AALBORG UNIVERSITET
STUDENTERRAPPORT

THE DGNB CERTIFICATION

AND ITS EFFECTS ON DESIGN PRACTICES FOR SUSTAINABILITY IN THE BUILDING INDUSTRY

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Dansk byggeri er på vej mod paradigmeskift, hvad angår bæredygtighed. Den nuværende mangfoldighed af forståelser, certificeringsordninger og standarder for bæredygtighed er ikke nødvendigvis positiv for udviklingen.

Formålet med dette studie er at evaluere DGNB-certificeringsordningens indflydelse på arbejdspraksisser indenfor bæredygtig projektering. DGNBs muligheder for samarbejde og innovation på byggesager blev vurderet gennem et casestudie gennemført i arkitektsfirmaet Arkinord A/S.

Analysen viser, at DGNB bevidstgør arkitekternes beslutningsprocesser for bæredygtigt design, forbedrer samarbejdet mellem alle aktører og er en god forudsætning for tværfaglig innovation.

CONTENTS

FOREWORD

This report has been prepared as final thesis within the Master programme *Management and Informatics in Construction (Cand. Tech. Ledelse og Informatik i Byggeriet)* at Aalborg University, Copenhagen. The period for the thesis has been 1st of September 2015 to 6th of January 2016.

The report presents a study of the DGNB certification system in Denmark, which has been performed in collaboration with the architectural firm Arkinord A/S. The purpose of the study has been to investigate how DGNB has affected the design practices of architects and constructors in the firm.

In the hope of strengthening the building industry's focus on sustainable development, I have myself through this study learned how challenging such a transition may in reality be.

I would like to express thanks to Jakob Dahl and Arkinord A/S for their hospitality and openness. Special thanks go to my supervisor Marianne Forman for the generous support in guiding the investigation process and writing of the thesis.

1. INTRODUCTION

The aim of this introduction chapter is to make the reader familiar with the general area of interest of this study and lead them through from the general topic to the more specific problem that will be investigated. In the process of that, general details on the topic are given. That includes key concepts and known facts about the topic. Findings and discussions from previous research are also presented to explain why the topic is important and what aspects need to be studied further. Lastly, the problem is presented, as well as focus, purpose of the study and research questions which guide the analysis.

1.1. THE CONCEPT OF SUSTAINABILITY

Sustainability can be explained as taking good care of the environment so that it is capable to meet our needs for resources, as well as those of the coming generations. This understanding of sustainability became widely known in 1987 through the definition of sustainable development, presented by UN's World Commission on Environment and Development in the famous Brundtland Report.

The survival and progress of humanity is absolutely dependent on resources and this presupposes that we all the time clearly realize our role as keepers of nature and look after it in a regular manner. The regular maintenance of the soil, or agriculture, is, for example, the reason for the growth of the first human civilizations, as well as an overall population growth. Unfortunately, we tend to neglect our duties to the environment from time to time. The most recent example in the history of mankind is the 18-19th-century industrial revolution and the unreasonably large exploitation of resources as a consequence. The following energy crises and environmental problems such as climate change have made us once again aware on the importance of sustainability.

It is nowadays crucial to think of the sustainability of construction practices, because the building industry is officially confirmed as one of the most resource-consuming. According to a study of the European Union from 2011, the building industry is responsible for 42% of the total energy consumption in Europe, 35% of its emissions of greenhouse gases and more than 50% of the exploited materials (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013, s. 29). On the bright side, research from *The Intergovernmental Panel on Climate Change* (IPCC) has shown that the building sector is one of the industries with largest promises for reduction of energy consumption and pollution (Berardi, 2012, p. 411).

1.2. STATE OF THE ART OF SUSTAINABILITY IN CONSTRUCTION

What is needed to achieve sustainable development in as a whole, including the building sector, is, according to Volenbroek, the combined and balanced

utilization of technologies, innovation and political strategies (Ortiz, Castells, & Sonnemann, 2009, p. 29). Moreover, designing and constructing buildings with respect to the environment must become an established and regular practice. How can this be achieved?

A concrete definition of sustainability seems to be the first step towards any efforts and any effective measurement of the performance of buildings.

The three aspects of sustainability, known from *The Brundtland Report* from 1897, have been adapted to answer the question of what sustainability is in the field of construction, in the European standard CEN / TC350 Sustainability of construction works. The International Organisation for Standardisation has likewise been specifying methods and requirements for assessing the environmental performance of buildings in, for example, ISO/TS 21929-1:200 and ISO/TS 21931-1:2006.

Nevertheless, *Bygningsreglementet* (BR) does not explicitly mention or cover sustainability. This is illustrated by a survey conducted by SBi in 2013 for the Danish Energy Agency (*Energistyrelsen*). What is more, BR does not provide a holistic design approach to sustainability (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013, p. 73). It is namely not guaranteed that efforts towards achieving good results in one of the areas of sustainability would not affect negatively the efforts in another area. At present, the introduction of a new voluntary sustainability class in BR in order to set a clear definition of sustainability in construction is being discussed.

Building rating tools and certifications have emerged as instruments for measuring building performance in a more holistic way. Building certification systems are a phenomenon in construction and have undeniably raised the awareness on sustainability and sustainable building (Berardi, 2012, p. 412). Nevertheless, there diversity is present here as well, as a result of the ambiguity of the definition of sustainability in construction. There is today a great variety of design principles and assessment tools for sustainable building design. A British research has, for example, counted 382 building software tools for energy efficient building or sustainable design, as registered of 2010 (Nguyen & Altan, 2011, p. 376). Obviously, one of the main obstacles to measuring building performance in a single undisputed way is that stakeholders in the construction industry have their own interests and impose different demands on how the building should perform (Haapio & Viitaniemi, 2008, p. 469). Another obstacle is the fact that buildings are mostly constructed uniquely after a client’s request, using not raw materials but products and technologies, produced likewise in elaborate processes (Berardi, 2012, p. 413).

Some of the tools have been specially designed to evaluate the whole building performance and others only building components and materials. For instance, in Denmark there has been a lot of talk around Environmental Product Declarations (EPD), Cradle to Cradle (C2C) and FSC wood (Forest Stewardship Council). Second, building assessment tools vary on the criteria included and the scope of the buildings' life-cycle, as well as the building types and age. Third, certification systems have been developed and used as common practical tools on national and international level (Haapio & Viitaniemi, 2008, p. 470) – BREEAM, LEED, DGNB, Passive house, AktivHus. On a smaller scale, organisations have for own purposes developed initiatives, design principles, methodologies and process manuals for sustainable construction. Among the most popularly discussed are recycling of building materials, solar energy, passive solar design, life-cycle costing and circular economy, life-cycle assessment of environmental impact, integrated energy design, zero-carbon building design. Finally, building assessment and certifications have been specially developed to correspond to the knowledge and competences of specific user groups such as architects, engineers and constructors (AEC professionals) or building surveyors.

1.3. PROBLEM FORMULATION

In Denmark, several building certification systems are presently known and simultaneously used. DGNB is among them and it is the only one, which is on the way of being recognised as a national standard.

The rather large number and different character of certification systems creates some problems. There is a lack of agreement on how to measure sustainability of buildings. Being unable to do measure sustainability in a single commonly accepted way makes the existing certification systems pointless. Because, as Haapio and Viitaniemi ask, what is the use of building certificates and scores if they cannot be compared? (Haapio & Viitaniemi, 2008, p. 478).

SIGNIFICANCE OF THE PROBLEM

Assuming again that the diversity of tools and systems is caused by the many interests of actors, it would be relevant to identify the largest user group and concentrate on making their definition of sustainability more synchronised. Haapio and Viitaniemi state that this is the group of AEC professionals (Haapio & Viitaniemi, 2008, p. 475).

Therefore, as a way of making current rating and certification systems more universal, questions such as how AEC professionals understand sustainability and how well existing certification systems act as planning tools and help them in their decision-making process need to be answered.

All things considered, it will be important to reveal this aspect of the topic – the influence of building certifications on design practices of AEC professionals, their opinions and knowledge. An investigation of a building certification system as a social technology would provide an insight into its innovative capacity. This would be beneficial to policy makers, interested in how to better take advantage of certification systems for advancing sustainability in construction.

KNOWLEDGE GAP

The opinions of architects, engineers and constructors on the methods and knowledge involved in working with building certifications have been paid relatively little attention. In her article ***The effect of BREEAM on clients and construction professionals***, L. Schweber signals for this knowledge gap in modern research on the topic of building assessment tools (Schweber, 2013, p. 129). She notes that most studies have either discussed the structure and contents of the tools, as criteria and weighing factors, etc., or examined the performance of assessed completed buildings. In comparison, little research has been done to provide insight into what impact building certification systems have on the traditional design processes of AEC professionals. In this way, few researchers have considered building certifications as *social technologie*s, and studied the social side, like Schweber does (Schweber, 2013, p. 129).

Additionally, there are many studies in literature on sustainability in construction and building assessment tools proving that certification systems contribute to the diffusion of sustainability in the industry (Berardi, 2012, p. 412). Yet, few of them have looked from the angle of the effects of building certifications on the processes of collaboration, innovation and creativity.

PROBLEM STATEMENT

The purpose of this study is to investigate the following problem:

> ***How does the DGNB certification system affect practices for sustainable building design in Denmark?***

In other words, the problem is how DGNB influences designers in the building industry, who work with sustainable building design.

RESEARCH QUESTIONS

In order to explore the ways in which DGNB influences design practices and to answer the study's main question, the following set of research questions is developed:

- How does DGNB’s concept of sustainability, as defined in its system criteria, match architects and constructors’ existing practices and understandings of sustainable building design?
- What kind of influence does DGNB have on teamwork and collaboration within a building project?
- How does DGNB support innovation for sustainability in the Danish building sector?

In this way, the factors, which are in this study selected to indicate how DGNB influences design practices, are DGNB’s potential as a design/planning method (1), DGNB’s role for collaboration (2) and for sustainable innovation (3).

Some of the questions are answered using information from a case, while some are answered only through the data from literature, articles and seminars.

PROBLEM DELIMITATION

The problem is perceived, because DGNB is currently becoming more and more popular, also among building owners who begin to request DGNB certificates.

Generally speaking, the problem is relevant for consultants in Denmark such as architects, engineers, constructors, etc. Nevertheless, the study focuses solely on the design practices of architects and constructors.

Architects and constructors, who work on building projects where DGNB certification has been demanded by the client, are therefore placed in the foreground.

The problem’s focus is the architects and constructors’ knowledge, workflow and challenges, which they have faced in their everyday practice, while working with the DGNB certification. The level of analysis of the problem is individual, which means that in the analysis the main interest is the experience of persons in the organisation.

The rest of the actors and objects that may participate in the certification process: authorised DGNB-consultants, Green Building Council Denmark, policy makers on national and regional level and legislation such as the Building Regulations – are placed in the background of the problem and are of less interest in the study.

2. METHODS AND EMPIRICAL MATERIAL

This chapter presents the methods used for collection and analysis of the empirical material. Moreover, the chapter explains what kind of study is used. The chapter also reflects on methods for verifying the quality of the study.

2.1. DESIGN OF THE STUDY

The problem is investigated as *qualitative research*. Qualitative research, as opposed to quantitative research, is interested in the experiences and views of the persons, involved in a given event. The event or phenomenon under investigation is the DGNB certification in Denmark, and the participants are architects and constructors. This study looks at their personal experience and reflections on the certification process.

The study's main research method is case study. This is because the problem has been expressed with a how-question; there is no control on the phenomenon under investigation and in the centre of the study is a contemporary phenomenon (Yin, 2014, p. 2).

The study's design has been middle to fixed, because although the problem and the research questions have been determined almost entirely from the start, the collection of empirical material has been rather flexible.

2.2. CASE

The unit of analysis or the *case* in this study is a constructor's work with DGNB in a middle-sized architectural firm from North Jutland, Denmark – Arkinord A/S.

Arkinord is a medium-sized architectural firm from Northern Jutland based in offices in Aalborg and Frederikshavn. Most members of the team are professionally qualified as architects and few of them are constructors. Arkinord offers architectural design, client consultancy, project and construction management and technical supervision on site. Their portfolio includes projects within residential, commercial, public and cultural buildings and also assignments within interior and urban design.

The firm was selected as a case, after reading in the press that Region North Jutland has since 2009 been intensively building with DGNB and that Arkinord has participated in a number of these projects.

2.3. SAMPLING METHODS

Sampling methods were employed in the selection of materials to be reviewed, of people to be interviewed and of events and sites to be observed.

In the start, sampling for a case concentrated on looking for architect and engineering firms who have completed DGNB projects. Information on such firms was fetched from GBC-DK.

Several companies were contacted in the process of looking for suitable interview persons. The criteria for selecting an interview person have been that:

- the person has directly experienced working with the DGNB certification in the design phases of a building project
- the person is neither a qualified DGNB-assessor nor has undergone any training in DGNB

Finally, an interview was held with Jakob Dahl (JD), a constructor from Arkinord, who in 2012 functioned as project manager (*projekteringsleder*) in the building project Hospital Pandrup.

Sampling for documentation was done parallel to the investigation process and was in the beginning based on the research questions. Later on the principle of *theoretical sampling* was also used. This means that some of the articles and other documentation was selected and collected according to what was revealed from the already completed interview and what remained unknown.

2.4. EMPIRICAL MATERIAL

The empirical evidence was collected from several sources and sites, which are described below.

LITERATURE REVIEW

The problem was identified on the basis of a literature review. Existing international literature on the topic of building certifications and their significance for sustainable development in construction was studied. In the exploration of scientific articles, the search words 'sustainability', 'building', 'assessment', 'certification' were used in different combinations.

The literature review helped making a general observation of current problems within the topic. That led to identifying and formulating the problem early on. Research questions were formulated under way, and later the problem was refined again.

ARTICLES IN PRESS

Articles from the press release were reviewed in order to collect background information on the status of DGNB in Denmark, on completed building projects and on opinions of professionals and the authorities on the future development of the certification system. Articles were sought from Danish newspapers and journals for AEC professionals – *Arkitekten*, *Ingeniøren*, *Konstruktøren*,

BYGGERI + Arkitektur, *Dagens Byggeri* and similar. Here, the search was done with a single search word 'DGNB' and included articles from the past 5 years.

The search led also to finding Arkinord as a case for the study. Since many articles were found on Hospital Pandrup and Region Nordjylland, the articles were also used to supplement empirical material from the interview. In this sense, the found articles as both secondary and tertiary documents, because some of the older articles described the building case in Pandrup during design phases, and others – the case as completed.

INTERVIEW

The interview was carried out as semi-structured *qualitative interview*.

The questions were prepared in advance and sent to the interview person before the interview. This allowed for the interview person to recall information from the project, which, from the point of the interview, was completed 3 years ago.

Interview questions were formulated according to principles from S. Kvale and aiming to motivate the interview person to give a description of own experience and to further clarify relevant statements. For instance, *'Could you give an example of…?'* and *'Could you tell more about…?'* During the interview, the prepared questions were followed to guide to the conversation, but space for improvisation was also made available. It was attempted to keep the conversation neutral from the interviewer's own opinions.

SEMINARS AND CONFERENCES

A participation in the trade fair for sustainable construction *Building Green 2015* in Copenhagen gave a good overview of the discourse on sustainable development in the Danish building sector. Current issues and visions were presented on seminars and conferences held by a variety of actors and interested organisations. The fair's exhibition presented new technologies and products for sustainable and energy efficient building. There was a strong presence from GBC-DK and DGNB was a topic on many of the seminars. Information was collected in the form of notes from the talks. It served as background information for the case and was also used in the end to put the study's results into context.

2.5. QUALITY OF THE STUDY

The triangulation of data sources has ensured the credibility of the study. There has been furthermore a triangulation of multiple theories. The credibility of the study was also achieved through the qualitative interview which ensured a good level of engagement in the person's experience of events. The search of articles in the press helped reaching saturation of the empirical data.

In the work with documents, their authenticity, credibility and representativeness were considered (Brinkmann & Tanggaard, 2010, p. 147). That included investigation of the document’s origin and author, supposedly bias and the character of the representation – a phenomenon, an abnormality or new outlook on a discourse.

In the analysis, the detailed description of the case in the analysis has improved the chances for generalisation for the case results. The pre-defined criteria for selection of an interview person may also help regarding the case as more general.

3. THEORETICAL FRAMEWORK

This chapter presents the theories which were found to be important and relevant for the study of the problem. The chapter explains the concepts of boundary objects, translation processes and information infrastructures. This theoretical framework is later in next chapter used to analyse the empirical data.

3.1. CHOICE OF THEORY

The problem of the study, as well as the research questions, was decisive for the choice of theory. It is sought that the theory can shed light on innovation and collaboration in building projects, and can reveal what role a building certification process play for that. For the analysis of collaboration, the theory on translation and boundary objects was selected. For innovation, Callon's perspective on boundary objects and knowledge boundaries was added. The concept of information infrastructures was included to examine the level of structure of the new or altered design practices, brought about by DGNB.

Boundary object is a theoretical concept from sociology and science and technology studies (STS). Boundary objects have been specially developed to study the interactions of people with various knowledge backgrounds, coming from various social worlds (Strauss) and working in a common environment. In order to improve collaboration between them, boundary objects translate knowledge and thus help communication. That is a strong argument for why the theory on boundary objects would be suitable for studying a building case. Building projects often put together teams of building professionals who are highly specialised within a knowledge discipline. The successful handing over of the project depends in this way on the collaboration and communication between these professionals.

Translation of knowledge and meaning is another relevant sociological concept known from actor-network theory. The concept was developed by M. Callon in 1986 to note the process of successfully uniting the meanings, which people with different backgrounds have on a single object, into one shared meaning. Translation would therefore be a useful for understanding the process of collaboration and communication in a building project.

Information infrastructure is a third concept from the field of information systems, also related to boundary objects. The concept has been essential for understanding computer systems in organisations, especially with the rise of the Internet. The information infrastructure organises information and the way information is shared between organisations. The infrastructure is constructed of boundary objects, linked to each other. The concept of information

infrastructures can be helpful for understanding how new work practices get established with more structure and standardisation.

Organisational identity is the self-image which members of the organisation shape constantly about themselves and the organisation. It is also influenced by the way the organisation interacts with other organisations, and thus by boundary objects, as well (Gal, Lyytinen, & Yoo, 2008, p. 291). Identity can be for example seen in how a construction company relates to its building clients, to partners, and to other organisations; it is expressed in what they do and what role they play.

Altogether, these theories give an understanding of how work practices of an organisation can be structured and organised to support communication, collaboration and innovation internally and with other organisations.

3.2. BOUNDARY OBJECTS

Boundary object is a concept within the theoretical field of sociology developed by S. Star and J. Griesemer. It is one of the most popular theories on relations between objects and work practices (Whyte & Lobo, 2010, p. 557).

In 1989 Star and Griesemer publish their first article on boundary objects, ***Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39***. In the article the authors present a sociological research on a case - the establishment of a zoology museum at the University of California, Berkley, back in the beginning of the 20th century. The case shows that the founder of the museum, J. Grinnell used standardised methods and tools in his aim to establish the museum. Star and Griesemer conceptualise these tools as *boundary objects.*

HETEROGENITY OF WORK

In the case of Star and Griesemer's article, the need for special methods arose from the fact, that several kinds of actors were involved in the collective effort of founding the museum. Professional scientists, university administration staff, amateur-biologist collectors and wild-animal trappers. The work was of heterogeneous character, as each of these actors had their own knowledge, competences, resources, tasks and working style.

In the article, Star and Griesemer identify the problem of communication and collaboration between actors from so many and so different social worlds:

'*The heterogeneous character of scientific work and its requirement for cooperation'* (Star & Griesemer, 1989, p. 392).

The authors also acknowledge an additional problem in the case, of how a certain new object may have a different meaning in the different social worlds.

The animal specimens found by the trappers, conserved and classified by the amateur collectors were of different meaning to these two types of actors. The meanings needed to be negotiated, if trappers and collectors were to collaborate on establishing the museum. For the university staff the meaning of the specimen was: a collected data which needed to be archived. For the professional scientists the specimen meant objects of scientific research. As a result, specimens are objects with different meanings - each actor of the different social worlds understands them through the perspective of their own needs, interests and goals.

Star and Griesemer demonstrate that the different meanings of specimens were translated between the social worlds with the use of a boundary object. The role of a boundary object in this instance was played through the species:

'This [species] *is a concept which in fact described no specimen, which incorporated both concrete and theoretical data and which served as a means of communicating across both worlds'* (Star & Griesemer, 1989, p. 410).

Species is more general than specimen, but a species is still not so general that it cannot distinguish between sorts of specimen. In this way, species became a useful category for both animal trappers and collectors when they had to agree on the kind of animal that should be caught.

TYPES OF BOUNDARY OBJECTS

Star and Griesemer regarded the species as an example of one of the four types of boundary objects – an *ideal type*, among also *repositories*, *coincident boundaries* and *standardised forms*.

Ideal type. An ideal type is:

'an object such as a diagram, atlas or other description which in fact does not accurately describe the details of any one locality or thing' (Star & Griesemer, 1989, p. 410).

It is something which is abstract enough to accommodate in itself several concrete and local examples. The examples may resemble and at the same time slightly differ from each other, but the ideal type unites them together including their differences. Ideal type is useful when working in the field with actors from other backgrounds, because a common understanding on the goal of the work can be reached.

Repository. The museum, which the actors in alliance were trying to found, is regarded by the authors as another type of a boundary object: a repository. Repository is like a library or like a pool of objects, where the objects are stored in a standardised order, such as index. The repository is available for use to

multiple actors, who can extract the information they need directly from the repository, instead of communicating with other actors:

'People from different worlds can use or borrow from the 'pile' for their own purposes without having directly to negotiate differences in purpose' (Star & Griesemer, 1989, p. 410).

A repository is also, for example, the projektweb database in building projects, where architects, engineers, contractors and building owners all can access project data, generated by everyone, for the purposes of their specific needs and work tasks in the project.

Coincident boundaries (maps). In the process of collecting specimens for the museum's collection, the amateur biologist collectors and the professional biologists produced each different versions of the map of California, where the collecting took place. Both maps had the same boundaries, the boundaries of California, but their contents were different. The map of California is therefore an example of the third type boundary objects, called coincident boundaries. Coincident boundaries are:

'Common objects which have the same boundaries but different internal contents' (Star & Griesemer, 1989, p. 410).

Paul Carlile calls coincident boundaries *maps of boundaries*, because they show:

'the dependencies and boundaries that exist between different groups or functions at a more systemic level' (Carlile, 2002, p. 451)

For example, the different interpretations of the map of California by the amateur collectors and the biologists are caused by their different functions. The maps of the collectors showed the roads, campsites, trails and places to collect. The maps of the biologists marked abstract ecological concepts such as life zones. But, despite the differences, there was a connection between the maps. The collected specimens were seen in the context of the ecological life zones. Therefore, the general map of California visualised the differences and explained in what way they depend on each other.

Standardised form. In Star and Griesemer's study, the collectors were provided with specially designed checklists in order to keep record of information necessary later on for biologists to build up scientific theories and ecological concepts on. The checklists contained a list of the taxa which inhabited a given local area within California. These checklists were typified by Star and Griesemer as standardised forms, the last fourth type of boundary object. Standardised forms are shared indexes or lists of standardised information to look for. In this way, uncertainties about the found information can be resolved:

'the advantages of such objects are that local uncertainties (for instance, in the collecting of animal species) are deleted' (Star & Griesemer, 1989, p. 411).

THE CHARACTERISTICS OF BOUNDARY OBJECTS

To summarise, the definition of boundary objects according to Star and Griesemer is the following:

'an analytic concept of those scientific objects which both inhabit several intersecting social worlds [...]*and satisfy the informational requirements of each of them'* (Star & Griesemer, 1989, p. 393).

Boundary objects have a heterogeneous nature. They are contradictory on the inside and contain in themselves contrasting qualities. These qualities are necessary indicators for proving that an object qualifies as a boundary object.

Plastic & **robust.** One quality of boundary objects is *plasticity*, flexibility. That is demonstrated by boundary objects being able to adapt to the needs of a certain actor at a certain work location. But because of their heterogeneous nature, boundary objects have also *robustness*, in other words, they are as inflexible as much as flexible. Boundary objects are robust, because they remain generally the same, even when they adapt to local conditions. Star and Griesemer compare boundary objects to marginal people, who live in more than one social world. In a similar way, boundary objects function in more than one professional world. However, unlike marginal people who have to shift identities in the different worlds in order to function properly, boundary objects do not need to do that due to their plasticity and robustness. They keep *'a common identity across sites'* (Star & Griesemer, 1989, p. 393).

Strongly & **weakly structured**. Another pair of contrasting qualities of boundary objects is the level of *structuring*. For instance, when used by several groups of actors at the same time, boundary objects are weakly structured. When someone works with them individually or when used at a single work location, boundary objects have a more structured character.

Abstract & **concrete**. Finally, boundary objects are both *abstract* and *concrete*. They become concrete in local and individual use, and more abstract in the interaction between many actors.

3.3. TRANSLATION

Translation is a process where people translate to each other the knowledge they have according from their backgrounds. This is a process of communication and collaboration.

Callon suggested in his article ***Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay*** that translation takes place in four stages:

'*Problematization'*, *'the devices of 'interessement' or how the allies are locked into place'*, *'how to define and coordinate the roles: enrolment'* and *'the mobilisation of allies'* (Callon, 1986).

INTERESSEMENT

Star and Griesemer build the theory of boundary objects upon the theoretical model of *interessement* developed by Latour, Callon and Law (Star & Griesemer, 1989, p. 390).

Interessement is Callon's term for the second stage of the four stages in the process of translation. Interessement is the stage when actors negotiate to bring their own interests closer together in the common goal of forming an alliance or network.

Boundary objects play a significant role in interessement, as Star and Griesemer argue that boundary objects are a successful tool for meeting the *'potentially conflicting sets of concerns'* of different actors (Star & Griesemer, 1989, p. 413) .

OBLIGATORY PASSAGE POINTS

The interessement model of Latour, Callon and Law illustrates the different actors and how they ally with each other by passing through an *obligatory passage point (OPP)*. Obligatory passage point is a solution, a method or technology, which both parties agree to use, or 'go through'. By using the OPP, actors can work together effectively and the network gets in this way stronger. Star and Griesemer make a modification on the model by adding more than one OPP and stating, that alliances can be formed between multiple kinds of actors. In Latour, Callon and Law's model (Figure 1) the professional, such as a manager, plays a central role and is the only one to form alliances with the amateurs. In Star and Griesemer's version of the model (Figure 2) alliances can be formed not only between the professional and the amateurs, but for example also between professional and a professional or between amateurs themselves. There are several OPPs to illustrate these new opportunities.

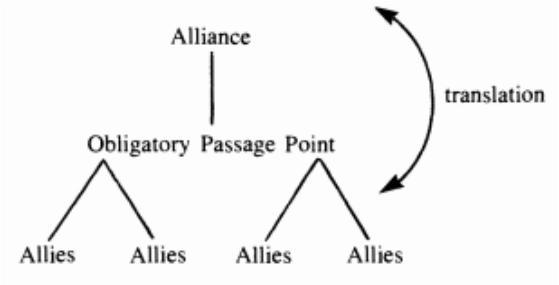

Figure 1 Interessement model as conceptualized by Latour, Callon and Law (Star & Griesemer, 1989, p. 390)

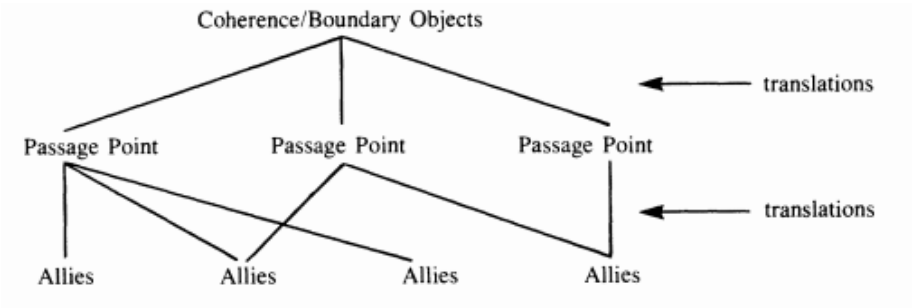

Figure 2 Interessement model of Star and Griesemer (Star & Griesemer, 1989, p. 390)

An OPP established by a certain actor could get unstable or even destroyed if parallel processes of translation by the other actors get in the way. Therefore, once established, the OPP must also be protected by the actors:

'Once the process has established an obligatory point of passage, the job then becomes to defend it against other translations threatening to displace it' (Star & Griesemer, 1989, p. 391).

3.4. BOUNDARY OBJECTS AND INNOVATION

In the article ***A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development***, P. Carlile expands the theory on boundary objects, as well as the view on management of knowledge in organisations. Here, he studies the problem of new product development, and why and how knowledge may be either a barrier to or prerequisite for innovation.

Carlile further develops the idea of translation. He demonstrates that for innovation to take place across multiple practices, it is not sufficient to translate knowledge, but also to *transform* it.

TRANSFER, TRANSLATION AND TRANSFORMATION OF KNOWLEDGE

Carlile calls the problems, people in organisations face when dealing with knowledge, *knowledge boundaries*. He identifies three knowledge boundaries and respectively three approaches to deal with them.

The *syntactic knowledge boundary* addresses the issue of communication and information processing (Carlile, 2002, p. 443). At this very basic level, knowledge is represented and information is exchanged, according to Carlile. The *syntactic approach* to dealing with this is a shared syntax or language which can ensure *'a quality information exchange'* (Carlile, 2002, p. 443). Carlile claims that the boundary objects which best fulfil the need of a shared syntax and can best represent knowledge, are repositories (Figure 3). They are practically databases for storage of information.

Types of Knowledge Boundary	Categories of Boundary Objects	Characteristics of Boundary Objects
Syntactic	Repositories	Representing
Semantic	Standardized Forms and Methods	Representing and Learning
Pragmatic	Objects, Models, and Maps	Representing, Learning, and Transforming

Figure 3 Carlile's division of the types of boundary objects according to their functions at the three knowledge boundaries. 'Type of Knowledge Boundary, Category, and Characteristics of Boundary Objects' (Carlile, 2002, p. 453)

At the *semantic knowledge boundary*, the problem is to understand the already represented knowledge, because people may still have different interpretations of it. The *semantic approach* seeks to learn about these differences in interpretations (Carlile, 2002, p. 444). Standardised forms are, in Carlile's opinion, especially suitable for this, because they describe concerns about problems (Carlile, 2002, p. 452). For example, checklists are often a collection of someone's experiences in a particular area.

Lastly, Carlile identifies *the pragmatic knowledge boundary*, which acknowledges the problem that differences are also dependent on each other (Carlile, 2002, p. 445). For example, Carlile points out that often in organisations the different functions are interconnected, but knowledge they possess is not the same (Carlile, 2002, p. 442). That is true also in any situation, where people from different backgrounds work together to reach a common goal. The problem arises from the fact that knowledge is *localised, embedded* and *invested in practice*. It means that knowledge, gained in a

certain work practice, can with great difficulty find application in another practice (Carlile, 2002, p. 442).

The *pragmatic approach* is to transform existing knowledge into new one. After having translated different meanings and knowledge, people realize that the differences must be solved and their existing knowledge will not be enough. The existing knowledge must be changed and people must collectively create new knowledge (Carlile, 2002, p. 445). Carlile states that objects, models and maps with coincident boundaries are the only types of boundary objects, capable of transforming knowledge. They are also the most complex and expensive to create (Carlile, 2002, p. 452). Since transformation of knowledge leads to innovation, it turns out that objects, models and coincident boundaries are the boundary objects, necessary for innovation.

In conclusion, Carlile argues, that boundary objects form together a *boundary infrastructure*, which is used by people to transfer, translate and transform knowledge (Carlile, 2002, p. 454). This is partly a reference to the concept of infrastructures, which is to be explained below.

3.5. INFRASTRUCTURES

S. Star goes in her research further on to study information infrastructures in her article from 1999, ***The Ethnography of Infrastructure***.

Infrastructures could be literally large physical systems, such as infrastructure for water supply, the railroad or for wheelchair access to a building. Infrastructures could also exist in organisations in the form of information systems. Anyway, Star emphasizes that infrastructures function when there is an organised practice of people:

'Infrastructure is a fundamentally relational concept, becoming real infrastructure in relation to organized practices' (Star, 1999, p. 380).

Star continues by giving nine characteristics of infrastructure. The characteristics make up the definition of an infrastructure and show why potential problems with infrastructures may appear.

THE CHARACTERISTICS OF INFRASTRUCTURES

Infrastructures are, first of all, *embedded*, built-in. They can be embedded into other systems, technologies or social practices. This embeddedness makes them sometimes hard to distinguish. For example, people do not think of the fact that sometimes a computer system is made up of several programs and software components (Star, 1999, p. 381).

Infrastructures are *transparent*. This means that they involve easy, familiar routine tasks usually every time. If someone is new to using the infrastructure, it becomes then less transparent.

Infrastructures have a temporal and/or spatial *scope, reach*. They last over time or/and spread within space. Infrastructures usually continue to exist after a single event has finished (temporal). Infrastructures also support practices carried out in more than one location (spatial).

Infrastructures are *learned as a part of membership*. Star states that infrastructures are something familiar and could be taken for granted only when the person is a regular participant in a common practice. Newcomers have often difficulties in using the infrastructure. It is something new and strange and less transparent to them. But if they participate long enough, they are able to learn it.

Infrastructures tend to *link with conventions of practice*. This means that infrastructure obey general rules in the community such as for example the day-night cycle, working-day hours. Or, they incorporate the community's widespread practices. For example, because the majority of people knew the QWERTY keyboard, most computers today have this keyboard, in spite of its limitations (Star, 1999, p. 381).

Infrastructures *embody standards*. The infrastructure incorporates some of the standards – i.e. terms, labels, standard software, and standard ways of structuring – which are accepted in the organisation/the community.

Infrastructures are *built on an installed base*. Infrastructures almost always start by building upon something that existed there in advance:

'Optical fibers run along old railroad lines' (Star, 1999, p. 382).

The installed base provides in this way support to the infrastructure for development. The installed base can also impose limitations on the infrastructure grow. For example, some old components may stay on the way of integrating some new.

Infrastructures become *visible upon breakdown*. This is according to their quality of being transparent – invisible, in times when they function well. In case of a breakdown in the infrastructure such as a server breakdown or power blackout, people begin taking notice of it.

Finally, infrastructures are *fixed in modular increments, not all at once or globally*. In the same way as pipes in the water supply system are replaced in sections/modules from time to time. This is due to the large size and complexity of infrastructures. A change in one module of the infrastructure needs to be synchronised with the other parts of the infrastructure. Replacement and

maintenance of the infrastructure's components takes therefore a lot of time. And no one is responsible for the maintenance of the infrastructure. It is usually maintained during work, on the go, during use.

INFRASTRUCTURE DEVELOPMENT

Star states that practice, culture and norm are incorporated deeply into the infrastructure design. As already mentioned above, it is a main characteristic of infrastructures to contain various standards and classifications. Change in the infrastructure may thus require negotiations on users' values and interests, which are usually reflected in those standards (Gal, Lyytinen, & Yoo, 2008, p. 291).

What resources would be needed for change to take place? Star argues that while some of these aspects of infrastructures may be changed rather quickly with a certain amount of resources: knowledge, time, funds, others require resources and efforts in the form of a social or political movement. She gives the example of the change in the application form of the U.S: Census bureau, responsible for counting US residents and registering their nationality and income. The wish was to include more than one racial category in the application form. In order to propagate for this change, a series of expensive political campaigns had to be held for several years (Star, 1999, p. 389).

Whyte and Lobo, whose research is reviewed later in section 3.6 in more details, find in a similar way that digital infrastructures for project delivery in building projects can hardly be developed in a single project. Efforts need to span through a series of projects (Whyte & Lobo, 2010, p. 565). The development of the infrastructure would require feedback from old projects on problems to be fixed, as well as design of new work practices for information sharing.

3.6. BOUNDARY OBJECTS AND ORGANISATIONAL CHANGE

Since its development by Star and Griesemer, the concept of boundary objects has found practice in research on knowledge management.

In the article ***The dynamics of IT boundary objects, information infrastructures, and organisational identities: the introduction of 3D modelling technologies into the architecture, engineering, and construction industry*** from 2008 U. Gal, K. Lyytinen and Y. Yoo discuss the idea that boundary objects:

'help bridge cognitive and practical differences between [multiple organisations] *to facilitate common understandings'* (Gal, Lyytinen, & Yoo, 2008, p. 291).

The article makes a contribution to theories on organisational change, by suggesting that boundary objects play a role in it. The article focuses on the

interrelations between boundary objects, infrastructures and organisational identities. The authors propose a model, showing that boundary objects influence information infrastructures and organisational identities, and neighbouring organisations, as well.

Gal, Lyytinen and Yoo use as a case for their study the shift in architectural and engineering CAD practices towards 3D technologies. They assume that 2D drawings, which have previously served as boundary objects, are now being replaced by 3D modelling. Building on Star's concept for information infrastructures, the authors create the following definition:

'[...] we conceptualise information infrastructure as a system of standardised practices and modes of communication that emerge in relation to a particular set of IT artefacts within organisational boundaries' (Gal, Lyytinen, & Yoo, 2008, p. 291).

This definition reveals what the connection between information infrastructures and boundary objects is. Boundary objects are present at the organisational boundaries, where they are used as tools for communication.

Boundary objects are crucial for communication and interaction at the organisational boundary. Gal, Lyytinen and Yoo argue for this in the following way: they acknowledge Star's point that infrastructures become meaningful when used in organised practices and that membership in the organisation is necessary for someone who wants to learn to use the infrastructure. On the basis of this, the authors also claim that infrastructures can function in more than one community. As organisations interact with each other and do not have clear boundaries, similarly, their infrastructures can overlap. The level of overlapping of infrastructures is determined by what practices, discourses and artefacts the organisations have in common (Gal, Lyytinen, & Yoo, 2008, p. 292). Boundary objects are part of the information infrastructure in each organisation, which ensures that work practices take place in a structured way. They bear a specific meaning in each organisation. When two organisations interact with each other, they share boundary objects and subsequently the different meanings. (Gal, Lyytinen, & Yoo, 2008, p. 293).

How boundary objects, information infrastructures, organisational identities are all woven together, is shown in Gal, Lyytinen and Yoo's model below (Figure 4). To explain the model, the authors give as an example a contract which functions as a boundary object for two organisations. The contract dictates the roles, responsibilities and the way they interact. It also enables collaboration and new roles; therefore, the contract as a boundary object influences their organisational identities.

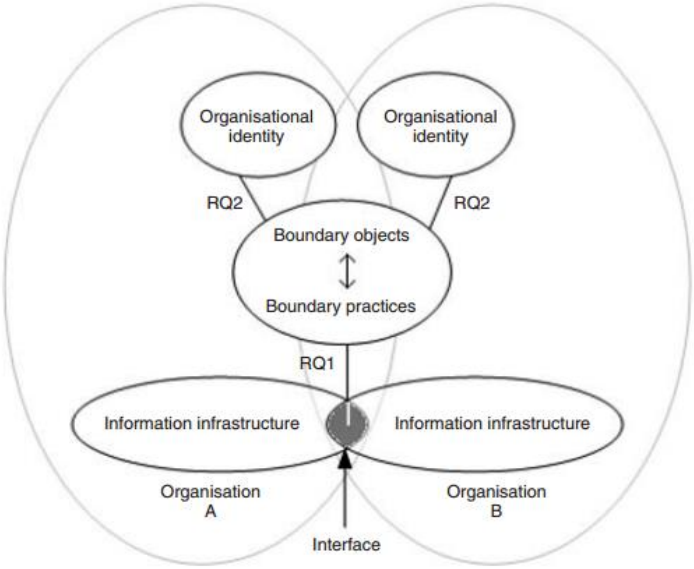

Figure 4 'Interrelationships of boundary objects, organisational identities, and information infrastructures' *(Gal, Lyytinen, & Yoo, 2008, p. 293)*

The two cases in the article are projects within the building industry. Both projects show that the 3D technologies, functioning as new boundary objects, which in the cases were shared by multiple construction companies, influenced the companies' boundary practices and identities. The effects can also spread in a broader context onto other companies in the industry.

On the basis of this finding, the authors point out a few potential implications. First, implementation of new boundary objects may be positive for the organisation's relations with other organisations, but it may cause a change in their own identity and internal practices. Second, an organisation may use boundary objects strategically to influence neighbouring organisations. Third, the authors give an answer to the question of resistance to change. Resistance to use of new boundary objects may be not only because new practices and competences are needed, but also because there may be a reluctance to change of the established identity (identity of members or of the organisation generally). Furthermore, because of the interconnectedness of organisations, resistance to change in one organisation may make the implementation of new boundary objects in another difficult (Gal, Lyytinen, & Yoo, 2008, p. 302).

4. ANALYSIS

This chapter presents an examination of the collected empirical evidence from articles and from the case. The analysis of the case employs the lens of the selected theories on boundary objects, knowledge boundaries and infrastructures.

4.1. DGNB IN DENMARK

The DGNB certification originates from the German certification for sustainable and green building. DGNB is in fact Germany's Green Building Council, called Sustainable Building Council instead (*Deutsche Gesellschaft für Nachhaltiges Bauen*) to emphasize a wider view on sustainability (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010, s. 29). DGNB developed the DGNB certification in 2007.

GREEN BUILDING COUNCIL

World GBC is the general association of more than 100 national GBCs in countries in the Americas, Europe, Asia and Africa. GBCs are the first international initiative on creating a single common assessment method for sustainability in construction globally (Ding, 2008, p. 457). In 1998, several national GBCs – the Australian, Canadian, Japanese, Spanish, Russian, United Arab Emirates', British and the American – began meeting, which led to the later establishment of World GBC in 2002. At present, it is the largest organisation for sustainable construction with over 27,000 firms and companies as members (WorldGBC).

World GBC is responsible for establishing new GBCs and for leading and supporting the existing ones. It designs strategies for how to strengthen GBCs positions in the local building industries and promote '*green*' building in the local building policies. The way World GBC accomplishes this has been through encouraging collaboration in the building sector, *'market intervention and education'* (WorldGBC, 2013). One of its initiatives that have helped influence the market without involving the government is the rating tools (systems). World GBC has even recently developed a framework for rating tools, to ensure that key socio-economic factors are included when a country develops its own sustainability certification. Another initiative of theirs has been bringing local governments and key actors together into a *collaborative policy making* process to create market pressure on the whole building supply chain and make a more permanent change towards sustainability (WorldGBC, 2013, p. 3).

Green Building Council Denmark (DK-GBC) is the Danish branch of World Green Building Council (World GBC). DK-GBC is an independent, member-based non-profit organisation funded by its members and sponsors.

It was founded in April 2010 by a variety of actors in the Danish building industry - investors, building owners, architects, engineers, suppliers, financial organisations, accountants, solicitors and municipalities – led by a steering group from the earlier Danish Economic and Building Agency (*Erhvervs- og Byggestyrelsen)* and SBi. Present-day members are again different kinds of companies and organisations, doing business in the building industry or interested in construction.

DK-GBC, as a part of the World GBC, works in accordance to World GBC's guidelines and strategies (DK-GBC, 2015). The main goals of DK-GBC, as they themselves state, is to popularise sustainability in the Danish building industry; to establish and manage a Danish certification for sustainable building; to encourage research and knowledge sharing; to promote international and European solutions for sustainability. Their primary approach is propagating the green building certification DGNB and functioning as an administration centre for DGNB in Denmark. In addition, they develop tools for estimating the life-cycle costs and the environmental impact of a building in its life cycle; train DGNB-consultants and assessors; offer educational courses in sustainability, DGNB and the tools. They have also a vision to create an open database of certified buildings, which will be available for knowledge sharing in the industry (DK-GBC).

DK-GBC's choice of DGNB

In 2009, Realdania assigned *Byggeriets Evaluerings Center* and *Statens Byggeforskningsinstitut (SBi)* with the task of testing existing international certifications for sustainable building in order to help the choice of a Danish certification. At this point, there was a public debate in the Danish building sector on whether Denmark should develop its own certification system or adopt one of the international (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010).

How did the findings of the research contribute later to the decision to adopt DGNB as a Danish certification?

SBi and *Byggeriets Evaluerings Center* conducted a research on LEED, BREEAM, DGNB and HQE. The research was based on two cases of buildings, recently built in Denmark. By doing that, the researchers could check how well-adapted the international certifications were to the Danish style of building, the conventional project documentation and project delivery processes. The two buildings were rated post-construction by qualified foreign assessors. The researchers compared the certifications by analysing their criteria, life-cycle costing aspects and certification costs per m^2 (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010, s. 9).

The results, published in June 2010, showed that HQE and DGNB were the two most expensive in terms of the price per hour per m^2, which measured the time; designers would have spent on forming the necessary documentation. All of the certifications covered criteria on the same topics, differing only in how the topics were examined and in what level of detail. The research identified furthermore the need in all of the certifications to adapt the criteria to conditions in the Danish building industry. With regards to circular economy (*totaløkonomi*), only BREEAM and DGNB were found suitable, because they were the only ones that required life-cycle cost calculations (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010, s. 9-10).

With respect to DGNB specifically, the research identified that DGNB was based on the European CEN standards and was also supported by European initiatives for sustainable building. Most of these standards are therefore also known in Denmark. This was evaluated as an advantage which could increase the certification's chances of survival in the future.

Based on the certification experience with the two buildings, the researchers noticed that in DGNB it was difficult to understand how working on a certain criterion would affect the total score of the building (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010, s. 59). The reason for this is the rather large amount of criteria in DGNB. The researchers experienced, that a lot of the criteria required documentation work (Birgisdottir, Hansen, Haugbølle, Hesdorf, Olsen, & Mortensen, 2010, s. 60). Designing with DGNB was assessed to be expensive and resource-consuming for designers, because in DGNB it is not allowed to focus on some criteria at the expense of others.

FEATURES OF DGNB

Since the selection of DGNB as a Danish certification system in 2011, the criteria and standards have been adapted to Danish norms, guidelines and standards. Moreover, at the end of 2014, The Danish Energy Agency (*Energistyrelsen*) developed tools for life-cycle costing and life-cycle assessment – *LCC byg* and *LCA byg* - for both general use in the building industry and use in the DGNB certification.

DK-GBC promotes the DGNB certification by highlighting a few characteristic features.

First of all, DK-GBC claims that DGNB is the building certification which has the most holistic perspective on sustainability (DK-GBC, 2014, p. 8).

Second, according to DK-GBC DGNB is unique because it pays attention to the circular economy of the building and values the economic side of sustainability

to the same extent as the social and environmental aspects (DK-GBC, 2014, p. 8). All of the three aspects are namely evaluated with 22.5% in DGNB.

Next, DK-GBC make a statement that DGNB stimulates innovation, because it sets functional requirements for the building's performance, as opposed to *'predefined solutions'* (DK-GBC, 2014, p. 8). A functional requirement gives the designers flexibility by presenting them with the opportunity to make alternative solutions. Thus creativity is encouraged, which is a prerequisite for innovation. In contrast, predetermined solutions are viewed as constraints to the creative process. This is how, as DK-GBC sees it, DGNB allows for a change in the present design practices towards more sustainable building design.

Lastly, DK-GBC stresses on the fact that in DGNB every project is assessed uniquely, both quantitatively and qualitatively (DK-GBC, 2014, s. 13). This means that assessors in DK-GBC tolerate the specificity of each building project and can take into consideration various kinds of documentation.

It can be further said that, as a basic of feature of building certifications in general, the requirements of DGNB are always higher than the conventional building regulations. This serves as a motivation for those who want to cover more than the minimum. The motivation may be, for example, for building professionals to gain a competitive advantage in the industry. For building owners the motivation may lie in an increased sales value of the building, as DK-GBC also states. They claim that the certificate can serve as a guarantee for quality and thus increase the sales price of the building (DK-GBC, 2014, p. 10).

As a structure, DGNB is composed of 6 categories also called *qualities* – Environmental, Economic, Social, Technical, Process and Site quality (Figure 5). The first four categories take up 22.5% of the total score, Process quality takes up 10%, and Site quality does not give any points, but must still be documented. The categories consist of subtopics, called *criteria*, which are weighed differently with a factor. The criteria are thus prioritized by their significance.

Another intrinsic feature of DGNB is the fact that no category can be overlooked in terms of quality. There is a minimum, which must be reached for each category for the building to get certified. According to DK-GBC, this minimum requirement for each of the categories ensures in the end an overall high quality of the building (DK-GBC, 2014, p. 13).

CERTIFICATION PROCESS

Fulfilment of criteria in the categories is measured with checklist points (*tjeklistepoint*, TLP). Later on, TLP are converted into evaluation points (EVP)

via the evaluation matrix (Figure 5). The final is presented as a percentage, divided into three categories – Silver, Gold and Platinum.

The certification process can be conducted during the design phases of the project, and no later than project completion.

It is obligatory to formally assign a supervisor from DK-GBC, called *DGNB assessor*, to follow through the design work and to collect documentation from the design team. If needed, the assessor can provide further help to the team.

DK-GBC also offers education as a *DGNB consultant* who does not have rights for official assessment but possesses knowledge to guide the certification process.

The necessary documentation which must be delivered by designers to DK-GBC for assessment and final certification includes: description of the building, specification of the technical installations, description of energy concept of the building, DGNB evaluation matrix, estimation of built area by floors, organizational chart and contract form for the project, information about the expected time of precertification and handing over. Additionally, the required drawing material is: elevations, sections, floor plans, location plan. Finally, the following calculations must be attached: LCA calculations, LCC calculations and calculations for water (DK-GBC, 2014, s. 21).

4.1. CASE ANALYSIS

This section deals with an analysis of the collected data on Arkinord's past and present experiences with DGNB.

ORGANISATIONAL IDENITITY OF ARKINORD

Reviewing Arkinord's profile description provides an insight into how Arkinord generally sees themselves, as well as who they are in the interaction with their clients.

Arkinord is an architectural firm with strongly established traditions, going back to 1935. The long history of the firm is the source of their experience with a wide range of buildings.

According to Arkinord, their approach to architecture is socially oriented, but attention to quality and craftsmanship is also important for them:

'The philosophy behind the architecture has always been such, that architecture should create a framework for life and unfoldment by being exciting and inspiring in its simplicity, characterised by quality, functionality and good craftsmanship' (Arkinord A/S).

DGNB Evalueringamtrix

Temaområde	Kriteriegruppe	Nr.	Kriterium	vægtning	gruppe vægtning
Miljø	Livscyklus vurdering (LCA)	ENV1.1	Livscyklusvurdering (LCA) - Miljøpåvirkninger	7	22,5%
	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	

Figure 5 Evaluation matrix in DGNB (DK-GBC, 2014, s. 14)

In this statement, it is worth noticing that Arkinord as architects share a concern also about the feasibility, technical execution and durability of their architecture. These values of quality and good craftsmanship are central features of sustainability. They ensure future-proofing of the building, because being of good technical quality means being durable and robust. It may be assumed that Arkinord think of architecture as more than aesthetics and social functions. They may have a tendency to think architectural design in a more sustainable way.

Arkinord is a service-minded firm, which places the client's needs and wishes upon pedestal. For example, the firm's core values are creativity and communication, respect and attentiveness, and Arkinord views them as:

'[...] important elements in all building projects, from concept to taking-over, which put the client at the centre.' (Arkinord A/S).

Moreover, they declare that:

'If we have specialised ourselves in a particular direction, it is in relation to our commitment to the client' (Arkinord A/S).

Arkinord regards the client as the most important stakeholder in a building process and coordinates its activities in order to be of good service to their clients. Arkinord has tuned into the recent development within energy efficiency and sustainability and 3D modelling.

In summary, Arkinord builds up a profile, recognised by architectural tradition and experience, openness to sustainability and willingness and flexibility to embrace new technologies.

ORGANISATIONAL PRACTICES: SUSTAINABILITY

Apart from working with DGNB since 2012, Arkinord has practiced some forms of sustainable building design. They have covered to some extent the three aspects of sustainability, as defined in the Brundtland Report of 1987 – environmental, social and economic sustainability.

Work practices with the Low-energy classes

Arkinord began working partly with sustainable building design when the higher energy requirements in the Building Regulations came into force for the first time in 2006. The new energy requirements caused them namely to work more with the environmental and economic aspects of sustainability. The changes in BR08 included the introduction of two voluntary Low-energy classes (*Lavenergiklasser*) 1 and 2. J.D. comments that designing according to the new

Low-energy classes was for Arkinord and others in the industry a new task which brought feelings of uncertainty. Up to that point, clients lacked knowledge on circular economy and Arkinord could not imagine how clients would demand low-energy building design:

'Suddenly, one had to design in Low-energy classes. How were we going to do it? It would cost a lot to design sustainably' (D., 2015).

Designing energy efficiency would certainly require more working hours of Arkinord in the design phases, due to the novelty of the task. New tasks in relation with the Low-energy classes were, for example, more considerations during design and calculations of future energy consumption in new tools such as Be06. All these efforts would bring additional costs to the client.

These initial challenges in the switch to sustainable design were overcome, as it slowly became generally known in the building industry, that the extra expenses for sustainable design can be greatly compensated for the client by the energy savings, realized in the operation and maintenance period of a building's life cycle.

The Low-energy classes could be identified as an ideal type boundary object, because they function as a flexible concept of environmental sustainability. The classes do not set a frame or restrictions on the design process. On the contrary, they are wide enough to include different instances of energy-efficient buildings in themselves. Therefore, the classes can be associated with the concept of ideal type, because although they can be composed of various elements, such as freedom in design and in the decision-making process, they can be still considered to be universal, namely by having a single goal, which unites all efforts. For instance, the architectural creativity is not constrained as long as it leads to a building, whose energy frame complies with (1100 KWh/heated area + 35 KW)/m^2*year (the old Low-energy class 1). As evident from the interview, the Low-energy classes served as boundary objects ideal types for energy-efficient building design.

Furthermore, the introduction of these classes most probably changed the information infrastructure for project delivery in Arkinord. The Low-energy classes provided a measurable target for the energy efficiency of their design. Design according to Low-energy class 1 and 2 became eventually a usual practice in Arkinord, as stated in the interview. Some examples of sustainable building design, they have been working with in the period of 2010-2012, are the Low-energy-class-1 buildings *Det Grønne Hus* and *Villa Strandeng* (residential) and *Senhjerneskadecenter Nord* (public, rehabilitation). Later on with the introduction of BR10, Low-energy class 1 turned into Low-energy class 2015. While Low-energy class 2 which has become the minimum energy requirement in

BR, Low-energy class 2015 is still higher. J.D. is glad that the buildings, which Arkinord had in the past designed as class 1, are today still energy efficient, keeping the firm's portfolio and image of sustainability on the market.

Work practices with life-cycle costing

Based on Arkinord's portfolio of low-energy design buildings, it may be assumed for them green, energy-efficient building equals sustainability. However this cannot be regarded as true, because another document on their site points to the fact that Arkinord also takes the economic aspect of sustainability into account. Arkinord has namely a manual for energy retrofitting, called ***3 steps energirenovering***. The manual is a technical guideline targeted at professionals and home owners. The three steps follow the phases of planning, execution and operation and maintenance and the manual gives advice on how to design, prepare the project documentation and contractual basis, coordinate and supervise the building site and follow up and monitor the energy performance of the finished building.

The manual gives an idea of the methodology of Arkinord, when they work with energy retrofitting projects. Their advice focuses mostly on the environmental aspect of sustainability, such as incorporating energy-saving technologies and improving the thermal quality of the building envelope. However, Arkinord takes into account also some social and economical concerns:

'The improvement should be, of course, obvious in the energy bill, but it must not ruin the aesthetic quality of your house, so that the house loses its worth in case of a sale' (Arkinord A/S)

They advise on making a calculation of the future energy consumption of the house, by calculating the life-cycle costs of the new technical installations:

'Estimate on the future energy consumption. Calculate savings in operation, counter payback time period, but also operational costs + current rent costs, counter operational costs + future rent costs (Remember maybe life-cycle time of installations, maybe some of the parts should be replaced every 5-10 years)' (Arkinord A/S)

This indicates that Arkinord began incorporating future operational costs of building components, that is to say LCC of, for example, technical installations. Arkinord has thus added considerations on circular economy and life-cycle costing to their calculations of the building energy frame.

Sub conclusion

In summary, Arkinord has good competences within low-energy building design with BR's Low-energy classes. Also, they pay special attention to social aspects in their architectural design, as evident from the firm's profile. Furthermore,

Arkinord work systematically with energy retrofitting, because there are some established procedures for energy-efficient renovation of buildings. Finally, they have started working with life-cycle costs and have in this way supplemented the environmental sustainability in their design practice with some economic aspects.

These concrete practices of sustainable design in Arkinord are not surprising, because in the Danish building industry it is common practice to consider energy consumption and indoor climate, due to the requirements of BR (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013, p. 73). SBi's survey on sustainable initiatives makes an observation, that as opposed to BR, DGNB matches quite well the indicators of sustainability of ***CEN / TC350 Sustainability of construction works*** (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013, p. 75). Therefore, Arkinord's application of LCC of building materials seems to be own initiative or a direct consequence of their work with the DGNB certification since 2012.

HOSPITAL PANDRUP: 1ST DGNB PROJECT

Arkinord's first work with sustainable building certification was during their participation in the planning of Hospital Pandrup in 2012. Hospital Pandrup became after its completion the very first DGNB-certificated building in Denmark.

Design consultants

Arkinord was assigned with the architectural design of the hospital as a part of a turnkey contract (*totalentreprise*), won by the North Jutland contractor Lund & Staun. For Arkinord, as well as for the rest of the project participants, this was first time working with DGNB and with a sustainable building certification at all. Up to this point, Arkinord had been designing only low-energy houses. Staying true to their organisational identity, Arkinord conformed to the client's wishes and embraced working with the new certification.

Client

Region Nordjylland was the client in the project. Two separate political decisions led to the Region's conclusion to build a new health care centre in Pandrup in a sustainable way.

On one side, in 2010 Region Nordjylland applied for funds, provided by the Ministry of Interior and Health (*Indenrigs- og Sundhedsministeriet*), for establishment of, among other, new hospitals in the peripheral areas of Denmark. Region Nordjylland had an interest to attract young medical workers in order to solve the demographic problems in the region.

On the other side, the Region made in 2011 an agreement with the Danish Society for Nature Conservation (*Danmarks Naturfredningsforening*) to become a *klimaregion*. This agreement requires of Region Nordjylland to reduce their CO_2-emissions from hospitals, regional strategies, educational initiatives, etc. with 2% per year until 2025. As one of the four to-be-built regional hospitals, it was decided that Pandrup would be designed sustainably with a low CO_2 footprint. To achieve concrete and guaranteed sustainable results for the hospital and to meet the *klimaregion*-agreement, Region Nordjylland chose to invest in the DGNB certification, which at the time was just recently chosen by DK-GBC as an official certification system in Denmark. Moreover, certificating Hospital Pandrup with DGNB would mean among all things a building with a better working environment and that would contribute to attracting qualified workforce to Pandrup.

Region Nordjylland's interests as a client are thus anchored in official and fixed political agreements.

Turnkey contractor

Lund & Staun is an average-size general contractor from Svenstrup, near Aalborg starting back in 1997 as a small carpentry and joinery firm. Since then, Lund & Staun has been working determinedly and gradually towards expanding their business.

The firm has an open-minded attitude towards innovation and new challenges:

'Our ambition is to be a construction company that thinks creatively and is not scared to go new ways' (Lund & Staun A/S)

For example, they have adopted LEAN and DGNB principles into their work. Apart from Hospital Pandrup, Lund & Staun is currently involved in another sustainable construction project - *Femhøje Stadion* in Hjørring – where they implement principles from DGNB as well.

For the firm, development of new competences is vital and a matter of survival on the market:

'[…] it is of course the professional competences that ensure the existence of our firm' (Lund & Staun A/S)

Lund & Staun shows a great willingness to constantly improve their working methods, and demands this also of their partners - material suppliers and subcontractors.

Lund & Staun's main interest can be therefore identified as building up new expertise and competences and increasing the size and complexity of the projects they are involved in.

Suppliers

One of the material suppliers in the project was a Danish chain supplier company of building materials and part of the Saint-Gobain concern. In the Pandrup project, they delivered interior lightweight walls, ceilings, sound-insulating doors and insulating materials. Reflecting on the project, the company's business manager says in the press:

'Especially in the public sector, there is an increased focus on sustainable construction and we would like to be up to date with this development, instead of being outdated, when it becomes an official requirement' (Puff, 2013)

This statement points out the company's major interest as building up of new skills within sustainability in order to stay competitive on the building market.

DGNB assessor

The role of a DGNB assessor for Hospital Pandrup was assigned to Carina Svejstrup Hedevang (CH), a civil engineer from Rambøll. She represented in the project the interests of DK-GBC, which are both promoting the DGNB certification and keeping the level of the DGNB standard high. Therefore, she had to balance between being strict about the delivery of documentation and on the other side giving assistance and showing understating, when the design team had difficulties due to inexperience or insufficient translated manuals at the time of the Pandrup project.

Sub conclusion

All project participants had an economic interest to win the tender for Hospital Pandrup. But in order to achieve this, they all had to combine efforts in working with the DGNB certification, which they at this point were equally inexperienced in.

That was especially necessary for the material suppliers, as it becomes obvious in the interview. The contractor Lund & Staun had to set clear demands before the suppliers:

'You should know that this project has certain requirements according to DGNB. Therefore, if you want to participate, you should be prepared to do make an extra effort and deliver more in terms of sustainability, documentation, etc.' (D., 2015)

The suppliers were probably never before confronted with the demand to prepare life-cycle assessment of their materials or other documentation for the environmental risks and impact of the materials, etc., required by DGNB.

Preparation of documentation for the DGNB certificate became in this way the obligatory passage point, which all project participants had to go through.

Arkinord, as well as Lund & Staun, met this new challenge with enthusiasm, according to the interviewer, because they looked on it as an opportunity to gain experience and competences and win more projects in the future.

WORK WITH DGNB

In the Pandrup project in 2012, the DGNB assessor CH decided to divide the work between Arkinord and Lund & Staun, by dedicating certain categories of the DGNB evaluation matrix to each of them.

For example, the Environmental category was given entirely to Lund & Staun to work with. This included first, LCA of the environmental impact: global warming potential, ozone depletion potential, photochemical ozone creation potential, acidification potential, eutrophication potential. To estimate these, one uses the LCA byg tool for a period of 50 years inclusive the building operation period, and for a period of 80-120 years for the building materials. Second, the environmental risk of building materials, which puts a restriction on the use of some substances and materials. Third, it included the environmental impact of use of resources, which means use of certified wood such as FSC or PEFC (Programme for Endorsement of Forest Certification). Fourth, it included LCA of the total primary energy demand and proportion of renewable primary energy. This covers the energy consumption of building materials during the construction phase (embodied energy) and building's operational energy consumption. Fifth, it included estimation of drinking water demand and volume of waste water. Sixth, it included estimation of how well the building utilizes the land, on which it is built, including soil contamination studies.

Lund & Staun were in this way given the task of working with the documentation of building materials. The documentation could be provided by the material suppliers, in form of information sheets on substance content of the building materials and certificates for the wood materials. The task of working with the Environmental category in DGNB was given to Lund & Staun because they were in charge of the contact with the material suppliers in the overall project organisation.

Another motivation for CH to distribute this task to Lund & Staun might have been that Arkinord as architects would work better with DGNB categories such as the Social quality. There, one works indeed with traditional architectural disciplines: acoustic comfort, daylight, user influence on building operation, accessibility, efficient use of floor area, public access, among other things. In this category, there are neither LCC, nor LCA to work with. It could be assumed that at this point Arkinord was not prepared to work with circular economy of the building materials, unlike today, when they work with life-cycle costing in renovation projects. In all cases, the division of work into categories was

supposed to make the certification process easier. Although Arkinord and Lund & Staun worked independently on the tasks, they also worked together once. On own initiative, they gathered together to get familiar with DGNB and discussed the tasks, given to them by the DGNB assessor.

While working on DGNB in the Pandrup project. Arkinord shared a concern on the fulfilment of the DGNB requirements to the building's energy consumption. For example, they spotted that the design of the building shape of Hospital Pandrup, created by the client consultant, could be energy-optimized. In addition, they displayed creative thinking and good competences in terms of energy efficiency of the building design. They proposed a change in the building shape:

'In Pandrup, we should design a rectangular building shape with an inner courtyard in the middle. This challenged the fulfilment of the energy requirements of DGNB, because we should have curtain walls and as a result, higher heat loss. We suggested then to change the building shape to two rectangular shapes' (D., 2015)

The client Region Nordjylland said 'no' to the proposal with the argument that it would bring re-design costs in the middle of the project. Region Nordjylland had namely a fixed budget for the hospital's planning phase and wanted to keep it. This was also a reason why they had set the DGNB target level to silver and not, for example, to gold.

Sub conclusion

The DGNB certification process can be conceptualised as a new organisational boundary for Arkinord. In the case, they had Lund & Staun at the boundary and participated together with them in a boundary practice – work with DGNB. This is a situation where boundary objects such as the DGNB evaluation matrix were used.

It can be said in conclusion that the splitting of tasks with DGNB hindered a larger degree of collaboration between Arkinord and Lund & Staun. If Arkinord and Lund & Staun were to fully collaborate, they would have to communicate, exchange opinions and knowledge and invent design solutions together.

What they met for instead was to get familiar with the DGNB categories and their criteria, the terms, concepts and language around DGNB and to understand what which each of them was assigned to work with. Since DGNB was a new thing to both of the parties, they needed a new common language to be able to process new information. In Carlile's terms, this means that a new shared syntax was established using the DGNB evaluation matrix. This was a process of communication and learning about DGNB, which means that

knowledge about DGNB was represented and translated, mostly through the evaluation matrix. Later on, the two parties concentrated on the specific DGNB categories. Knowledge was not transformed, because the architects worked with the architecture-oriented categories and the contractors with the building materials.

A higher level of collaboration would have led to transformation of knowledge and innovation across the whole project. Each party may have innovated on its own, but without teamwork across the project there was no guarantee that separate design innovations can work well together for the final DGNB assessment and for reaching DGNB-silver.

NEW BOUNDARY PRACTICES AND BOUNDARY OBJECTS

According to the interview, the time of Arkinord's first encounter with DGNB in 2012 can be considered as the formation of new organisational boundaries and boundary practices due to the following reasons.

First of all, there was employed a new form of interaction such as when Arkinord had to communicate with DK-GBC in the face of DGNB assessor CH from Rambøll. Hence, a new channel of communication was established, as a result of the need of the firm to refer to a specific authority.

Second, DGNB brought also changes into Arkinord's communication with the client. Under the initial discussions with the client on requirements and functions of the future building, they were able to discuss sustainability as defined in the DGNB certificate levels. At an early DGNB-screening meeting with Region Nordjylland in the conceptual phase of the project, it was decided that the desired level of certification was DGNB-silver. This level was the basis, on which solutions later on would be selected.

The DGNB levels functioned as **ideal types.** The DGNB levels make the communication with the client easier, because they help explain the otherwise broad concept of sustainability to the client, the designers and the contractors. The DGNB certification levels – bronze, silver and gold, set functional requirements to the building with regard to sustainability. At the same time, the levels leave an opportunity for flexibility in the design. Similarly to the Low-energy classes of BR, the DGNB levels serve as an ideal-type boundary objects. They cover though more aspects of sustainability than the Low-energy class levels, because DGNB covers the social, economic and environmental aspects of sustainability, while the Low-energy classes were created to measure only energy performance.

The DGNB evaluation matrix functioned as a **standardised form.** The DGNB evaluation matrix (Figure 5), which describes the six main categories of

sustainability in DGNB, can be viewed as a standardised form. It served as a shared method for designing the building in a sustainable way with regards to economy, environment and social quality, as well as technical, process and site quality. This is to say, it serves as an index of six areas of sustainability, which the designer must incorporate into the building design. The DGNB evaluation matrix is both abstract and concrete. Abstract, because the requirements in DGNB for each of the categories are functional and measure the building's final performance, not its conformity to a checklist of prescribed solutions. The DGNB evaluation matrix is at the same time concrete, because it sets practical limits to the designer's efforts for designing the sustainability of the building, by guiding him to work within the categories.

DGNB assessors use the evaluation matrix in their assessment work to measure the quality of proposed solutions and to transform quality into a quantitatively measured score – TLP and EVP points. But in the case, the assessor used the DGNB evaluation matrix also as an educational tool in the communication with designers. CH explained to Arkinord and Lund & Staun through the matrix what the DGNB certificate covered and what DK-GBC understood as sustainability.

DK-GBC's database functioned as a **repository.** DK-GBC's database, which supplies building professionals with manuals and other guiding materials, can be considered as a kind of repository, external for Arkinord and companies in the building industry. The database of manuals and guidelines is since 2014 made available on DK-GBC's website not only for members, but for everyone. Moreover, DK-GBC has started building up a database of completed projects, where experiences from the building cases would be stored and made available to members (DK-GBC). Arkinord has already contributed to the database with their experience from the project Hospital Pandrup.

The DGNB manual functioned as a **map of coincident boundaries**. The DGNB manual is the main educational tool of DK-GBC. The manual is a representation of a DGNB certification process *'to be'*. The manual is used by people with professional backgrounds in architecture, engineering or construction, for a variety of building types – offices, multi-storey apartments, row houses, urban areas, etc. DK-GBC receives feedback from professionals from the building industry, who express their concerns about issues with the certification process. The DGNB manual is in this sense the tool for making amendments to the DGNB certification. DK-GBC produces the manual and sends it out in the building industry. Then, building professionals send information on performance from projects and requests for improvements back to DK-GBC. In the end DGNB certification is updated to suit the industry's practices, and a new or modified manual is issued.

To illustrate this, Arkinord has recently faced a technical challenge from their latest DGNB-project - the renovation of a nursing home in Mariager. As the existing building is going to be extended, there is unclearness on how the existing building could meet the DGNB-requirements for accessibility. Arkinord is namely not assigned with making accessibility improvements on the old part of the building. Nevertheless, the DGNB certificate must apply to the whole building, including both the new and the old part. In connection with this particular problem, Arkinord has sent feedback to DK-GBC. As claimed in the interview, DK-GBC has been very understanding and work towards adjusting the certification to such special cases.

Sub conclusion

The DGNB levels, evaluation matrix and DK-GBC's database were identified in the case of Hospital Pandrup as boundary objects, because they were present in the *social worlds* of the architects, the craftsmen and the material suppliers at the same time. These boundary objects managed to support communication on sustainable building design and negotiate different meanings on the measurability of sustainability across the worlds.

The DGNB evaluation matrix was used by Arkinord, Lund & Staun and DGNB-assessor CH for various purposes (Figure 6). The matrix served as a standardised form to represent knowledge, where the designers understood the meaning of sustainable building design, seen through the perspective of DK-GBC. In this way, transfer and translation of knowledge took place (Table 1Interpreted from Functions of the boundary objects in the case.Table 1).

The DGNB levels played the most complex role of boundary objects. The DGNB levels played the role of ideal types in Arkinord's communication with the client, the contractor and the DGNB assessor (Figure 6). They were sort of labels, which showed the demanded level of work, both in quantity and quality. Specifically for Region Nordjylland, the DGNB levels were an important tool for managing the amount of work on the project and to communicate their client demands to Arkinord and Lund & Staun. In the same way, Arkinord used the DGNB levels as an indicator for the quantity of their work efforts for themselves, during discussions with DK-GBC/the DGNB assessor and during collaboration with Lund & Staun. The DGNB levels signified the quality of the work. For the client quality was measured through the performance of the completed building and for DK-GBC - through the delivered documentation for assessment. As a whole, the DGNB levels were the only boundary object, which drove all project parties towards constant collaboration to achieve a common goal – the DGNB-silver level. The DGNB levels transferred, translated and transformed the parties' knowledge (Table 1).

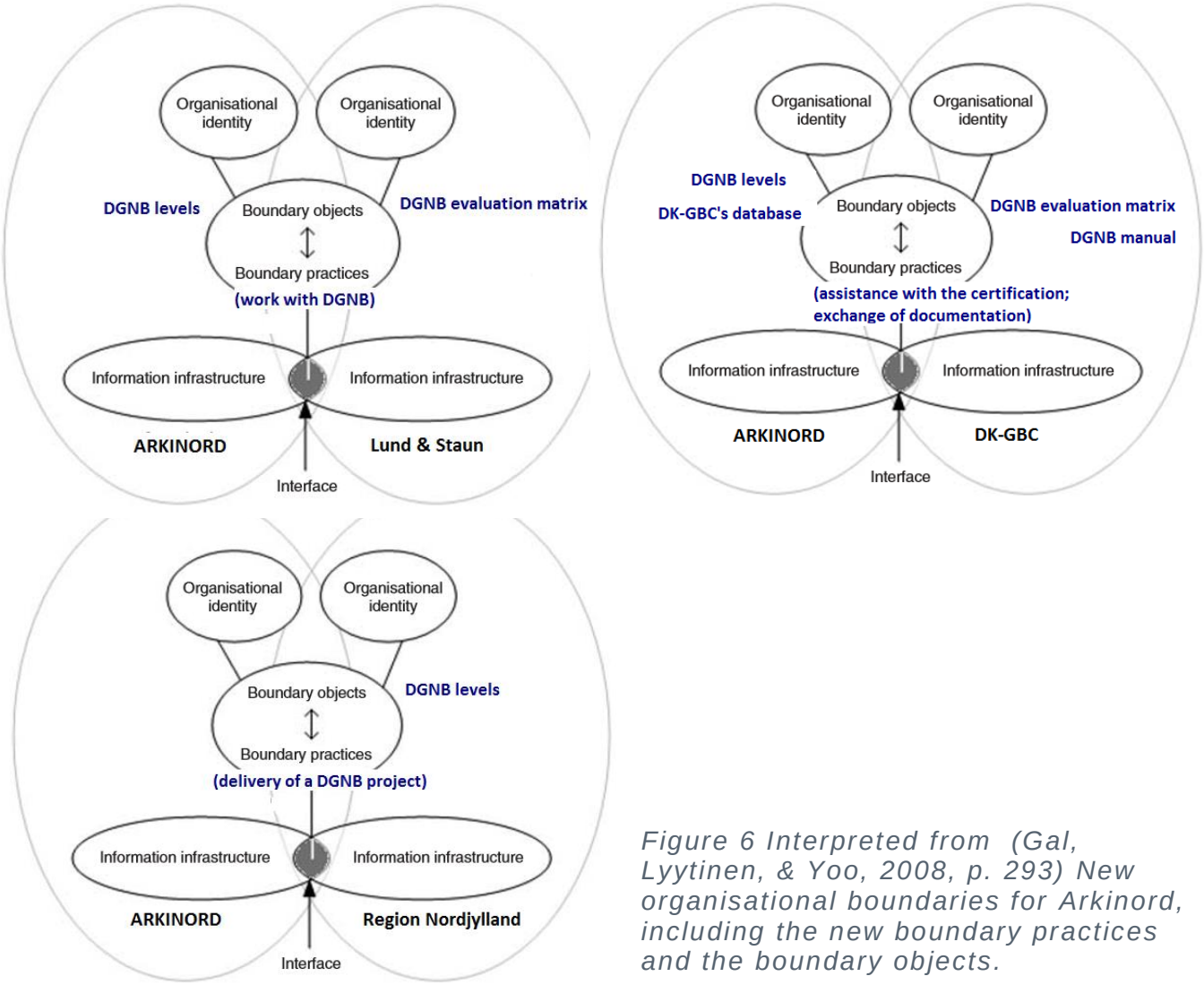

Figure 6 Interpreted from (Gal, Lyytinen, & Yoo, 2008, p. 293) New organisational boundaries for Arkinord, including the new boundary practices and the boundary objects.

KNOWLEDGE BOUNDARY	CATEGORIES OF BOUNDARY OBJECTS	FUNCTIONS OF BOUNDARY OBJECTS	EXAMPLES OF BOUNDARY OBJECTS FROM THE CASE
Syntactic	Repositories	Transfer	**DK-GBC's database**
Semantic	Standardised forms and methods	Transfer Translate	**DGNB evaluation matrix**
Pragmatic	Objects Models Coincident boundaries	Transfer Translate Transform	**DGNB levels; DGNB manual**

Table 1Interpreted from (Gal, Lyytinen, & Yoo, 2008, p. 293) Functions of the boundary objects in the case.

DK-GBC's website database, which contains manuals, tools and a collection of completed projects, functioned as a repository (Figure 6). As a repository, the database provided common manuals and guidelines on the DGNB certification process. In the Pandrup project in 2012, the availability of manuals was lower, projects references were from abroad and Arkinord used English manuals. The database was back then accessible only through a DGNB-assessor to those participating in a DGNB-project. Nowadays, Arkinord and others in the building industry have a public access to manuals in Danish for several building types.

The DGNB manual in particular plays the role of a map of coincident boundaries and found application in the communication between Arkinord and DK-GBC (Figure 6). It was provided by the DGNB assessor CH to the design team to help them in completing the DGNB-certification process for Hospital Pandrup. On the other side, it is also a tool for Arkinord and others to communicate their needs as building professionals to DK-GBC and to suit the DGNB certification to their practices. Therefore, the DGNB manual plays a vital role for the development of the DGNB certification. It holds the DGNB certification up-to-date and useful. The DGNB manual has also a unifying effect to identified needs and differences of the building industry. It solves the concerns of architects, engineers and constructors with regards to sustainability of buildings in a coordinated and systematic way.

INTEGRATION OF DGNB IN ARKINORD

Not only did DGNB create a new organisational boundary for Arkinord during their first experience with it on the Pandrup project, but it also brought a change in the firm's information infrastructure. This becomes evident from few examples.

First, JD comments:

'At that time the DGNB-manuals were available only in English, which was a challenge for us' (D., 2015)

This shows Arkinord's willingness to integrate DGNB standards such as the manual into their infrastructure for design delivery, despite the language barrier. One can speculate that today when the availability of manuals and guiding materials in DK-GBC is better, Arkinord would integrate some of them into their practice. There is a fair chance, because JD agrees in the interview, that something they like about DGNB is that it is systematic (D., 2015). This implies that Arkinord would like to have system and structure of the work with sustainability. The way towards this is the establishment of a new infrastructure inside the firm, potentially created through the DGNB system.

Second, although Arkinord did not get the chance to work with LCC and LCA in the Pandrup hospital project, their own manual on energy-efficient renovation is an indication of the fact that they might have already extended their practice of sustainable design to include circular economy. In the Pandrup hospital project, Lund & Staun prepared the documentation of LCC and LCA of some building materials, but in the end the client's materials were selected. That was because Region Nordjylland had specified the materials beforehand. Regardless of that, nowadays Arkinord obviously sees the importance of life-cycle costing and can probably even integrate the new LCC byg and LCA byg tools into their design practice. Projects like Hospital Pandrup may have brought Arkinord's attention to circular economy.

Next, a change in Arkinord's own quality assurance system can be observed. The new DGNB infrastructure seems to be built upon the existing infrastructure for quality assurance (*kvalitetssikring*). JD states in the interview that:

'Working with DGNB made us more aware of our own quality-assurance system' (D., 2015)

This greater awareness was triggered, because preparing documentation for DGNB resembled much the documentation process of risk areas in the traditional quality assurance process in Denmark. On their website, Arkinord state that they have been keeping their quality assurance system up-to-date with legislation since 1986 when the first legislation on quality assurance - *Cirkulære om kvalitetssikring af byggearbejder*, came into force. This includes also the latest tendencies, which are:

'The latest edition [of regulations on quality assurance] *expresses a will to continually adapt to the market and to the internalisation of the building sector'* (Arkinord A/S)

Arkinord will therefore, by keeping their quality assurance system modernized, be always in step with the development on the market and be internationally recognised. DGNB is for Arkinord potentially a way to become better recognised both on the national and international market. Maybe that is why in 2012 JD saw DGNB as similar to a quality assurance system for sustainability of buildings. Or, as he puts it, an expansion to their usual quality assurance system:

'DGNB expanded our quality assurance system so that one should, because of DGNB, now document also things, which were before perhaps not taken into consideration' (D., 2015)

He explained that by telling how he, due to DGNB, had to document a decision which he considered before as a matter of common sense:

'For example, that windows on the 3rd floor have low operational costs and can be cleaned without using a lift' (D., 2015)

He knew from experience that the windows' maintenance would not be expensive. The operational cost of windows was namely something he usually thought of, but did not need to provide documentation for. DGNB required now documentation of such design consideration. The example shows how requirement of documentation makes the designer be more aware of his design decisions. Today, JD has started to question the advantages and disadvantages of solutions more, also within quality assurance:

'DGNB is one reason why I have become more thorough with my work for quality assurance' (D., 2015)

All of this points out a good compatibility between DGNB and quality assurance as practices. For other design firms in the building industry who, like Arkinord, already work systematically with quality assurance, adoption of DGNB may likewise make good sense.

The new infrastructure uses also Arkinord's design technologies such as CAD and 3D modelling. JD mentioned in the interview, for example, that quantity take-offs from the 3D models were used in connection with LCC of building materials and preparing documentation for DK-GBC on efficient use of floor area.

JD mentioned that design meetings with regards to DGNB were not many and thus did not hamper the overall project progress:

'There are some fixed points during the project, when documentation must be delivered to DK-GBC. In this regard, we met with CH and it was not more than 2-3 times all in all' (D., 2015)

This shows that DGNB's processes match well with the traditional division in project phases. For example, the initial DGNB-screening, pre-certification work and delivery of documentation for final assessment are synchronised with respectively the programming phase (*programfasen*), the design phase (*projektering*) and the handover (*afleveringsfasen*).

Sub conclusion

In brief, a new infrastructure for delivery of sustainable design is being established in Arkinord through DGNB. DGNB as an infrastructure employs boundary objects such as those, identified in the case: the DGNB levels, the DGNB evaluation matrix, the DGNB manual and DK-GBC's database.

The new infrastructure is built on an installed base: the common procedures for project delivery for architects, engineers and other consultants.

The new infrastructure is built into systems and practices, common for Arkinord. It is embedded in Arkinord's design practice, as DGNB brings specific principles of sustainable design. DGNB resembles and builds upon the system for quality assurance. Arkinord's existing practice of 3D modelling supported the work on LCC for building materials in DGNB. The new DGNB infrastructure also intervenes with Arkinord's usual practices of communication and collaboration with clients and project partners. Besides, the DGNB infrastructure links with accepted conventions of practice, such as the traditional project phases in the building process.

The new infrastructure embodies standards, known in the building industry. For example, the LCA and LCC of buildings and construction products is a popular method, supported by several Danish and European standards (Birgisdottir, Mortensen, Hansen, & Aggerholm, 2013, p. 13).

The new infrastructure was in the Pandrup project not 'transparent' for JD, because he lacked at that point any experience in DGNB. The tasks connected with the certification work were not routine for him, as they were for the trained DGNB assessor CH. JD learned the procedures and standards in the DGNB infrastructure through his participation in the Pandrup project. Today, he probably sees work with DGNB as a set of established tasks and procedures. The infrastructure, established in the Pandrup project, continues to function on the present DGNB project in Mariager.

The DGNB infrastructure develops, as more buildings get certified, and it develops in a modular way, area by area. One of these areas is, for instance, the expansion of DGNB to cover more types of buildings. Since 2012, building types have increased through testing in pilot projects. In 2015, pilot projects were carried out for adjusting the DGNB certificate to schools and kindergartens and renovations. Nevertheless, the further adjustment of DGNB continues, like Arkinord's current experience from the renovation project in Mariager shows.

CHANGE IN ORGANISATIONAL IDENTITY

At present, Arkinord keep on working with DGNB in the DGNB-project in Mariager, where the client is again Region Nordjylland. Arkinord believes that the already accumulated experience with DGNB has given them an advantage over other design firms on the market, especially in the region (D., 2015). They are hopeful that they could get to work on even more DGNB projects, perhaps regional again. For Arkinord, the current and future development of DGNB is politically directed:

'The future of sustainability and DGNB is dictated by policy makers such as Region Nordjylland. Municipalities and regions demand DGNB in building

projects and design firms and contractors keep up with the development' (D., 2015)

In North Jutland, the prospects are, indeed, that Region Nordjylland will carry out more DGNB-projects - new buildings or renovations, as part of the *klimaregion* agreement. This would give local design companies a chance in working with the DGNB certification.

Arkinord's experience with DGNB is slowly changing the firm's image on the market, putting them one step further in front of their competitors. In the interview, JD admits that not many of their partners in North Jutland offer currently these services, except for big companies such as Rambøll, who has few of their employees trained as DGNB-consultants.

In spite of the signs that DGNB establishes a new infrastructure and organizational practice for sustainable design in Arkinord, at the moment they do not plan on investing in DGNB:

'So far, we do not plan on educating our employees as DGNB consultants' (D., 2015)

It is understandable that larger companies can afford to educate employees in DGNB earlier than smaller firms. Smaller firms like Arkinord can for the moment rely on own experience from the DGNB projects, they have participated in. At present, this temporarily causes a decreased competitiveness for the smaller firms in relation to the big actors who already have upgraded their competences with a DGNB-education.

Arkinord's decision not to train employees in DGNB can be interpreted also as a wish not to be quick to change their organizational identity. This may be due to the fact that development of DGNB is still under way. Perhaps, they do not yet consider DGNB as a something well established and steady to identify with. For instance, they have put the Low-energy classes of BR in their portfolio as examples of low-energy buildings. The Low-energy classes are part of the building legislation in Denmark, unlike DGNB which up to now remains a voluntary certification system.

Sub conclusion

Arkinord's organisational boundaries grow after the first DGNB project in Pandrup. Arkinord's interaction with an organisation with role such as DK-GBC is of new kind. Arkinord and DK-GBC participate together in a new boundary practice, where DK-GBC provides assistance during the certification process and Arkinord exchanges documentation with them (Figure 6). With regards to some conventional organisational boundaries, Arkinord's relations with the

client and the contractor broadened. A negotiation of DGNB target levels became a new practice with the client.

The organisational identity of Arkinord is not yet affected by the new boundary practice with DGNB. There are slight signs showing that the firm’s internal procedures are changing to incorporate the work processes of DGNB. However, at present, Arkinord do not think of themselves as DGNB consultants. There is no resistance in Arkinord to the use of the DGNB boundary objects, but there may be a resistance to change the firm’s established identity on the regional market. There are larger companies in the region who have changed their organisational identity towards DGNB. They may indirectly trigger change in Arkinord’s organisational identity, if DGNB develops further and becomes officially accepted.

5. DISCUSSION

In the project Hospital Pandrup, Arkinord accepted the challenge of working with a building certification in a comparatively confident way, due to their previous experience with low-energy building design. During the certification work with DGNB, collaboration was not further encouraged, because Arkinord and Lund & Staun produced the design solutions on their own. A few of the elements of DGNB played an important role for promoting communication, collaboration and innovation. DGNB incorporated well into Arkinord's existing design practices of quality assurance, 3D modelling and LCC. With DGNB, the negotiation process with the client was altered and a new relation to DK-GBC was formed. The organisational identity of Arkinord is for the moment almost unaffected by DGNB. Future collaboration in DGNB projects with larger actors may influence Arkinord towards perceiving themselves as DGNB consultants.

The shaping of design practices in Arkinord with the introduction of DGNB gives input to the debate on the role of architects for popularisation sustainability in construction. Having been influence by Lund & Staun, Arkinord is currently in a position to influence new project partners to adopt DGNB. L. Schweber concludes in her research on BREEAM that it does not cause change in identities, but has helped creating a niche market of architects, engineers and contractors who aim at specialising in sustainable design (Schweber, 2013, p. 139). Similarly, DGNB seems to have brought Arkinord, Lund & Staun and larger companies like Rambøll into a network and a new market niche to answer the demand of sustainable building in the region. Another observation from the case which is recognized also in Schweber's research is how a building certification may shift from being a normative standard to tool for control of design decisions (Schweber, 2013, p. 139). DGNB acted in the same way in the case, where both Arkinord and Region Nordjylland used as the concern of reaching DGNB silver as an argument to back up a design decision and defend own interests.

6. CONCLUSIONS

In this study, Arkinord's experiences with DGNB were reconstructed on the basis of information from the interview and articles in press. As a result of the thorough analysis of this data, answers to the research questions were found.

- In the case, DGNB's holistic definition of and approach to sustainability influenced the architects and constructor's awareness of their own understanding and knowledge on sustainable design. DGNB provided an operative definition of sustainability and it brought the architects'

attention to sustainability concepts, which they had before considered but not explicitly documented or announced in their professional profile.

- The case demonstrated that DGNB promoted collaboration between the client, the architects and the contractor, who altogether through the DGNB target levels, gained an improved and mutually shared understanding of the project goals. The architects and the contractor had through DGNB formed a common language and discussion on sustainable building design, which is otherwise not often practiced.
- It becomes evident from the case that DGNB has a good potential for innovation not only within the design practices of architects and other project parties. Innovation on the whole project level may be fully realised, when coordination of the work with DGNB is left to the designers. Such a scope of innovation would involve the knowledge of each practice and a successful knowledge flow would bring a common understanding. Knowledge flow is considered by authors in literature decisive for the diffusion of sustainable building practices in organisations in construction (Thomson, El-Haram, & Emmanuel, 2010, p. 276). Thus, DGNB has the innovation potential to improve sustainable design practices.

REFERENCES

Arkinord A/S. (u.d.). *3 steps energirenovering.* Hentet fra ARKI NORD - arkitekter Nordjylland: http://www.arkinord.dk/step_1.asp

Arkinord A/S. (u.d.). *Profil*. Hentet fra ARKI NORD - arkitekt Nordjylland: http://www.arkinord.dk/Profil.asp

Berardi, U. (2012). Sustainability assessment in the construction sector: rating systems and rated buildings. *Sustainable Development, 20*(6), 411-424.

Birgisdottir, H., Hansen, K., Haugbølle, K., Hesdorf, P., Olsen, I. S., & Mortensen, S. (2010). *Bæredygtigt byggeri: Afprøvning af certificeringsordninger til måling af bæredygtighed i byggeri.* København: Byggeriets Evaluerings Center.

Birgisdottir, H., Mortensen, L. H., Hansen, K., & Aggerholm, S. (2013). *Kortlægning af bæredygtigt byggeri.* SBi forlag.

Brinkmann, S., & Tanggaard, L. (2010). *Kvalitative metoder: En grundbog.* Hans Reitzel.

Building Green . (28-29. oktober 2015). *Building Green fagmesse for bæredygtige og energieffektive bygninger.* FORUM, København.

Callon, M. (1986). Some elements of a sociology of translation: domestication of the scallops and the fishermen of St. Brieuc Bay. *Power, action, and belief: A new sociology of knowledge*, 196-223.

Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization science, 13*(4), 442-455.

D., J. (6. november 2015). Konstruktør. (A. Hristova, Interviewer)

Ding, G. K. (2008). Sustainable construction—The role of environmental assessment tools. *Journal of environmental management, 86*(3), 451-464.

DK-GBC. (2014). *DGNB system Denmark manual for Kontorbygninger 2014 1.1 .*

DK-GBC. (2015). *Mini-guide til DGNB.*

DK-GBC. (2015). *Vedtægter for Green Building Council Denmark.*

DK-GBC. (n.d.). *Om os - om Green Building Council*. Retrieved december 2015

Flick, U. (2008). *Designing qualitative research.* Sage.

Gal, U., Lyytinen, K., & Yoo, Y. (2008). The dynamics of IT boundary objects, information infrastructures, and organisational identities: the introduction of 3D modelling technologies into the architecture, engineering, and construction industry. *European Journal of Information Systems*, 290-304.

Haapio, A., & Viitaniemi, P. (2008). A critical review of building environmental assessment tools. *Environmental Impact Assessment Review, 28*(7), 469-482.

Henderson, K. (1991). Flexible sketches and inflexible data bases: Visual communication, conscription devices, and boundary objects in design engineering. *Science, technology & human values*, 448-473.

Kvale, S. (1997). *Interview : en introduktion til det kvalitative forskningsinterview.* Hans Reitzel .

Lund & Staun A/S. (u.d.). *Om Lund & Staun*. Hentet fra Lund & Staun - Tømrer, snedker og murer i Aalborg: http://lundogstaun.dk/om-lund---staun

Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education. Revised and Expanded from" Case Study Research in Education.".* ERIC.

Nguyen, B. K., & Altan, H. (2011). Comparative review of five sustainable rating systems. *Procedia Engineering, 21*, 376-386.

Ortiz, O., Castells, F., & Sonnemann, G. (2009). Sustainability in the construction industry: A review of recent developments based on LCA. *Construction and Building Materials, 23*(1), 28-39.

Puff. (21. september 2013). Certificerede byggerier stiller krav til byggemarkedet. *Puff*, s. 10.

Schweber, L. (2013). The effect of BREEAM on clients and construction professionals. *Building Research & Information, 41*(2), 129-145.

Star, S. L. (1999). The ethnography of infrastructure. *American behavioral scientist*, 377-391.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology,translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, 387-420.

Thomson, C. S., El-Haram, M. A., & Emmanuel, R. (2010). Mapping knowledge flow during sustainability assessment. *Proceedings of the ICE-Urban Design and Planning, 163*(2), 67-78.

Trompette, P., & Vinck, D. (2009). Revisiting the notion of boundary object. *Revue d'anthropologie des connaissances*, 3-25.

Van de Ven, A. H. (2007). *Engaged scholarship: a guide for organizational and social research: a guide for organizational and social research.* Oxford University Press.

Whyte, J., & Lobo, S. (2010). Coordination and control in project-based work: digital objects and infrastructures for delivery. *Construction Management and Economics*, 557-567.

WorldGBC. (2013). *A New Era in Building Partnerships.*

WorldGBC. (u.d.). *Annual Report 2012/2013.*

Yin, K. R. (2014). *Case study research: Design and methods.* Los Angeles: Sage publications.

FIGURES

TABLES

APPENDIX

INTERVIEW, ARKINORD A/S

Noter fra interview med Jakob Dahl, Arkinord A/S den 6. november 2015

1. Hvor længe har man i Arkinord A/S arbejdet med DGNB?

Jakob Dahl (JD) er uddannet konstruktør. Han har fungeret som projekteringsleder på projektet Sundhedshus Pandrup.

2. Hvor længe har Arkinord A/S arbejdet med bæredygtighed?

Det begyndte i 2006 hvor de højere energikrav kom med i BR. Man skulle pludselig projektere i lavenergiklasser. Det lød lidt skrammeligt i starten: *Hvordan skal man lave det? Det ville nu koste meget at designe bæredygtigt.* Dengang var det også sådan, at man tænkte kun på anlægssum og der var (næsten) ikke noget fokus på driftsomkostninger. Og det, ved man i dag, er netop driften, der kan give de store besparelser.

Så det (at arbejde med lavenergi projektering) var noget svært at gå i gang med. Men det er blevet helt normalt i dag, almindeligt praksis.

Det nye BR15 kommer, men fordi man indtil nu har bygget efter lavenergiklasser 2015 og 2020, opfylder disse byggerier stadigvæk BRs energikrav og er bæredygtige.

4. Hvad var Arkinords første projekt med DGNB?

Arkinords første projekt med DGNB-certificering var Sundhedshuset i Pandrup, hvor projekteringsperioden forløb i 2012. Det er derfor det allerførste DGNB-byggeri i Danmark i alle funktionsklasser. Dengang fandtes manualerne til DGNB stadigvæk kun på engelsk, hvilket var noget udfordring.

Bygherren er Region Nordjylland. Det er der, hvor ønsket om en DGNB-certificering kom fra. Regionen har i lang tid stillet krav på sine byggerier om DGNB og det gør de også i dag. For eksempel er JD p.t. involveret på et nyt DGNB-projekt bestilt af Region Nordjylland. Projektet er udført i totalentreprise af Lund og Staun med rådgiverteamet bestående af Arkinord og Rambøll. Rambøll bringer ind en af deres DGNB-konsulenter. Det er en renovering af et hjem til botilbud i Mariager. Det planlægges, at projektet skal opnå DGNB-bronze, og de projekterende er nu i gang med en DGNB-screening. Screeningen skal nemlig vurdere, om ambitionsniveauet for projektet er opnåelig. Det ligger en del udfordringer i, at det er en ældre bygning. Renoveringen omfatter ikke hele bygningen, men det er både den eksisterende og den renoverede del, der skal opnå certifikatet. Den udeladte del er et kælderrum, der delvis er under

jorden, hvilket medfører en del tekniske udfordringer og er pga. dette blevet udeladt.

En anden udfordring for DGNB-kravene ved projektet bliver tilgængelighed, for hvordan sikrer man at tilgængeligheds kriteriet for hele bygningen bliver opfyldt, hvis man ikke arbejder med tilgængelighed i den ældre del af bygningen. Dette problem har Arkinord sendt feedback tilbage til Green Building Council Denmark om. GBC DK er meget forståelige ift. sådan nogle tilbagemeldinger. De sørger for at tilpasse DGNB-kravene til særlige situationer så at det ikke bliver firkantet.

6. Hvilke udfordringer stod man for ved arbejdet med DGNB første gang i Arkinord? (modstand mod forandring)

Ved det første DGNB-projekt var der i starten entusiasme blandt både Arkinord og totalentreprenøren Lund og Staun for at arbejde med den nye certificeringsproces. Det var ikke noget man havde arbejdet med eller kendt til, ud over den tilknyttede DGNB-auditør (Carina Hedevang (CH)). Det var netop hende der i begyndelsen sad sammen med hele projektteamet, herunder også underentreprenører fra Lund og Stauns side, og forklarede over for dem, hvad DGNB var. Underentreprenørerne blev spurgt: *I skal vide, at det her projekt vi går med, har nogle DGNB-krav. Hvis I derfor vil være med, så skal I være klare på at lave noget ekstra indsats og levere mere ift. bæredygtighed, dokumentation, osv.*

Senere distribuerede CH opgaverne blandt teamet, så at f.eks. JD kun skulle arbejde på nogle DGNB-områder. Totaløkonomi blev eksempelvis entreprenørens opgave, herunder LCC- og LCA vurderingerne. LCC- og LCA-vurderingen af byggematerialer foregik lidt særligt på projektet, for Region Nordjylland har låst materialerne. Det gør de på sine projekter. Dvs., at man stadigvæk vurder levetidsomkostninger, men det er de samme bestemte materialer man i sidste ende vælger at arbejde med, for det er bygherrens ønske.

Man indsendte sin del af dokumentationsarbejdet pr. mail.

7. Hvor stor for en indlæring krævede arbejdet med DGNB-standarden?

Der var som sagt ikke nogen, der kendte til DGNB-certificeringen, heller ikke hos Lund og Staun. Under projektering sad JD sammen med Lund og Staun og de hjalp hindanden med at blive bekendte med DGNB-standarden og bedre forstå opgaverne ift. det. Det var på denne måde et godt samarbejde.

8. Hvor mange nye opgaver ift. DGNB skulle man lave i projekteringen?

Arbejdet med DGNB og det, at man skulle dokumentere alle beslutninger mht. opfyldelse af DGNB-kriterierne, gjorde JD mere opmærksom på Arkinords egen

kvalitetssikringssystem. KS handler om at dokumentere tekniske valg og vurdere risikoområder. DGNB udvidede Arkinords KS på den måde, at man nu mht. DGNB-krav skulle dokumentere også ting der før måske var taget for givet. F.eks. at vinduer på 3. sal er driftsbillige og kan vaskes og pudses uden brug af lift. Det kunne JD dokumentere en dag, hvor han tilfældeligt så en vinduespudser bruge stig, og tog et billede af ham og håbede på at det kunne tjene som dokumentation – og det kunne godt. DGNB har gjort, at JD er blevet mere omhyggelig med arbejdet med KS.

9. Hvilke af DGNB-værktøjerne krævede ekstra indsats? (fx LCA/LCC-værktøjet)

(Det var entreorenøren, der arbejdede med LCA og LCC)

10. Udover DGNB-konsulenten på projektet, hvor mange i Arkinords team kendte i forvejen til DGNB-standarden? Hvad med de andre projektparter?

Rambøll har uddannet en af sine medarbejdere til DGNB-konsulent og derfor kender de til DGNB. Ellers kender andre ikke meget til DGNB.

11. Hvem havde koordineringsrollen ift. DGNB-arbejdet på projektet? Og så hos Arkinords team?

Koordinering af certificeringsarbejdet var CHs opgave i sin rolle som auditør.

12. Hvad var der af behov for (diskussions-)møder med DGNB-konsulenten?

Der er nogle fastlagte tidspunkter i projektforløbet, hvor der kræves levering af dokumentation til GBC. I denne forbindelse mødtes man med CH, og det var endelig ikke mere end 2-3 gange.

13. Hvor stort for et engagement krævede arbejdet med DGNB hos Arkinords team?

14. Foregik der noget samarbejde ift. DGNB med de andre projektparter?

Se spørgsmål 7.

15. Hvor gode, følte man, var mulighederne for kreativitet i bæredygtig projektering på projektet?

I Pandrup projektet skulle man f.eks. projektere en rektangulær bygningsform med gård i midten af bygningen. Dette udfordrede de energimæssige krav i DGNB, for man skulle have glasfacader og der var som konsekvens et højere varmetab. Men da man så foreslåede at ændre bygningsformen til to rektangler med fælles punkt, så var bygherrens – Region Nordjylland – svar, at *Nej, det*

koster en masse penge at lave det. På denne måde blev kreativitet ift. energitgitg arkitektur lidt begrænset pga. hensyn til udførelsens pris.

17. Har man i Arkinord siden da inkorporeret nogle DGNB-principper i sit arbejde med bæredygtig projektering?

Jeg: Kan man sige, at det er disciplinen i DGNB, som I godt kunne lide? At DGNB giver god systematik?

Ja, det kan man godt sige.

18. Hvilket værdi giver erfaringerne med DGNB for Arkinord? Hvilke fordele har DGNB givet til jeres firma i forhold til konkurrenterne i industrien?

Erfaringerne har selvfølgelig givet positive fordele for Arkinord over for andre rådgiverfirmaer i branchen. Arkinord fortsætter med at arbejde på DGNB-projekter. De planlægger indtil videre ikke at uddanne medarbejdere som DGNB-konsulenter.

19. Hvilke andre bæredygtighedsstandarder/initiativer er man i Arkinord villig til at arbejde med i fremtiden?

Arkinord har ikke arbejdet med andre bæredygtighedsstandarder/initiativer end DGNB. (se også spørgsmål 2)

20. Hvordan ser fremtiden ud for bæredygtighed i byggeriet ifølge Arkinord?

Fremtiden for bæredygtighed og DGNB dikteres af de politiske beslutningstagere som f.eks. Region Nordjylland. Kommuner og regioner stiller krav om DGNB på byggerier, og rådgivere og entreprenører følger med udviklingen.

JD var for nylig med til en paneldebat med Aalborgs borgmester og bl.a. Lene Espensen, administrerende direktør for Danske Ark, hvor visionerne for DGNB i danske kommuner blev diskuteret.