as it raises the general quality of products and services (Terziovski & Power, 2007). To project this onto the case of GBC-DK and the DGNB system, it could be beneficial for the entire sustainable building industry to follow and work on a single certification system.

There are, however, implications to the pressure seen in manufacturing industry towards being ISO certified. Research has found that manufacturing firms see different results from the adaption of the ISO certification. Firms that are proactive and voluntarily choose to become ISO certified see better results in terms of optimization in production and general happiness with the system. On the other hand, firms that are becoming ISO certified in a reaction to pressure from customers and competitors see little to none results of optimised organisational performance (Terziovski & Power, 2007).

5.5. Part-Conclusion

This chapter analysed the factors that are important to innovation in construction and how these affects the development of GBC-DK and the DGNB system in Denmark. In connection with this, an analysis was made of why companies in general seek to be more sustainable and what benefits might be available from seeking a 'greener' path.

GBC-DK and its members was analysed through the theory of open innovation, which found, that the DGNB system can viewed as an *Innovation Architect* in the sense, that it connects products and technologies in new ways. GBC-DK can also be seen as an *Innovation Mission-*

ary as the organisation is a non-profit focused on the accumulated development of the sustainable building in Denmark. The important aspect of GBC-DK through open innovation theory was the fact that the organisation and its member is a collaborative network where cooperation is a huge factor.

A comparative analysis was made of the ISO 9000 certification, and the benefits for companies connected with adopting a certification system. We found, that firms in the manufacturing industry saw varied results, depending on the way the certification was acquired. Immense industry pressure from customers and competitors might force manufacturers to get an ISO 9000 certification in order to stay competitive in the market.

6. DGNB as the leading certification system

When Green Building Council Denmark was started, the DGNB certification system was chosen to be the focal point and the main scheme and thereby it was backed by many stakeholders within the industry cf. Interview with Klaus Hansen. With the introduction of DGNB through GBC-DK they were always aware that the end goal was to make this certification system an industry leader in Denmark and with the potential of becoming a dominant design. The definition of a dominant design has been explained earlier in thesis and with this definition in mind we can see that in order for a design to become dominant in a market or industry, it would have to be widely acknowledged. In this section, an analysis will be made to look at the benefit for an industry to choose a dominant design and how GBC-DK can leverage and influence its external relationships in order to increase the likelihood of DGNB becoming the industry standard within the Danish construction and building industry.

The DGNB system is still in the early stages of implementation in Denmark since its introduction 5-6 years ago. This means that the scheme at this moment in time cannot be considered as an industry standard. But the question here remains, what is to be gained for GBC-DK by encouraging the industry to follow in their footsteps and acknowledge the DGNB certification system as an industry standard?

From Schilling we know that once an industry has chosen a dominant design, the focus of the companies in the industry shifts. From focusing on working with alternative systems such as BREEAM and LEED, companies now focus on the continuous improvements concerning efficiency on the chosen design that is DGNB (Schilling, 2013). A lot of effort was put into making the GBC-DK and thereby the DGNB system in Denmark a reality cf. interview with Klaus Hansen. From what Schilling points out, we can see that GBC-DK is a way for the industry to work together instead of working against each other with different designs/systems cf. interview with Karsten Withington Brink.

When GBC-DK introduced the DGNB system it was also a way to guide the industry in a way that they felt both benefitted GBC-DK, but also the whole industry and its stakeholders. As

Porter explains, a company can change an industry through innovation to their own benefit (Porter, 1980). GBC-DK had a much broader focus, as the main goal of the organisation was to implement the DGNB system and try to create a dominant design through collaboration with other stakeholders in the industry. Porter showed that in 1980, his focus was on strategic positioning. He also included analysis tools like SWOT and the Five Forces to help firms understand and react to their environments. In later years he acknowledged that firms do not need to be so wary of competition, but instead focus on placing the firm or organisation in a comfortable position and enjoying positive externalities of healthy industries. The shared value strategy was developed to acknowledge that it is possible to work with competitors to receive various positive effects. For firms and organisations this could mean economies of scale, benefit from endogenous sunk costs and so on. However, it has shown that various dynamic capabilities can be quelled if you focus more on competition than collaboration. At the same time, it is still important that firms and organisations satisfy environmental and social responsibility issues, according to Porter. With GBC-DK we can see that they focused on collaboration and inclusion of stakeholders in the industry when implementing the DNGB system cf. interview with Klaus Hansen. This focus on collaboration within the industry might have created a mutual respect, as GBC-DK could have chosen another route of action.

In understanding what can be gained for GBC-DK and other companies in the Danish building industry by choosing the DGNB as the dominant design and thereby the main certification system we return to Schilling. She talks about the increasing returns an industry could exhibit when adopting a chosen design. With GBC-DK and the DGNB certification system in mind, we can establish that the organisation want to develop and grow its relations with actors in the industry. By doing this, they can hope to achieve a certification system that is continuously being used and improved upon by all actors in the industry cf. interview with Thomas Fænø Mondrup.
If the DGNB certification system gains momentum and becomes accepted as the go-to system, actors within the industry could focus towards building more effective supply-chains and improve upon the processes around certification systems. The learning effects would begin to have an impact on the industry, as the actors get more familiar with the system and

how to use it. For example, the learning effects could be the learning curve of suppliers who will improve processes and thereby learn to make products more efficiently. Suppliers often come up with new technological solutions to producing a product more efficiently (Schilling, 2013). If suppliers are forced to innovate and produce more sustainable products, the learning effects could take place as these products start being manufactured with the result of a higher degree of efficiency.

In continuation of this, Schilling also mentions the effect called "positive consumption externalities", which shows the effect of adoption of a product or process within an industry/market (Schilling, 2013). These network externalities can have the effect of making the value of a good increase with a rise in the adaptation rate in an industry.

In extension of this theory we can assume that if more actors in the sustainable building industry adopts and start using the DGNB certification system, the overall value of the system increases which could attract more companies/investors towards the system. This trend could push the DGNB system towards becoming a dominant design in the sustainable building industry. The actors in the industry who choose to adopt the system as their main certification system when starting new projects, we can refer to as the *Installed Base* according to this theory of Schilling (2013). The growth of the *Installed Base* comes with new stakeholders and partners, which GBC-DK must manage in order to keep growing the DGNB system in Denmark. We can see GBC-DK as a separate organisation that is affected by its members/partners in the sustainable building industry. And to generate and source knowledge from outside the entity that is GBC-DK we can look at their partners and members as external. These external knowledge sources are important to GBC-DK as they must act to inputs and critique from partners in the industry when pushing DGNB towards becoming a dominant design cf. interview with Thomas Fænø Mondrup. As this knowledge is created in the partnering firms, it is not automatically transferred to GBC-DK, and therefore we can establish that this knowledge can be considered as an external source.

To view the battle towards dominant designs for DGNB we can look at through another perspective, which is the case of 'standards wars' from Shapiro & Varian (1999). To analyse the industry 'war' that is happening in the sustainable building industry we can look at the key assets that GBC-DK and the DGNB system need to attain in order to win this war and be-

come a de facto standard in the industry. This 'war' of standards is a very one-sided battle, at least in Denmark, as DGNB is the only publicly supported system. Other systems such as LEED and BREEAM does not have organisations supporting them in Denmark but is still very internationally recognised. Therefore the fight towards dominance is not happening directly between firms or organisations but instead between the certification systems. Firstly we can look at the control over the installed base of users, which GBC-DK have in some degree over the users through their memberships. However there is no lock-in for actors when supporting DGNB in Denmark. This means GBC-DK must work hard to convince their 'customers' that the DGNB system is the best system to use. This can and is being done by including members in the future decisions made about the system cf. interview with Thomas Fænø Mondrup.

Generally, firms and organisations do their utmost to protect their intellectual property rights. In the case of GBC-DK and DGNB, the system and all of the criteria involved is free for all, whereas the pre-, and final certification of projects has to be done by authorised consultants and auditors cf. interview with Klaus Hansen.

The ability to innovate both within the DGNB certification but also to create innovation for members is a very important aspect in this case. If GBC-DK is able to continuously update the DGNB certification system with the help from members, the likelihood of the system staying ahead will increase. The fact that the system can help create innovation throughout the industry, both in processes and products, is a major benefactor to winning the 'war' in becoming a de facto standard in the industry.

The DGNB is known as a second-generation sustainability certification system and was created with roots connected to other earlier certification systems but developed to what has now expanded to incorporate some other aspects of sustainability cf. interview with Lone Hedegaard Mortensen. In connection with the ability to innovate, firms and organisations are more likely to support GBC-DK if they can see that innovation is being created in this system, whether it is within products or processes. This innovation could lead to first-mover advantages in the market place and thereby a more sustainable competitive advantage for members of GBC-DK.

GBC-DK and the DGNB certification system do not necessarily have strength in complements to further their position in the market, but they have however created a network of firms and organisations that cooperate to fix present challenges cf. interview with Thomas Fænø Mondrup. When firms must choose to support specific certification system in the market, the choice might land on DGNB and GBC-DK because of the extensive partnering that happens in this network cf. Thomas Fænø Mondrup. Another angle in terms of complements is the services that might arise along with the popularity of the DGNB system in Denmark. Actors and stakeholders are likely to have pecuniary interests in the increasing popularity of the DGNB system, as the demand for educated auditors and consultants will increase as well. The service market for DGNB certified auditors and consultants might see an exponential increase in demand, if the combined sustainable building industry were to support a single certification system. This too would benefit GBC-DK, as they are the only organisation educating the before-mentioned auditors and consultants at the moment.

In order for GBC-DK to make the DGNB system a dominant design in the sustainable building industry, a brand name and reputation would have to be built. This part is important to the overall success of the system in Denmark, because of the effect the certification should have in the end when a project is done. If no one knows or respects the extra work and effort that is put into getting a project DGNB certified, the system would basically have no effect. The extra added value that investors most likely would expect to come from a certified DGNB project, would be close to none if the support of this system was very limited. Therefore, establishing a brand name and reputation is very important for GBC-DK, and is already in the process.

6.1. Collaboration around GBC-DK and DGNB

When the GBC-DK was started, initial research was done on new buildings with several different certification systems in order to establish which system was to be chosen for the Danish building industry cf. interview with Klaus Hansen. To do this research, GBC-DK initiated partnerships with different actors in the industry to gain support for the system that would be chosen after the research was done (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010).

There are a lot of legitimate reasons for stakeholders in the industry to form a partnership and join together behind a single certification system. The obvious one is that a partnership like this would be for the betterment of all stakeholders involved, including the end-consumers as the growth of a single certification system would create transparency.

An integral part of making and categorising the DGNB system as a dominant design in Denmark would be to gain as much support as possible. So now, the question can be asked of how GBC-DK can grow and use their already established partnerships to promote the DGNB certification system to gain industry wide acknowledgement. With this challenge in mind, we can look towards Struben & Sterman (2008), who have analysed the challenges of changing systems within an industry.

From our case of the DGNB system in Denmark, we can analyse how GBC-DK can, along with their partners, persuade other actors in the industry to get behind DGNB as the main system in Denmark to push it towards becoming a dominant design. There are differences between the theory and the case of DGNB but there are also similarities, which makes it a relevant perspective. Struben & Sternan (2008) chose to analyse how the willingness of regular consumers to change to alternative fuel vehicles can change effected by a number of factors. In this section we can use this research to analyse how GBC-DK can affect the willingness of stakeholders in the industry to support and acknowledge the DGNB system as the main certification method of sustainable building projects in Denmark.

Struben & Sterman (2008) states with their paper that total exposure to a platform, which in this case would be non-participants' exposure to the DGNB certification system can arise from three components as explained theory chapter of this thesis. Firstly we can take a look at the 'marketing' perspective of this theory:

Marketing

In the preliminary phases of introducing a certification system of sustainable projects in Denmark a partnership was started with *Realdania* who agreed to fund the research groundwork for choosing the right system (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010). This was all done with the intention to create the GBC-DK, which eventually would be a non-profit organisation. With the help from researchers connected to state functions, the

choice in the end fell on DGNB as the best system, which could show that the choices made was with the best intentions in mind cf. interview with Klaus Hansen. With GBC-DK being a non-profit organisation the choice was made from a neutral position, which meant that there were consensus towards DGNB being the best and most suitable system. In the end what matters here is that funding from different stakeholders did not coerce the choice.

Secondly, we can analyse the 'word-of-mouth from participants' factor of the theory against our case:

Word-of-mouth from participants

From the three factors from the theory of exposure to a platform, the 'word-of-mouth from participants' might be the most important one of the three. This factor shows potentially how successful the DGNB system can become, by the already participating members of GBC-DK. When becoming a member of the GBC-DK the participants of the organisation shows commitment towards the DGNB system, and at the same time supports the further growth and expansion of the system.

The key thing when it comes to the members of the GBC-DK organisation is keeping them well informed and essentially 'happy'. The members must see the positives of supporting the DGNB system and how it is the best option for the Danish building industry to commit to. Knowledge sharing within the organisation and its members is crucial to keep growing the organisation and the acknowledgement of the system in Denmark. If members of the organisation are pleased with the project, and the see the upsides, this could spread to other 'non-participants', which could steer other actors in the industry to support the DGNB system.

Lastly, the effect of 'word-of-mouth from non-participants' towards the system are analysed below:

Word-of-mouth from non-participants

This last factor in theory is the least relevant for our case, as non-participants would have little to no incentive to actively speak out against the DGNB system. However as the systems are in a sense, competitors, we can assume that actors supporting other certification systems are inclined to speak better of those systems.

With this in mind, we will not look closer at the last factor 'word-of-mouth from non-participants' as it is not really relevant for the analysis of this theory.

6.2. DGNB as a platform leader

In this section we look into the notion of external platforms or industry platforms, as it will be analysed according to the case of GBC-DK and the DGNB certification system. We can start the analysis by relying on the definition of platforms from Gawer & Cusumano (2012) mentioned earlier in the thesis. With this definition in mind, we can look towards the GBC-DK and the DGNB certification system implemented in Denmark. We can state, that the DGNB system can be categorised as an industry platform in the sense that it is a system, which actors use to develop projects, products, and processes. The criteria from the system are free for all to use, however the process to get a project audited and certified comes at a cost cf. interview with Klaus Hansen. GBC-DK has sought support from actors within the building industry to get behind a single certification system of sustainable buildings. With the creation of the GBC-DK as a non-profit organisation it showed that the main focus was on getting the best possible solution to certifying sustainable buildings cf. interview with Klaus Hansen. The best solution for GBC-DK was based on several criteria but mainly focused on the ease of adaption to Danish regulation and standards. Along with the ease of adaption there was also a focus on the general sustainability of the system, long-term plan, freedom of method and performance. The long-term plan was aimed towards the adaption of future European standards in the area of sustainable building (Birgisdottir, 2012). The 'platform', which, the DGNB system can be described as, can be worked on from all the participants of the system, which will lead to incremental improvements on the system. However, as the information within the system is open for all, input can essentially come from anywhere cf. interview with Lone Hedegaard Mortensen. A platform like the DGNB system can be seen as convergence of technologies because new processes and technologies can be combined for a certified DGNB project.
As the GBC-DK is a non-profit with members from all around the industry, it means that these partnerships allows for open access and thereby quicker problem solving if it should come to that cf. interview with Thomas Fænø Mondrup. The positive network effects from these part-

nerships can increase the likelihood of the DGNB certification system becoming a de facto standard and dominant industry design.

The DGNB system is as mentioned implemented in Denmark by GBC-DK with focus towards Danish law and regulations cf. interview with Lone Hedegaard Mortensen, and is therefore developed as an external platform. To look closer at this, we can turn our attention to the theory of 'two-sided networks' and how these factors affect our case.

6.2.1. Network effects

DGNB as a certification system can be categorised as a platform as analysed above, which then can be connected to the theory of 'two-sided markets'. Eisenmann, Parker, and Van Alstyne (2006), have analysed the connection between platforms and 'two-sided networks' and in the theory chapter this was explained.

The DGNB system will eventually become a factor when investors will sell projects to the consumers in the sense that a certified sustainable building could be worth more cf. interview with Karsten Withington Brink. Thereby GBC-DK and the DGNB system can tie two groups of actors together through the certification system. The two groups would be the participants and stakeholders in the GBC-DK on one side, and the investors/consumers on the other side. The certification system would act as a stamp of approval when selling new projects. By entertaining the idea that a sustainability certification of new projects will be mandatory by law in the future, GBC-DK and the DGNB system as the potential dominant design in the industry would act as facilitator in this 'two-sided network'.

GBC-DK as an organisation is solely focused on the development of the sustainability building industry as a whole, and thinks that the correct way to certify sustainable building projects is through DGNB cf. interview with Klaus Hansen. By introducing and implementing the certification system in Denmark GBC-DK is essentially pushing the industry towards a more sustainable alternative to the present. Even though GBC-DK has no fiscal incentive to introduce specially DGNB, they realised that there is a lot to learn and gain from introducing a certification system in Denmark. By collaborating with actors within the industry they created positive network effects. As explained in the theory chapter these effects can happen on both sides of the network. The two user groups involved in this network are the 'subsidy-side' and the

'money-side'. The 'subsidy-side' users in this theory can be described on two levels when compared to the GBC-DK and DGNB. The first level involves investors that are investing in DGNB certified projects and are believing that a sustainable certification will bring added value to the finished project. The second level is the end-consumers of DGNB certified projects, who buy houses or apartments that are DGNB certified and believe the sustainability aspects and thereby the added value. The 'money-side' users in this 'two-sided' market or network are all the stakeholders behind the development of DGNB certified projects. This could be developers, architects, building material supplier and manufacturers who all contribute when developing a certified sustainable building or project. To give an overview of the two sides of the network, an illustrative figure has been created and is shown below:

In this case investors are to be found on the 'subsidy-side' due to the fact they are customers of the DGNB project. End-consumers are the people who buy or rent a house/apartment that has been DGNB certified.

Now that we have established who both user groups are, we can analyse the network effects:

"Same-side" network effects

We have analysed how the DGNB system can be described as a platform with a 'two-sided network' with GBC-DK controlling how the system has been implemented and used over time. GBC-DK sees the DGNB system as the way forward, and is therefore putting all their support behind together with the members/participants of the organisation. The hope is that

many more actors in the industry will get behind the system, which is described as the "same-side" network effects. The more actors that become stakeholders and thereby members of GBC-DK will make the DGNB system in Denmark a more attractive and valuable system to use in the future (Eisenmann, Parker, & Van Alstyne, 2006).

"Cross-side" network effects

The "cross-side" network effects are the most valuable to come through 'two-sided networks' due to the fact that these effects have the potential to bring exponential growth and support for the DGNB system in Denmark. The DGNB certification system will automatically create "cross-side" network effects, which will happen through the support within the industry. The "cross-side" effects in this case will happen when investors/consumers start showing and increased interest in DGNB certified projects and thereby pushing more actors within the industry to choose the system as their main scheme. The other way around also happen, meaning, that when investors/consumers see the growing industry support for the system, they will choose a DGNB certified project the next time they want to invest. This will, in the end create a demand for a continuously updated and improved DGNB system.

6.2.2. Criteria for successful platforms

With Gawer & Cusumano (2012) in mind, we can analyse how GBC-DK should act in order to have, as Gawer & Cusumano calls it, "effective practices for platform leadership". The paper works with four factors, which if an organisation/company is successful with these, can make a system more likely to accomplish the objective of becoming a platform leader.

An organisation must choose an element or system with the potential to become a platform, and with the DGNB system, GBC-DK have indeed done this. The next job is to identify other actors within the industry to join the organisation and thereby support the system. Many stakeholders are already involved with GBC-DK and the DGNB certification system in Denmark and have the ability to contribute with experiences and knowledge to the project cf. interview with Thomas Fænø Mondrup. 'Complementors' to the DGNB system could in the future be the stakeholders updating and realizing that new criteria must be implemented in order to keep up with the development in the industry.

The DGNB system has already been accepted in the industry by various actors, and this shows that the GBC-DK have done a good job of implementing the system with a strong technical architecture that is attractive to support for actors. The DGNB system has been developed and implemented in Denmark with the intention to make it accessible and easy to work with for stakeholders cf. Interview with Klaus Hansen. The ease of use with the system gives incentive for participants to stay innovative and develop complementary products, which in this case could be building materials with a higher degree of sustainability.
By focusing on collaboration around a single certification system, actors can work towards a common goal, which is to create a better sustainable building environment. By getting familiar with a single system, stakeholders can increase learning effects and cut costs by improving building processes. GBC-DK has done the groundwork and research for choosing the most optimal and suitable certification system in Denmark, which reflects that if actors show support for DGNB they could gain competitive advantages cf. interview with Klaus Hansen.
Lastly, it is important for GBC-DK to create an environment where incremental improvements are continuously in the progress of happening and being implemented. The innovation that happens in and around the system is essential in the pursuit to make and keep the DGNB system as a platform leader. GBC-DK along with other actors must convince stakeholders to keep investing in long-term sustainable innovative solutions in order to keep the industry developing and improving.

Through the analysis of the above-mentioned factors, it has been shown how GBC-DK can increase the likelihood of the DGNB certification system gaining and keeping an effective platform leadership.

6.3. Part-Conclusion

We learned, that as GBC-DK and the DGNB certification system gains support in the industry, the stakeholders would most likely show greater returns from network externalities and learning effects. In order for the DGNB system to become a dominant design in the industry, GBC-DK would be relying on 'marketing' and 'word-of-mouth from participants'. The fact that GBC-DK is a non-profit organisation shows that the choice they made for DGNB to be

the system was unbiased. At the same time, GBC-DK would have to keep members and other stakeholders well informed to become a dominant design. The 'war' of standards that is happening amongst the different certification systems, is not a battle between companies but rather between the systems.

An analysis was made to determine that the DGNB system could be considered a platform, as well as the effects from platforms and two-sided markets that might affect the DGNB certification system. In this analysis, we found that for the DGNB system to gain and maintain platform leadership GBC-DK would have to use their partnerships in the organisation to gain momentum. The effects from the two-sided network that is the DGNB certification are instrumental to GBC-DK. By sharing the vision of DGNB becoming the go-to certification system in Denmark with members and stakeholders, they would increase the likelihood of it becoming a dominant design. The system, however, would have to be improved upon continuously with input from all members and stakeholders, in order for the certification system to become a de facto standard and later remain, as a platform leader in the industry.

7. The factors against DGNB becoming a dominant design

A lot can be done for the DGNB system to be accepted as the dominant design in the sustainable building industry in Denmark. There are, however, at the present moment factors that ultimately will be working against a single certification system becoming a dominant design in the Danish sustainable building industry. One of the biggest factors is the fact that the DGNB certification system is most known in some parts of Europe. This means that many customers/investors from other parts of the world do not choose DGNB as the main certification system in their projects as they, simply put, are more familiar with other systems cf. interview with Karsten Withington Brink.

The easiest way to make the DGNB system a dominant design in the industry would be to have all stakeholders in the sustainable building industry adopt it and use this single certification system in the future. The major obstacle in this dream scenario is that in most cases the client/customer of the construction project decides which certification is to be used if the final building will be certified.

This leaves stakeholders and members of the GBC-DK in a dilemma, as they do not control the entire decision themselves of which certification system should be used when starting new building projects across the country. In general, this factor limits the present potential of the DGNB system if or until it becomes a more recognised system outside of Europe as many international clients favours the systems they know the best when hiring developers and contractors to do new projects in Denmark cf. interview with Karsten Withington Brink.

7.1. Discussion of theory

In general the theories used in this thesis have had high degree of applicability which is shown earlier through the analysis. There are also aspects of the theories used that could decrease the relevance and applicability for a set of problems faced in this thesis. These aspects will be discussed throughout this section.

Sustainability is a term heavily used in thesis, and therefore it makes sense to look at the opportunities for firms and organisations to choose a greener path and become more sustainable. The theory used to enlighten this area (Nidumolu, Prahalad, & Rangaswami, 2009), focuses

mainly on how for-profit organisations should go about this greener strategy. The relevance of this theory can then be discussed as the focus in this thesis is aimed more towards the work of GBC-DK and the network of members to lead a whole industry towards a more sustainable future.

The theory of open innovation has been used in this thesis as one of the first layers of the theoretical underpinning and shines light on the network of actors as well as the roles of the these individual stakeholders. The theory focuses on the fact that a firm or organisation uses external knowledge sources to create innovation within the firm/organisation. That also happens in the case of GBC-DK and the DGNB system through continuously feedback and optimisation of the system. Equally as important, is the innovation that happens inside the firms and organisations as stakeholders to the DGNB system, which is instrumental to the further development of the system.

In the analysis of the 'war' on standards towards a dominant design in the industry, the DGNB is argued to be a standard and design in the sustainable building industry, making the use of these theories relevant. The fact that the DGNB system is more a service than a physical product changes the perspective as these theories focus mostly on physical products to be the design or standard in the industry.

The use of theory regarding platforms and the connected theory of two-sided markets/networks can be argued as the discussion on whether the DGNB system can be established as platform could tilt either way. Platforms are physical or non-physical 'products' that connects people, which could be buyers and sellers. The DGNB system is an instrument used to label buildings and projects a certain degree of sustainable, and do not fall under the standard categorisation of platforms. However, the mechanisms that are happening with the use of certification systems like DGNB has relevance to platform theory and two-sided networks.

8. Conclusion

A description was made of the three different aspects of sustainable building, which are the environmental, economic, and social aspects. We found that there has been an increased focus on updating rules and regulations to follow a more sustainable approach. Both the Danish building regulations and the energy labelling system has been updated to exacerbate the requirements for energy saving in new buildings. Standards in the European Union have been introduced to create more regulation around the performance of construction products and materials in Europe. These standards have harmonised test methods across the member states and created transparency amongst building materials. From a description of the more popular certification systems, BREEAM, LEED, and DGNB, we saw the differences and similarities between these. The market for certification of sustainable buildings is a separate one within the Danish building industry, as the certification is a service delivered by both GBC-DK and individual auditors/consultants.

In order to understand how innovation in construction takes place, an analysis of these effects and how they affect the DGNB system and GBC-DK was made. In extension, an analysis of how sustainability might benefit companies in the long-term was made. From open innovation theory, we found that GBC-DK and its members can be considered as one big network where the DGNB system acts as an *Innovation Architect* and GBC-DK as an *Innovation Missionary*. The DGNB system was compared to the ISO 9000 system see how the use of certifications in the manufacturing industry has affected different factors. The results from the studies made in this area, were varied as some companies saw benefits from adopting the ISO 9000 certification, while other companies did not see many positive upsides. The internal industry pressure to get a certification was interesting in the case of the DGNB system, as this could be compared to the effect that might happen in the sustainable building industry.

We learned, that in order the DGNB system to become a de facto standard in the industry the reliance on marketing and 'word-of-mouth from participants' would be important. GBC-DK would have to keep members and stakeholders in the organisation well informed to achieve becoming a dominant design in the industry. The 'Standard War' that takes place in

the industry is not amongst firms but rather between the individual certification systems. The DGNB system can be considered as a platform as it connects people and organisations and is continuously being updated. An analysis of the two-sided network found that the both the 'same-side' and 'cross-side' effects have a substantial impact on the development of GBC-DK and the DGNB system. The partnerships that GBC-DK establish through the memberships, are important for the DGNB system to gain momentum towards becoming a dominant design.

One very important factor working against the DGNB becoming a dominant design, in the Danish sustainable industry, is the clients/investors of construction projects. In the end, many stakeholders of building projects do not have much to say, if the client/investor wants a certain certification of the final project. This mostly happens with international clients/investors if they prefer another certification system because of a higher familiarity or want to appeal to a certain market. The DGNB system must therefore grow organically in order to be recognised and acknowledged in larger part of the world.

In conclusion, the strategy of GBC-DK to develop the DGNB system as a dominant design in the Danish sustainable building industry is a feasible one. GBC-DK must however rely on its members to help grow the organisation and attract more members over time to increase awareness of the DGNB system. The economic factors derived from using the DGNB system could attract more actors and thereby increase the use of innovative sustainable construction in the industry. Until the DGNB system has achieved a higher range of acknowledgement around the world, GBC-DK might struggle to make the system a dominant design in the industry, as other systems will still play a big role.

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10. Annex

Appendix 1 – Interview: Klaus Hansen

Klaus Hansen var med til at stifte Green Building Council Denmark og var med da valget faldt på DGNB. Han var med til afprøve forskellige certificeringsordninger og er tidligere forsker ved Statens Byggeforskningsinstitut.

Interviewguide

Hvilke erfaringer har du med certificeringssystemer (DGNB, LEED osv.) ?
Var med til at introducere og implementere DGNB via Green Building Council Denmark.

Hvilke erfaringer har du med Green Building Council Denmark?
Var med til at stifte og afprøve forskellige certificeringssystemer i Danmark.

GBC-DK har implementeret og tilpasset DGNB i DK. Er det, det rigtige valg?
Der var diskussioner og test af LEED, BREEAM, DGNB og HQE. Valget faldt på DGNB i sidste ende, da man mente ordningen passede bedre på de ønsker og krav der var til systemet.

Er certificeringssystemer den rigtige vej at gå mod mere bæredygtigt byggeri?
Ja, det hjælper bestemt til at fremme bæredygtighed.

Hindrer certificeringssystemer innovation? Man låser sig fast i bestemte processer?
Ikke nødvendigvis, hjælper aktører til at tænke mere bæredygtigt og måske også mere innovativt

Burde vi i DK, have lovpligtig certificering af nybyggeri eks. DGNB?
Det kunne være en god idé, og diskussionen har været der men der er nok et stykke vej endnu.

Ville det styrke innovation indenfor produkter/processer at fremme certificeringssystemer?
Ja, formentlig. Sætter krav til produkter og processer

Besværliggør det byggeprocessen at efterleve DGNB?
Ikke nødvendigvis.

Appendix 2 – Interview: Thomas Fænø Mondrup

Thomas er ansat ved MT Højgaard A/S og arbejder til dagligt i afdelingen for Bæredygtighed.

Interviewguide

I hvilket omfang arbejder MT Højgaard med bæredygtigt byggeri?

MT Højgaard arbejder med alle de store certificeringssystemer indenfor bæredygtighed. Tilpasser kompetencer/ydelser efter kundens behov.

Hvilke erfaringer har du med certificeringssystemer (DGNB, LEED osv.) ?

Er uddannet DGNB konsulent/auditør og skal stå for kontrollen af MT Højgaards nye domicil.

Hvilke erfaringer har du med Green Building Council Denmark?

GBC-DK er åbne hvis der brug for hjælp i forbindelse med problemstillinger i DGNB byggeriet, eller hjælper virksomheder til at samarbejde hvis de har været igennem de samme problemstillinger.

Hvilke interesser har MT Højgaard i GBC-DK og DGNB?

Er Premium medlem og har et samarbejde kørende.

Er certificeringssystemer med til at fremme bæredygtigt byggeri?

Det kan de være. Mange bruger certificeringer som branding til at have et bevis på den bæredygtighed som bygningen lever op til når den er færdig. Men certificeringssystemer kan være med til at skubbe byggeindustrien i en mere bæredygtig retning.

Vil brugen af eks. DGNB styrke innovation af produkter/processer i byggeindustrien?

Ja, til dels, da brugen af mere bæredygtige produkter vil skabe en stigende efterspørgsel efter produkter der yder bedre i forhold til bæredygtighed. Denne proces vil dog tage en del år.

Har du oplevet problemer/ulemper ved brugen af certificeringssystemer?

Man kan nå en grænse, hvor graden af bæredygtighed ikke nødvendigvis giver nogen merværdi for den specifikke bygning. Hvis man sigter efter en høj DGNB-score, eksempelvis DGNB Platin, kan være nødt til at lave nogle tiltag, ikke nødvendigvis for bygningens skyld, men udelukkende for DGNB-systemets skyld, og for at kunne opnå nødvendige DGNB point. Her kan man diskutere, om det er optimalt at bruge ekstra-ressourcer på noget, som kun tilgodeser selve certificeringen.

Der er nogle kriterier der i princippet modstrider hinanden, så hvis man vil score højt i et emne, må man muligvis leve med at få en lavere score i et andet.

Hvordan bliver byggeprocessen påvirket ved brugen af DGNB? Besværliggjort?

Ikke decideret besværliggjort, men gør at folk på eksempelvis byggepladsen skal involveres mere, og være bekendte med de DGNB-relaterede beslutninger og processer, de indgår i. Som eksempel tilskriver DGNB mere opmærksomhed omkring trivsel på byggepladsen (fokus på arbejdsmiljø/sikkerhed samt reduktion støj, støv, affald mv.), ligesom byggepladsens el-, vand- og varmeforbrug også skal dokumenteres.

Burde vi i DK have lovpligtig certificering af nybyggeri eks. DGNB?

Ville være svært. Men en form for incitamentsordning hvor virksomheder bliver belønnet for at vælge mere bæredygtigt byggeri frem for andet kunne være en interessant mulighed. Vil dog også være svært at implementere og opretholde.

Hvordan tror du fremtiden ser ud indenfor byggeindustrien ift. Bæredygtigt byggeri?

Bæredygtighed er en vigtig del af fremtidens byggeri og har været i fokus i mange år. I dag ser vi en mere helhedsorienteret tilgang, hvor det tidligere mere har handlet om kun energiforbrug og CO_2-udledning. Systemer som DGNB er med til at understøtte den helhedsorienterede tilgang, hvor også emner som social bæredygtighed og totaløkonomi inddrages.
Men Bygningsreglementet stiller i dag allerede høje bæredygtighedskrav til byggeri i DK, i hvert fald hvad angår energiforbrug og indeklimaforhold.

Appendix 3 – Interview: Lone Hedegaard Mortensen

Lone Hedegaard Mortensen er forsker ved Statens Byggeforskningsinstitut og har været med til at tilpasse DGNB manualerne til de danske love og reglementer.

Interviewguide

Hvilke erfaringer har du med certificeringssystemer (DGNB, LEED osv.) ?

Har været med til omskrive/tilpasse DGNB manualerne til Danmark og er en del af den uvildige 3. Part når bygninger og projekter skal certificeres i DK.

Hvilke erfaringer har du med GBC-DK?

Har været i tæt kontakt og samarbejde med GBC-DK under den løbende tilpasning af DGNB manualerne.

Hvilke interesser har virksomheder i at være medlem af GBC-DK?

Der er to typer af interessenter i GBC-DK. Der er dem som er med fordi de tror på udviklingen og at det er den rigtige vej at gå. Der er formentlig også den del, som prøver at holde tempoet nede for at det ikke skal løbe løbsk og man pludselig ikke kan følge med.

Er certificeringssystemer med til at fremme bæredygtigt byggeri?

Bestemt. Det gør bæredygtighed mere konkret, og er med til at sætte fokus på vigtige ting.

Ville brugen af eks. DGNB styrke innovation af produkter/processer i byggeindustrien?

Formentlig ikke processer. Det er en meget traditionspræget industri, så der bliver lavet præcise køreplaner for hvordan et byggeri skal gennemføres hvis det skal opnå en bestemt certificering i sidste ende. Det skaber ikke særlig plads til nytænkning og hele processen om at tænke over de valg der bliver taget.

I forhold til produkter, er det meget muligt at der bliver skabt en efterspørgsel efter mere bæredygtige produkter.

Hvordan bliver byggeprocessen påvirket ved brugen af DGNB? Besværliggjort?

Der bliver lavet meget præcise køreplaner, så det er ikke en synderlig besværliggørelse at lave et DGNB certificeret byggeri.

Burde vi i DK, have lovpligtig certificering af nybyggeri eks. DGNB?

Kunne være interessant men vil formentlig ikke ske. Den politiske dagsordning vil nok ikke se den problemstilling som den mest vigtige.

Hvordan tror du fremtiden ser ud indenfor byggeindustrien ift. Bæredygtigt byggeri?

Der kommer bestemt en mere helhedsorienteret tilgang til byggeri i fremtiden som vi allerede ser tegn på nu. Den udvikling fortsætter og der er stadig stigende DGNB projekter i DK.

Appendix 4 – Interview: Karsten Withington Brink

Karsten Withington Brink er underdirektør for PensionDanmark Ejendomme, som er den del af PD der står for køb og opførelse er ejendomme. PensionDanmark har de senere år haft ekstra fokus på investering i bæredygtigt byggeri. Karsten er desuden en del af bestyrelsen i GBC-DK.

Interviewguide

I hvilket omfang arbejder PensionDanmark med bæredygtigt byggeri?

PensionDanmark arbejder i et bredt omfang med bæredygtigt byggeri. Alt nybyggeri som PD er en del af skal certificeres. PD har også pilotprojekter omkring mulighederne ved certificering af eksisterende byggeri.

Hvilke erfaringer har du med certificeringssystemer (DGNB, LEED osv.) ?

PD ser helst at alt nybyggeri de er en del af certificeres efter DGNB systemet, men er ikke altid muligt da eksempelvis internationale kunder helst ser en LEED certificering.

Hvilke erfaringer har du med Green Building Council Denmark?

Er en del af bestyrelsen i GBC-DK så har derfor gode erfaringer og mener organisationen har et godt formål.

Hvilken interesse har PensionDanmark i GBC-DK og DGNB?

PD er interesseret i at præge den bæredygtige udvikling i Danmark og gør dette ved at være aktive i GBC-DK men også gøre deres for at præge byggeriet i en bæredygtig retning.

Hvilke fordele ser du, som investor, ved at certificere bæredygtigt byggeri?

PD er investorer på den lange bane, og mener derfor at ud fra et helhedsorienteret synspunkt får man generelt en bedre bygning ved at certificere dem med minimum en DGNB Guld certificering (tidligere sølv). Man får gladere lejere da, de får en bedre/sundere bygning at være i, og samtidig kan PD få lavere driftsomkostninger ved et certificeret byggeri.
I sidste ende kan bygningen have en højere værdi ved videresalg end hvis bygningen ikke havde været certificeret.

Er certificeringssystemer med til at fremme bæredygtigt byggeri?

Bestemt. Det hjælper til at fremme bæredygtigt byggeri på flere måder. Man får bare bedre bygninger/ejendomme da DGNB ser på det store billede og at levere en sundere bygning helt overordnet. Det er også en måde for virksomheder at brande sig som "grønne" ved at være tilstede i en certificeret bygning.

Hvor stor en andel af PD's ejendomsportefølje er bæredygtigt byggeri?
Ved ikke præcist. Men en ok andel. Men PD investerer stadigt i eksisterende ejendomme hvis investeringen er god. Så det er svært at sige.

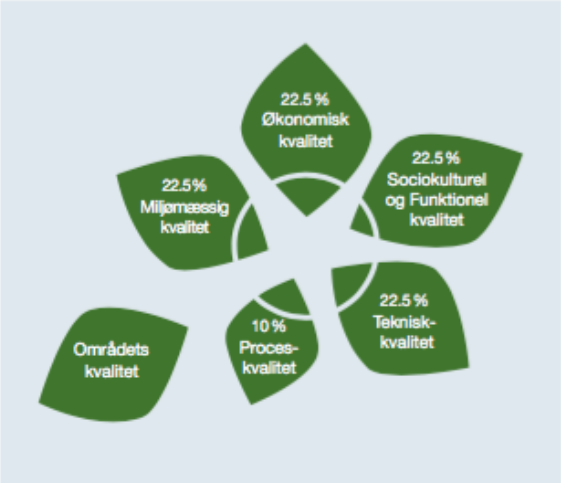
Hvordan tror du denne fordeling vil ændre sig fremover?
Andelen af bæredygtige bygninger vil helt sikkert stige i fremtiden. Endnu mere hvis projektet om at certificere eksisterende bygninger.

Burde vi i DK have lovpligtig certificering af nybyggeri eks. DGNB?
Er måske på vej derhen af, men dog ikke helt. Måske dele af DGNB systemet vil blive brugt i eksempelvis bygningsreglementet.

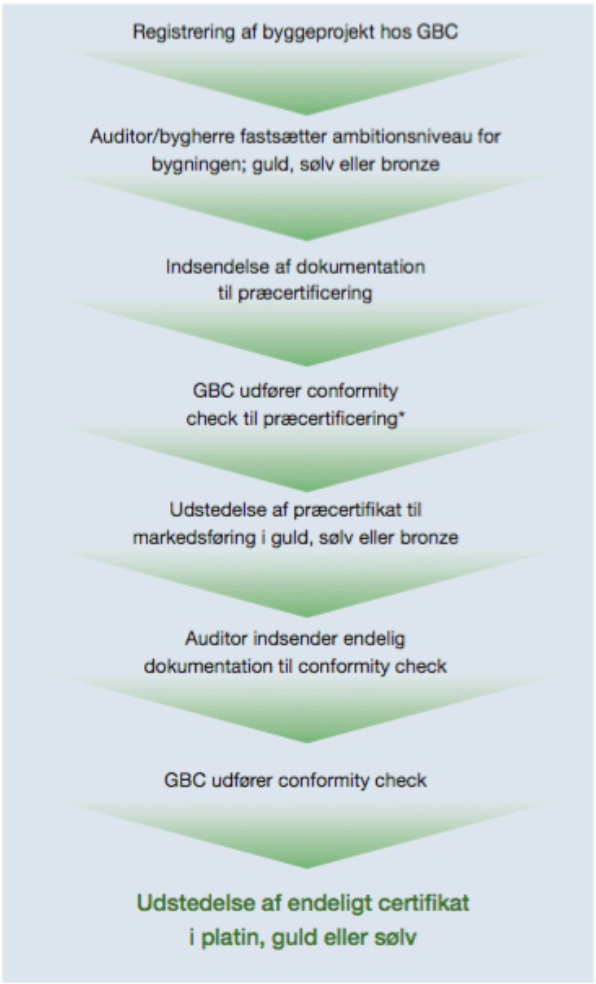
Hvordan tror du fremtiden ser ud indenfor byggeindustrien ift. Bæredygtigt byggeri?
Bevæger sig helt sikkert i en mere bæredygtig retning. Det kræver at aktører i industrien tager initiativ til at gå i en mere bæredygtig retning hvilket allerede er ved at ske.

Appendix 5 – DGNB Guide

Vægtning af kriterier i DGNB



Vejen til certificering



Evalueringskriterier

DGNB evalueringsmatricen

Temaområde	Kriteriegruppe	Nr.	Kriterium	Vægtning	Gruppe vægtning	Performance index samlet score
Miljø	Livscyklus vurdering (LCA)	ENV1.1	Livscyklusvurdering (LCA) - Miljøpåvirkninger	7	22,5%	100,0%
	Globalt og lokalt miljø	ENV1.2	Miljøricisi relateret til byggevarer	3		
		ENV1.3	Miljøvenlig indvinding af materialer	1		
	Ressourceforrug og affald	ENV2.1	Livscyklusvurdering (LCA) - Primærenergi	5		
		ENV2.2	Drikkevandsforbrug og spildevandsudledning	2		
		ENV2.3	Effektiv arealanvendelse	2		
Økonomi	Totaløkonomi	ECO1.1	Bygningsrelaterede levetidsomkostninger	3	22,5%	
	Økonomisk fremtidssikring	ECO2.1	Fleksibilitet og tilpasningsevne	3		
		ECO2.2	Robusthed	1		
Social	Sundhed, komfort og brugertilfredshed	SOC1.1	Termisk komfort	5	22,5%	
		SOC1.2	Indendørs luftkvalitet	3		
		SOC1.3	Akustisk komfort	3		
		SOC1.4	Visuel komfort	3		
		SOC1.5	Brugernes muligheder for styring af indeklimaet	2		
		SOC1.6	Kvalitet af udedørs friarealer	2		
		SOC1.7	Tryghed og sikkerhed	1		
	Funktionalitet	SOC2.1	Tilgængelighed	2		
		SOC2.2	Offentlig adgang	1		
		SOC2.3	Forhold for cyklister	1		
	Æstetik	SOC3.1	Tiltag til at sikre arkitektonisk kvalitet	3		
		SOC3.2	Bygningsintegreret kunst	1		
	Plandisponering	SOC3.3	Plandisponering	1		
Teknisk	Teknisk udførelse	TEC1.1	Brandsikring	2	22,5%	
		TEC1.2	Lydforhold	2		
		TEC1.3	Klimaskærmens kvalitet	2		
		TEC1.4	De tekniske systemers tilpasningsevne	1		
		TEC1.5	Bygningens vedligehold og rengøringsvenlighed	2		
		TEC1.6	Egnethed med henblik på nedtagning og genanvendelse	2		
Proces	Planlægning	PRO1.1	Kvalitet i forberedelsen af projektet	3	10,0%	
		PRO1.2	Integreret design proces	3		
		PRO1.3	Vurdering og optimering af kompleksitet i planlægningen	3		
		PRO1.4	Sikring af bæredygtighedsaspekter i forbindelse med udbudsmateriale og ordretildeling	2		
		PRO1.5	Vejledning om vedligehold og brug af bygningen	2		
	Udførelse	PRO2.1	Byggeplads/Byggeproces	2		
		PRO2.2	Dokumentation af kvalitet i udførelsen	3		
		PRO2.3	Commissioning	3		
Område	Område	SITE1.1	Mikroområde	2	0,0%	
		SITE1.2	Områdets og kvarterets image og tilstand	2		
		SITE1.3	Trafikforbindelser	3		
		SITE1.4	Adgang til faciliteter i nærområdet	2		