CHALMERS

Environmental certifications in the Swedish construction industry

For small to mid-sized construction companies considering to implement environmental certifications

Master of Science Thesis in the Master's Programme Design and Construction Project Management

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Department of Civil and Environmental Engineering
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2013
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ABSTRACT

Today the customers have more knowledge about the environmental issues and know that it is important to build sustainable and environmental friendly buildings. For small and mid-sized companies it can be hard to choose the right certification to spend resources on and also hard to communicate it to their customers. This master's thesis compares and analyse four of the most commonly used certifications in Sweden. The four certifications are BREEAM, LEED, GreenBuilding and Miljöbyggnad. Through interviews with personnel at different type of construction organizations we have managed to evaluate which certification is most suitable for small to mid-sized companies in Sweden today. There are some barriers involving; cost, time, quality and knowledge management that smaller companies does not have enough resources to handle. The will to change might be there but these companies needs a push in the right direction and this thesis can be the launch to such changes.

Key words: Environmental certification, BREEAM, LEED, GreenBuilding, Miljöbyggnad, small to mid-sized construction companies.

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Preface

We would like to thank all the interviewees for their support and contribution to this master's thesis. We would also like to thank our supervisor Martine Buser who works at the Department of Construction Management at Chalmers for the support and the helpful feedback.

Kim Bauer & Viktor Johansson

Gothenburg

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1 Introduction

1.1 Background

The climate change has received attention during the last years (Bonde et al 2009) and we humans and our buildings are largely responsible for this. For example buildings consume 40% of the world's energy and we use 3 billion tons of raw materials for construction annually (Lenssen & Roodman, 1995). One of the challenges with environmental construction is to reduce the energy consumption and material waste without increasing the cost or lowering the buildings' quality.

In order to reduce the negative effects from buildings and construction, several construction organizations have provided environmental certifications in order to offer a green alternative for the construction industry. The World Green Building Council has the global responsibility of many of the environmental certifications available today. World Green Building Council also have local branches with local certification systems, such as Sweden Green Building Council in Sweden with the domestic certification system, Miljöbyggnad.

The certification systems are very comprehensive, for example the British certification organization BRE with their 'BREEAM technical guide for new construction' has more than 400 pages, and they have several guides for different types of construction projects and for different markets.

BREEAM, BRE Environmental Assessment Method, was developed in the UK in 1990's and is suited for all kind of buildings from factory shells to prisons and laboratories however it is mainly used for commercial buildings such as offices. LEED, Leadership in Energy and Environmental Design, is one of the leading certifications in the U.S. and were developed in the 1990's and is also adapted to many types of buildings. With BREEAM and LEED it is possible to certify whole communities while for the domestic certification, Miljöbyggnad, you can only certify specific buildings.

Miljöbyggnad is not as extensive as BREEAM and LEED and is one of the leading certifications in Sweden today. Miljöbyggnad only considers three main areas for certification while BREEAM and LEED have several areas to cover. GreenBuilding is a European Union initiative, which was launched in 2004 and only considers the energy consumption of buildings. GreenBuilding is only used for non-residential buildings.

BREEAM, LEED and GreenBuilding are international certifications, while Miljöbyggnad is built on the Swedish legislations and regulation system.

Since the certifications are suited for different kind of buildings it can be impractical and an unnecessary drain on resources for small and mid-sized companies to integrate all systems in their company. It can also be difficult to know which certification is best suited for a specific company.

1.2 Purpose

The purpose of this thesis is to guide small and mid-sized construction companies in Sweden and provide a comparison of processes, costs and time between four different environmental certification systems that are currently used in the Swedish construction industry. The purpose is also to determine what environmental certification system that is most suitable for small to mid-sized companies.

1.3 Limitations

LEED, BREEAM, Miljöbyggnad and GreenBuilding have been studied in this thesis. The focus is on new constructions in the Swedish construction industry. However, since the American and British construction industries are more familiar with LEED and BREEAM the thesis includes studies from projects in the U.S. and UK. Four companies have been interviewed in this thesis; two of them are large construction companies that both work in Sweden and abroad, one Nordic consultancy firm and one domestic client. The companies we interviewed are larger than the ones our report aims at but we believe they have a better understanding of the systems. We tried to get more interviews and with smaller companies but most companies did not answer us at all, and the companies that answered did not have time with interviews or did not work with environmental certifications.

1.4 Research questions

What certification system is best suited for small to mid-sized companies?

In what type of projects could it be better with a different certification?

1.5 Method

This thesis is based on a desk research and interviews, with the aim of getting a better understanding of the different environmental certifications. The desk research involved gathering information from the certifying organizations' websites and technical guides. The paper also includes information from several academic papers, gathered from data bases, such as Chalmers Library and Emerald. Keywords used during the search were for e.g. "environmental certification", "green building", "LEED", "BREEAM", "GreenBuilding", "Miljöbyggnad" etc.

After the initial desk research there was a few systems that were more interesting than the other that was found. We choose LEED and BREEAM because of the wide international usage and that the systems covered a lot of aspects. Miljöbyggnad was interesting since it is a Swedish system based on the legislation and regulations in Sweden. To get another perspective GreenBuilding were investigated, since it only considers low energy usage and is only adapted for non-residential buildings. Svanen was also considered as an alternative, but the other four systems were selected.

In order to get a deeper understanding in the practice of how a company uses and chose environmental certifications, a search for suitable companies was done by sending e-mails to locally based construction companies, working with or considering different types of certifications. However many of the contacted companies did not respond or were unable to participate in interviews. The companies that were able to participate in interviews were larger than our target group, but all had experience with the environmental certifications. Some of the companies had worked with all of the certifications and one only worked with Miljöbyggnad. In order to get a holistic view of the work with environmental certifications, we tried to get interviews with people in different positions in the organisations.

Four semi-structured qualitative interviews, approximately 60 minutes each, were conducted with people in different companies with different roles. The interviews included a project manager at a nation-wide housing company, two environmental managers at two of the largest construction companies in Sweden and an office manager at a Nordic consultancy firm.

The semi-structured interviews allowed us and the interviewees to speak more freely about the subject. An interview guide were conducted with 35-40 questions in seven different categories; background, personnel, project process, energy, materials, documentation and comparison. This enabled the interview to take different paths and elaborate on topics that were not included in the beginning; due to new insights from the interviews we also had follow-up questions with the interviewees over e-mail. The information from the recorded interviews were transcribed, compiled and structured in a document, which was the basis of the findings in this thesis.

One of the problems we faced was to evaluate the actual cost of environmental certification projects. The cost we could find was the assessment, registration and educations. Many of the cost factors are hidden beneath normal duties during a project, such as documentation, materials etc. and it is hard to get an actual number of resources spent. For e.g. in order to reduce the energy consumption you might need to choose a more efficient but also more expensive HVAC system. Should this be considered as a cost of the environmental certification or a normal project cost?

We have previous experience in working in a project certified with Miljöbyggnad. The experience is from the actual construction of the building rather than from the project development stage. Interaction with the site manager informed us about differences between ordinary work and environmental certification work. The largest difference was the documentation on site with all the material handling.

2 Theoretical framework

This chapter explains the barriers for innovation and change for small to mid-sized companies. The problem for small and mid-sized companies is often the lack of resources and time in order to implement changes in their organisations. The situation in the Swedish construction industry is also evaluated within this chapter.

2.1 Barriers for small and mid-sized companies

Companies react to environmental pressure in different ways, some are proactive and aim to be leading in the field and considers environmental work as an opportunity and some only react to comply with legislation (Ángel and Junquera, 2003). The responsibility of how a company should proceed falls on the management and according to (OCDE, 1993) there are two types of managers; one who keeps it stable and avoids taking risks and a second that encourage growth and accept risks in order to take advantage of opportunities. The second type also establishes links with educational and technological organizations in order to improve their products and employees.

Azzone and Noci (1998) conducted a study with 15 companies and found that SME's (small and mid-sized companies) are more reactive and mainly followed competitors and governmental incentives. In a study conducted by Smith, et. Al (1996) they found that even if the companies aim was not to produce a greener product they did it anyway 'in pursuit of commercial aims'

Developing knowledge within a company is expensive and therefore it is necessary to be able to utilize the knowledge generated. Knowledge development is not just a onetime cost since the competences needed changes over time (Bougrain & Haudeville, 2001). According to Alberti, et. Al (2000) it is easier for larger companies to implement environmental practices than it is for SME's due to a well-structured organization and an economy of scale. SME's lack the financial resources, which prohibits them from developing environmental competences within the companies (Azzone et al (1997)).

Van Hemel and Cramer (2002) specified the most influential stimuli and barriers for environmental work. The external stimuli are customers' demands, governmental regulations, industrial sector initiatives the internal stimuli are innovation opportunities, increase of product quality and new market opportunities. The most significant barriers to environmental work are if it is not perceived as responsible, no clear environmental benefit and no alternative solution

However it is easier for a SME's to adapt to a changing environment and Alberti et al (2000) also claims that with an advanced environmental management the companies can be more efficient in dealing with unexpected events. According to Azzone et al (1997) in order to make environmental strategies possible it is necessary to have an organizational unit in charge of the environmental work.

2.2 The situation in the Swedish construction industry

The Swedish construction industry is criticised for being conservative and resistant to change. This criticism is often followed by requirements that the industry needs to become more innovative and creative. Change and innovation would lead to increased productivity, lower costs and cheaper housing with higher quality. Knowledge Management plays a central part for explaining innovation and change in the construction industry. In the report from Svergies Byggindustrier (2012) the authors state that knowledge can be developed both internally and externally.

Svergies Byggindustrier (2012) point out three important problems with change and innovation from their survey carried out in the report. The survey involved over 2 200 construction companies with at least 5 employees:

- First the respondents stated that the largest problem for construction companies is the extreme cost focus the industry has today. One historical aspect of the extreme cost focus is the law of public procurement that only focuses on the lowest price instead of other aspects, such as quality. The companies will be affected by the constant focusing on cost rather than promote innovation and change, which would lead to expensive and prolonged investments. The customers often want the cheapest solution instead of the "better". Then the construction companies have difficulties to see the benefit of investing in innovation and change.
- Time is the second parameter with 71% of the respondents, or more accurately that the time between procurement and construction is not enough. This means that there is not enough of time to plan, develop and establish new ideas or test new products before the projects start. This leads to different types of improvised solutions during projects which can lead to interruptions and delays.
- On third place with 63% of the respondents, is the profitability. An important parameter for both organizational and technical innovation, the companies often lack financial incentives to enable innovation and change. The companies' profit margins are slim and dependent on the economic situation on the market.

Sveriges Byggindustrier (2012) also points out that a notable problem with innovation is a high degree of decentralisation. This however does not seem to be a problem for the respondents. The in-depth analysis of the companies that had undergone most transformation showed that the projects uniqueness was an important barrier for innovation.

The contracts for carpenters and other workers is an important part of developing innovation and change. The traditional contracts that are used in the Swedish construction industry are based on the quantity of work instead of the quality. The respondents answered that there are not enough incentives in order to renew the work processes to increase the value for customers. Further, larger companies have more resources to enable planning and work with innovation and change, even under high work load, than smaller companies.

3 Environmental certification systems

In this master's thesis, four different environmental certification systems have been examined, BREEAM, LEED, GreenBuilding and Miljöbyggnad. The four systems measure different aspects and therefore the client and the entrepreneurs can choose what certification that is most suitable for their project. Each certification system has a number of categories and key areas where the building can score points and they will get a grade based on the combined points awarded.

LEED have seven different key areas, BREEAM have ten, Miljöbyggnad have three and GreenBuilding only have one key area. In the construction industry there have been changes towards more energy efficient buildings. Today the consumers can get different types of energy savings in their homes. Passive houses for e.g. have been an innovation that has become more and more accepted on the housing market and have set the bar high for low energy consumption.

Not only residential buildings are certified, Byggindustrin (2012) published an article, which states that more owners of malls and shopping centres want to certify their buildings and get a recite for their environmental work. Those buildings consume a lot of energy because of their freeze counters, lighting and ventilation systems. The awareness has also increased in the manufacturing industry where companies want to build factories with more energy efficient shells. An environmental certification can also help companies with building permits.

Table 1. Difference between the four certifications and their measurements. (SGBC, 2012)

	GreenBuilding	**Miljöbyggnad**	**BREEAM**	**LEED**
Energy	X	X	X	X
Materials		X	X	X
Indoor environment		X	X	X
Water			X	X
Facilities management			X	X
Waste			X	X
Infrastructure and communication			X	X
Ecology and space			X	X
Pollution			X	X
Process and innovation			X	X

3.1 Sweden Green Building Council (SGBC)

The Sweden Green Building Council (SGBC) is responsible for GreenBuilding and Miljöbyggnad certification in Sweden. They also work with adapting LEED and BREEAM to the Swedish legislation and regulations. SGBC have 186 member companies and offer their members environmental courses where they can learn about the different systems. SGBC have certified 37 Swedish buildings with Miljöbyggnad and 267 Swedish buildings with GreenBuilding. To become a member of the Swedish Green Building Council there are yearly fees depending on how large the company's annual turnover is (SGBC, 2012):

Table 2. Annual turnover and member's fee for SGBC (SGBC, 2012)

Turnover	**Yearly fee**
<10 MSEK	10 000 SEK
10-50 MSEK	20 000 SEK
50-500 MSEK	50 000 SEK
>500 MSEK	70 000 SEK

New members that join after 1 July pays half of the yearly fee for the rest of the year and companies that join after 1 October pays a quarter of members' fee. Members of SGBC have some perks including a large network of instigating companies and people both nationally and internationally, reduced education fees, workshops etc. The members also have the opportunity to engage in SGBC's workgroups and committees.

3.2 LEED – Leadership in Energy and Environmental Design

LEED was developed between 1994 and 1998 by the U.S. Green Building Council (USGBC). USGBC is a non-profit organization that consist of over 30 000 members from over 16 000 different organizations in the construction industry (USGBC, 2012). LEED have certified over 11 000 commercial buildings and registered 32 000 projects, all together this comes down to over 2 billion square feet of commercial certified area (USGBC, 2012). The LEED certification provides independent, third-party verification that a building or community is designed and built using strategies aimed at achieving high performance in key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality (USGBC, 2012).

Buildings certified by LEED should according to USGBC (2012):

- Lower operating costs and increase asset value
- Reduce waste sent to landfills
- Conserve energy and water
- Be healthier and safer for occupants
- Reduce harmful greenhouse gas emissions
- Qualify for tax rebates, zoning allowances and other incentives

According to Kibert (2005) the reason that LEED have reach acceptance throughout the industry is the engagement of so many people and organizations during the development process. Yudelson (2009) claims that LEED for New construction (LEED-NC) is the dominant rating system. Further he also state that LEED-NC is a carfully constructed rating system with a lot of people involved in the compilation process. LEED-NC was introduced in March 2000 after a two-year period of pilot testing.

LEED is divided into nine different rating systems depending on type of building:

- Homes
- Neighbourhood development
- Commercial interiors
- Core and shell
- New construction and major renovations
- Schools
- Retail
- Healthcare
- Existing buildings, operations and maintenance

The purpose of the energy category in LEED is to reduce the building environmental and economic impact associated with excessive energy use, lower operation costs, fewer contractor call-backs, better building documentation, improved occupant productivity and verification that the energy systems performs in accordance with the project requirements. Reduced stratospheric ozone depletion is also an important part of the prerequisites for the Energy and Atmosphere category.

There are some options in order to reach the goals, either you can use a computer based simulation for the whole building project where you demonstrate a 10% improvement in the proposed building performance for new buildings and identify the most cost-effective energy efficiency measures. For projects outside the U.S. a World Green Building Council member organization must examine that the local standards are equivalent to the requirements of LEED.

The energy performance is measured by percentage and how much you have reduced the energy consumption. It should also include all energy costs associated with the building and overlook the energy consumption over time. This is done through an implementation of a measurement and verification plan and covers a period of at least one year.

Reductions of waste generated from the project, extending the lifecycle of existing building stock, conserve resources, retain cultural resources and reduce environmental impacts of the new building as they relate to materials manufacturing and transport. This section also encourages usage of building products and materials that are manufactured within the region, which results in a lower environmental impact from transports.

By providing designated, easily accessible areas for storage and collection of materials for recycling as well as other waste management strategies to further enhance the recycling program. Establish a construction waste management plan to achieve these goals, considering recycling cardboard, metal, brick, mineral fiber panel, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. The waste is measured by how many percentages that is recycled, reused or salvaged.

3.2.1 Certification process

Before a company can register their project the project manager must select a LEED Green Rater, who provide technical assistance to help the project team to evaluate if the project meet all prerequisites and the minimum points needed for certification. After you have registered a project the project team can start the planning process. The LEED Green Rater will continue to work with the project team during the planning process as they perform on-site verification and documentation. When this is completed the building is ready to apply for certification. When choosing what type of rating system there can be multiple rating systems that are applicable for a project, and then you can choose system based on space usage. For e.g. LEED-NC is appropriate for high rise buildings (7 or more stories), LEED-Homes are more suitable for low-rise (1-3 stories) and mid-rise (4-6 stories) residential buildings. The certification process for LEED is divided into 5 steps:

1. **Choose**
   Depends on what type of project you are going to certify.
2. **Register**
   Registration fees for projects.
3. **Submit**
   Payment of certification review fee, which differ depending on building type and square footage.
4. **Review**
   Different time depending on building type.
5. **Certify**
   Which can be accepted or appealed. An confirmation that the building is certified.

3.2.2 Fees for some of the educations in LEED according to USGBC (2012):

- **LEED for Homes Green Rater**
  336 SEK in application fee, 1 680 SEK in exam fee
- **LEED Green Associate**
  336 SEK in application fee, 1 008 SEK in exam fee for members and 1 344 SEK for non-members. There is also a CMP renewal fee of 336 SEK every two years.
- **LEED Accredited Professional**
  672 SEK in application fee, 2 016 SEK for members and 3 024 SEK for non-members for a combined exam otherwise 1 344 SEK for members and 1 680 SEK for non-members that want to take only the exam. There is also a renewal fee of 336 SEK every two years.

Table 3. Fees for LEED New Construction

Size, area m²	**<5000**	**5000-50000**	**>50000**
Registration fee, SEK	6000	6000	6000
Combined Design & Construction Review, SEK	15000	15000-151000	15100
Total, SEK	**21000**	**21000-157000**	**157000**

**USD converted into SEK with a ratio of 6,72 (SEB, 2012-11-12)*

3.2.3 The rating system

The LEED rating system is based on a scale of 100 points, plus an extra 10 bonus points. The total of 110 points that you can achieve is divided into the nine key areas, sustainable sites, water efficiency, energy and atmosphere, materials and resources and indoor environmental quality, innovation in design and regional priority. A building becomes certified if it obtains 40 points or more:

Table 4. Table of grade and required points (USGBC, 2012)

Grade	**Points required**
Certified	40 points
Silver	50 points
Gold	60 points
Platinum	80 points

3.2.4 Criteria for certification

According to USGBC (2012), LEED seeks to minimize the buildings impact on the ecosystem. A holistic approach is used where all aspects of a building and its surroundings are included. The following nine criteria are evaluated in the certification process for new constructions.

Sustainable sites (26p)

The selection of site is important in order to minimize a buildings impact on the ecosystem. LEED encourage land developers to place buildings on already exploited land with an appropriate landscaping for that area. Land developers should try to reduce the light pollution as well as the construction-related pollution. They should also use already exploited land in order to reduce the impact on the ecosystem and waterways, both construction related pollution as well as other types of pollutions.

Water efficiency (10p)

Water efficiency tries to reduce the waste of water usage by using different types of efficient fixtures, appliances etc. Both outdoor and indoor is considered since buildings are major users of water. The outdoor water efficiency criteria can be for e.g. an efficient landscaping of a garden

Energy and atmosphere (35p)

According to the U.S. Department of Energy (2010), buildings in the United States use 39% of the energy and 74% of the electricity produced each year in the United States. By encouraging the land developers to use a smart energy strategy, such as renewable and clean sources of energy and hopefully reduce the energy and electricity usage of the building.

Materials and resources (14p)

Sustainably grown and harvested, locally produced and transported products and materials are encouraged in this category. Products that are locally produced will decrease the environmental impact on the ecosystem caused by long transportations. This will lead to a reduction of waste and an increase in reuse and recycling since the building generates large quantities of material waste during its life cycle.

Indoor environment quality (15p)

The U.S Environmental Protection Agency (2009) states that people in the U.S. spend approximately 90% of their time indoors during the last several years. There has also been an indication that the indoor air quality can be more polluted than the outdoor air in larger industrialized cities. Strategies for the indoor environment quality should improve the indoor air and acoustics and at the same time provide access to natural daylight.

Innovation in design (6p)

Innovation is an important category which provides bonus points for projects that use innovative technologies and well suited strategies will improve the buildings performance beyond the criteria. This can be satisfied by using a LEED accredited professional in the project team. This will ensure a holistic approach to the design and features of the building.

Regional priority (4p)

USGBC have regional affiliates that have identified the most important local environment concerns. This indicates the importance of knowing your surroundings and what is most important depending on where you are planning to build.

3.2.5 LEED credits for different types of buildings

The credits are divided differently depending on what type of building the certification is for:

Table 5. Example of LEED-credits for different types of buildings (USGB, 2012).

	Existing buildings	**New construction**	**Core & shell**	**Schools**	**Commercial interiors**
Sustainable sites	26	26	28	24	21
Water efficiency	14	10	10	11	11
Energy & atmosphere	35	35	37	33	37
Materials & resources	10	14	13	13	14
Indoor environmental quality	15	15	12	19	17
Innovation in design	6	6	6	6	6
Regional priority	4	4	4	4	4
Total	**110**	**110**	**110**	**110**	**110**

3.3 BREEAM – Building Research Establishment Environmental Assessment Method

BREEAM sets the standard for best practice in sustainable design and urban development and describes a building's environmental performance. BREEAM is one of the widely used environmental assessment method and rating system for buildings in the world. BREEAM was introduced in 1990 when the UK environment minister introduced the first scheme. After the launch a there was a large request for buildings being assessed and today over a million buildings have been registered for assessment and over 200 000 buildings are certified (BREEAM, 2012). BREEAM provides clients, developers, designers and others with:

- Market recognition for low environmental impact buildings
- Confidence that tried and tested environmental practice is incorporated in the building
- Inspiration to find innovative solutions that minimise the environmental impact
- A benchmark that is higher than regulation
- A system to help reduce running costs, improve working and living environments
- A standard that demonstrates progress towards corporate and organizational environmental objectives.

According to Prior (2007) the purpose of the assessment is to demonstrate to the public what buildings are better for the environment and thus make them more attractive to potential buyers. BREEAM is also a good tool in educating the public in what negative effects buildings can have on the environment and what can be done to improve the situation. BREEAM can also help in distinguishing between what buildings simply claim to be environmentally friendly and those that really are reducing the effects on the environment. However when building houses and other buildings the global environmental effects are not the only one to consider according to prior, since we spend 90% of our time indoors the choice of materials can impact our health. However using BREEAM does not begin with the certification, it begins during the first planning stages of the construction and is on-going even after the tenants move in.

When assessing a building BREEAM evaluate several categories, in the European scheme there are nine categories (BREEAM, 2012). The categories are Management, Health and Wellbeing, Energy, Transport, Materials, Waste, Water, Land Use and Ecology, Pollution and Innovation. During the evaluation, points are rewarded in each category based on the buildings performance. The points are the weighed and adjusted for the final score depending on the importance of that category, energy is rewarded up to 30 of the total 100 points while water is only considered 9. In order to get a certification the building needs to receive 30% but to receive a silver or gold certificate more points are needed. According to (Lee and Burnett, 2008) it is harder to get a high sore on energy reduction with BREEAM compared with LEED and HK-Beam, a Hong Kong environmental building certification system.

The goal is promote buildings with low energy consumption and carbon emissions and to reduce the negative effect of energy production in a way that don't lower the

building quality for the building users. And to make the users aware and in control of their energy use and have the energy locally produced with as little carbon emissions due to the building as possible. To reduce the energy usage BREEAM rewards several energy saving measures. Efficient lighting and other fixtures such as elevators refrigerators and laboratory fume cupboards, installing energy usage monitoring systems in each of the apartment/department and by using locally produced energy from a renewable source. The renewable energy does not have to cover all of the buildings energy needs however BREEAM promotes 'carbon negative' which means that the energy consumption does not result in any carbon dioxide emissions

The actual energy consumption is measured and the energy usage and carbon emissions are evaluated using sanctioned computer software. The amount of energy efficient equipment is also measured as well as the source of energy. In order to reduce the impact on the environment BREEAM promotes materials with low degree of substances that are harmful to the environment and with long durability to avoid unnecessary replacement. And to have documentation and sourcing of the main elements of the building. The materials and fixtures used should be assessed in accordance with the green guide and have low environmental impact and a traceable source. The materials chosen should also have long durability. The lifecycle impact of the materials used in the building are analysed and scored in accordance with the green book and the BREEAM mat 01 calculator.

3.3.1 Certification costs

The certification fee is a combination of the design and post construction review fee. The fees are calculated for international residential

Table 6. Registration and certification fees according to BRE (2011)

Size, area m²	**<5000**	**5000-50000**	**>50000**
Registration fee, SEK	7000	10000	14000
Certification fee, SEK	24000	28000	39000
Total, SEK	**31000**	**38000**	**53000**

**GBP converted into SEK with a ratio of 10,69 (SEB, 2012-11-12)*

3.3.2 Certification process

1. **Decide which BREEAM scheme applies**
   Dependis on the building type.
2. **Contact a licensed BREAAM Assessor or BREEAM In-Use Auditor**
   Applies for new and existing buildings and you can also involve a BREEAM AP (Accredited Professional) to help achieve higher BREEAM scores.
3. **Carry out a pre-assessment**
   With help of the assessor you can predict a likely score. This is not a certification and no final score; this is a guidance of what could be achieved.
4. **Register for an assessment**
   The BREEAM Assessor register the project as early as possible in the process.
5. **Get certified**
   You can be certified both at Design Stage (recommended) and Post-Construction Stage. The Assessor submits to BRE Global for certification, whether Design or Post-Construction.
6. **Buildings/Assets listed on GreenBookLive**
   BRE Global list for certified buildings and assets.

3.3.3 Education

BREEAM offers a course for people that want to be an assessor outside the U.K. for the price of £1475 without a yearly licence fee. (16000 SEK)

Cost: 4000:- members 5700:- non-members (sgbc.se) B-course

3.3.4 The rating system

The BREEAM rating system is based on a maximum number of score depending on what kind of building, office, school etc. The score in each category is then weighed and combined and the percentage of the maximum score is calculated. In order to receive a grade there are also a minimum score in some categories for certain grades.

Table 7. Grade and per cent of maximum points for BREEAM (BREEAM, 2012)

Grade	**Per cent of max point**
Unclassified	<30%
Pass	30% (75% of buildings)
Good	45% (50% of buildings)
Very Good	55% (25% of buildings)
Excellent	70% (10% of buildings)
Outstanding	85% (less than 1% of buildings)

3.3.5 The categories

The different categories are divided into sub categories in order to grade them. Each subcategory has a predetermined number of points with instructions of what needs to be done in order to receive the points. (BREEAM, 2011)

Management (22p)

Deals with ensuring that the project is conducted the right way with proper allocation of roles and responsibilities. It also ensures that the building meets the predetermined requirements and that there is proper documentation of the building and how it should be run. Aims to make sure the contractors follow the regulations of the U.K. compliant scheme. To ensure that the site manager keep records of energy use, water use, CO2 emissions and material transports to the site as well as making sure there isn't any waste in the previously mentioned areas. The contractor also needs to use an Environmental Management System, a plan for how to involve the different stakeholders in all stages from the planning stage of the project. And to make sure all potential users will have access to the building, such as elderly and handicapped. A third party also needs to make an evaluation of how well the building is working after completion, including feedback from the residents. A complete life cycle cost analysis including the different design options considered in the design stage.

Health and Wellbeing (10p)

To ensure sufficient light are available in the building, both sunlight and artificial, there are different regulations for different types of building. In buildings such as healthcare building there is also necessary to include green areas and other courting areas and to ensure that no air intakes are close to a source of pollution. And that there are no sources of pollution inside such as paint that evaporate toxins. It is also necessary to perform tests to ensure that there are no toxins or other pollutions in the air after the construction is completed. A computer generated modelling of temperature in the different areas of the building both during winter and summer. All water systems must be done according to regulations to avoid contaminations in the water such a legionella bacteria and feds for water coolers. Sound levels cannot exceed the regulations and sound sources outside need to be included and an acoustician need to perform the necessary tests. Bicyclists and pedestrians need to have direct access to the main entrance and bicyclists also need to have bicycle storage at the entrance. There also needs to be sufficient lighting on access roads for bicyclists and pedestrians. A security consultant also needs to be consulted regarding the layout of the building.

Energy (30p)

In order to receive all points the building (or a source credited to the building) needs to produce more carbon neutral energy than it is using, the higher percentage of other power used the less points they get. The building need to have monitors measuring the energy consumption of the different systems such as heating, cooling, hot water, lighting and other major energy consuming systems. The building also needs to give the tenants access to monitor their own energy consumption. The lights need to produce at least 50 lamp lumens/circuit Watt indoors and 60 lamp lumens/circuit Watt outside. There also need to be a time switch or a light sensor preventing outdoor lights to be turned on during the day. A study needs to be carried out to investigate the most appropriate sources of energy, preferably zero carbon emission. The building will receive an extra point if they use free cooling, such as night time cooling or groundwater cooling. The building should us tested refrigeration systems which shows low indirect carbon emissions. The exact need for escalators and elevators need to be determined by the design team in order to calculate the optimum size and number of escalators and elevators. The systems used also need to be energy efficient in such a way that the take advantage of the energy gained from transporting someone

down. Fume cupboards needs to reach national regulation in a loss of air flow the fumes should not endanger other occupants. Major energy consuming equipment should be "green" and used in ways that minimizes energy consumption. There need to be adequate and secure space internally or externally to dry clothes and means to dry the clothes, for example cables.

Transport (9p)

Depending of what type of building and access to public transportation the building will get up to 5 points. The building can get one extra point if the building provides a bus to and from the city centre supposing that many tenants come and go at the same time. If the building is in close proximity of amenities such as schools and hospitals it can get an extra point if the close proximity makes it redundant to use other transportation such as cars. If the building provides adequate bicycle storage based on type of building and number of users they will get 1 or 2 points, based on type of building. To promote alternative ways of transport 1 or 2 points will be rewarded if the building has less than the maximum number of parking spaces based on type of building and number of users. During the design stage all relevant traveling plans for the buildings users and efforts should be made to reduce the need for a car to access the building.

Water (9p)

Water using components should be water efficient and based what percentage of water is saved compared to a 'normal building' up to 5 points will be awarded. All separate sections, apartments or stores, should have a separate water meter. If any object in the building uses more than 10% of the buildings water for example a plant or swimming pool it should also be equipped with a water meter. The building needs a leak detection system to prevent major leakage in the building. Every WC area needs a water flow controller to prevent minor leakage and a timer to ensure that water is only used when needed. Irrigation systems should be water efficient and end equipped with soil moisture sensors and take advantage of rain and grey water if possible.

Materials (12p)

The building is evaluated based on the life cycle impact on the materials and products used in the building. 80 per cent of external boundary protection and hard landscaping needs to receive at least a grade A according to the 'green guide'. All elements and the materials they care comprised of are evaluated and graded, based on the combined score up to 3 points can be awarded. All thermal insulation is evaluated based volume and thermal conductivity and at least 80 per cent needs to be certified in accordance with the 'green guide'. To avoid unnecessary replacement of materials, the building needs to be designed in a way prevents damage especially in areas with high usage.

Waste (7p)

The amount of construction waste is compared with the square meters built and can be rewarded with up to 3 points. If a majority of the waste does not go to landfills an additional point can be awarded. More than 25 per cent of the materials use needs to be reused from other sites. A suitable amount of space on the construction site needs to be dedicated for recycling waste. The waste containers need to be properly labeled in order separate the different recyclable materials. The builder shouldn't finish all floors and ceilings because then the tenants can choose for themselves and don't need to redecorate when they move in.

Land Use and Ecology (10p)

75 per cent of the building needs to be on land that has been developed within the last 50 years. If the building is built on contaminated soil, which is purified by the contractor, an additional point will be awarded. The construction site needs to be on land that is considered to be of low ecological value. The building should not impact the ecology in the area or reduce the number of different kind of plants. In ecologist should be hired to try and improve the ecological value at the site. The hired ecologist should produce a habitat management plan regarding the first five years

Pollution (13p)

The building should not use refrigerants. The emission of NO_x should be minimized. The risk for flooding should be analysed and steps taken to prevent a flooding. The building should not be at risk for flooding just because the local drainage system malfunctions. The lights should not be pointed up towards the sky and besides safety lights, all external lights should automatically turn of between 23:00 and 07:00. If there is noise sensitive areas surrounding the construction site construction cannot raise the volume by more than 5 dB during the day and 3 dB during the night.

Innovation (10p)

If the building performs extremely well in the following categories, an extra point can be rewarded in each category Sustainable procurement, Responsible construction practices, Visual comfort, Reduction of CO_2 emissions, Low or zero carbon technologies, Cold storage, Water consumption, Life cycle impacts, Responsible sourcing of materials, Construction site waste management and Recycled Aggregates.

3.4 Miljöbyggnad

Miljöbyggnad is a certification based on the Swedish construction and government regulations as well as Swedish construction practices. Miljöbyggnad was previously known as Miljöklassad byggnad and since 2011; the Sweden Green Building Council is responsible for the certifications. It is relatively easy and cost effective but still effective for creating environmentally sustainable buildings. With Miljöbyggnad you will receive a certification of the important qualities of a building in terms of energy, indoor environment and materials. Miljöbyggnad is used for newly constructed and existing buildings regardless of size.

There are three grades in Miljöbyggnad, bronze, silver and gold out of which gold is the hardest grade to receive, for example it requires that the buildings energy consumption is less than 65% of the requirements of the Swedish building regulations.

The purpose of the energy usage category is to promote buildings that are designed and built to reduce the energy consumption. The buildings needs to both be able to withstand different temperatures of summer and winter with a low need of cooling and heating. Miljöbyggnad also promotes the use of renewable sources of energy.

There are no specific regulations on how to reduce the energy consumption as long as the standard building regulations are followed. However when it comes to the energy source Miljöbyggnad promotes renewable sources of energy and favours energy that comes from sun, water and wind. The buildings total energy consumption is measured during a 12-month period and compared with the requirements of BBR, the Swedish building regulations. The ratio of different energy sources is also measured.

The purpose is to promote buildings that use materials and fixtures, which don't contain any substances with harmful properties. And to have the products containing dangerous materials documented in order to handle them better if necessary. All materials and fixtures used in the building should be documented and compared with KEMI's list of harmful substances to avoid using materials that are harmful. The amount of harmful substances in the documentation is analysed in accordance with KEMI's list.

3.4.1 Certification process

1. **Registration**
   To get a building certified by Miljöbyggnad you need to register the building to SGBC. The date decides which version of manuals and clarification of certification that should be used. After the registration fee is paid and before the application have been sent there is a possibility to get answer on three questions from an administrator or the Technical Council. If SGBC don't receives the application within three years of the registration there will be mandatory with a new registration and registration fee if the building should be certified.
2. **Application**
   The application form can be printed from Miljöbyggnad's homepage. Documentations and a suggestion of grade should be attached with the application in order for the administrator to see if the building reaches the goals.
3. **Review**
   A third-part specialist review the application by controlling the data with the manuals. The control matches the results with the manuals in order to make a decision.
4. **Decision**
   When the board have approved an application the building can be certified.
5. **Certification**
   After the certification committee has approved an application, the building owner gets a certificate and a placard for the achievement. The certification is valid for up to 10 years.
6. **Verification**
   Newly constructed buildings or major renovations shall be verified after earliest one year and latest within two years. After the verification is accepted a verification fee should be paid.

3.4.2 Certification cost

Depending on if the company is a member of SGBC there are some differences in registration and certification costs of different building types:

Table 8. SGBC members' fee. Avgifter för certifiering - Miljöbyggnad (SGBC, 2012)

	Small houses	**Other building types**				
Size, area m²	**All**	**<1500**	**1500-10000**	**10000-20000**	**20000-40000**	**>40000**
Registration, SEK	2000	2000	2000	2000	2000	2000
Review, SEK	5500	10000	14000	16000	18000	22000
Revision, SEK	**Depends on the extent**					
Certification, SEK	2000	4000	4000	4000	4000	4000
Verification, SEK	4000	7000	9000	10000	11000	13000
Total, SEK	***13500***	***23000***	***29000***	***32000***	***35000***	***41000***

There are fees for transferring a certified building to another company:

Members fee: 4700 SEK

Non-members fee: 6720 SEK

3.4.3 The categories

1. **Energy use**, measures the buildings yearly energy consumption, for heating, cooling, hot water and energy used for facility maintenance. Energy used by home or business isn't included by BBR however since it affects the indoor climate Miljöbyggnad includes it in their calculations.
2. **Need for heating**, the buildings need for heating per m2 due to heat disappearing from walls floor and roof, air leakage and ventilation
3. **Heating from sun**, to avoid the need for comfort cooling the buildings should minimize the heating effect from the sun.
4. **Source of energy**, to promote renewable sources of energy the different sources are graded 1 to 4. The best sources for energy, graded 1, and are water, wind sun and waste heat, which wouldn't have been used otherwise. The worst sources, graded 4, are coal, gas, oil and nuclear.
5. **Sound**, the building is evaluated in accordance with the Swedish noise standards SS 25267 and SS 25268.

6. **Level of radon**, the level of radon indoors is measured at several places and needs to be lower than 200Bq/m3 for bronze and 50Bq/m3 for gold
7. **Ventilation**, all rooms need to have a flow of air of at least 7 liters per second plus 0,35 liters per second and m2 floor area. There also need to be a control system which regulates air flow depending on room usage
8. **Nitrogen dioxide**, the level of nitrogen dioxide indoors should be less than 40 µg per m3 for silver and less than 20 for gold. Since the level of nitrogen dioxide is dependent on the outside environment and traffic the lowest grade is bronze which is awarded when the level is above 40.
9. **Moisture proofing**, in order to avoid water damages all buildings need to be water proofed in accordance with the Swedish building regulations. There also need to be an appointed water proofing expert in charge.
10. **Thermic climate during winter**, the thermic climate during winter is determined by computer simulated PPD, Predicted Percentage Dissatisfied occupants
11. **Thermic climate during summer**, the thermic climate during summer is determined by a combination of a computer simulated PPD and by determining the heating effect from windows.
12. **Daylight**, the amount of daylight is measured indoors and is supposed tom be more than 1.2% of the light outside in all rooms such as offices, living rooms and kitchens.
13. **Legionella**, to avoid the risk of legionella spreading in the water system all out going hot water should be at least 60°C and there shouldn't be any parts of the water system where water stand still for longer periods of time.
14. **Documentation of materials and products used in the construction**. All materials and products used in the construction should be documented and the location of the products should also be documented if possible.
15. **Exclusion of dangerous substances**, all materials used in the building should be evaluated in accordance with the criteria of KEMI (kemikalieinspektionen, www.kemi.se).

3.4.4 Education

SGBC offers courses to certify people working with Miljöbyggnad. Having a certified person working in a project will enhance the work and increase the chances of getting certified. There are two curses, B (basic course) and C (certifying course) in order to be a certified person you need to take both courses and pass the exams.

3.5 EU GreenBuilding

GreenBuilding is an EU initiative launched in 2004 to accelerate energy efficiency in the construction and property sector. In Sweden, GreenBuilding has become a strong brand of energy conservation for non-residential buildings. In May 2011, about 200 buildings had been certified by The Swedish Green Building Council which is responsible for the GreenBuilding certification in Sweden. The requirements for certification of a building is a 25% lower energy consumption than before or 25% lower energy consumption than the building requirements in the Swedish legislation BBR (Boverkets Byggregler) (SGBC, 2012).

According to SGBC (2012) the reason why GreenBuilding is so popular in Sweden is because it:

- Shows costumers that your company works with the energy problem and trying to reducing the environmental impact.
- It is easy to understand and communicate within the company, to tenants and customers.
- It is a quality insurance of promised energy savings towards the customers.
- Lower overall maintenance costs.

Newly constructed non-residential buildings should have primary energy consumption 25% below building standard. There are some other objectives that can be achieved with GreenBuilding:

- Saving money by reduced energy bills
- Increasing property value
- Improving work conditions
- Growing attention of consumers and investors
- Enhanced publicity through press coverings

To become a GreenBuilding partner you have to perform an energy audit, develop and submit an action plan, which describes the measures that have be conducted. The GreenBuilding partner should also report the success of the action plan implementation.

The measurement is divided into 8 different categories: building envelope, heating, ventilation/air-conditioning/cooling, summer heat protection, lighting, control system, renewable energy sources and other. The category for ’other’ includes measures for water saving systems. On average a GreenBuilding partner performs 3-4 measurements on the building and the results are displayed as relative savings in percentage.

3.5.1 Goals for the GreenBuilding Programme

The following information is gathered from The European Commission (EC, 2012):

- The main objective of GreenBuilding is to trigger investments in energy efficiency and renewable energy technologies in non-residential buildings with focus on existing premises on a voluntary basis.
- GreenBuilding is designed to help to open up markets – in particular by increased awareness, know-how and technical capabilities, the access to finance and energy service offerings – to achieve investments with high benefits and short payback times.
- GreenBuilding wants to initiate energy efficiency investments in non-residential buildings which are clearly profitable and are based only on proven technologies.
- GreenBuilding complements and goes beyond the standards imposed by the European building directive and national building codes in force.
- By encouraging energy efficiency and renewable energy measures beyond the existing regulations which are economically viable, GreenBuilding does not stop at the implementation of state-of-the-art energy standards but actively contributes to the advancement of the present state-of-the-art in energy saving techniques in the non-residential building sector.
- GreenBuilding intends to provide information and support as well as public recognition to companies, which are ready to make commitments to improve the energy efficiency of non-residential buildings well beyond the legal requirements with measures that are proven and profitable.

3.5.2 Certification process

1. **Registration**
   The building can be registered by SGBC.
2. **Application**
   An application is sent to SGBC:s administrators.
3. **Review**
   The administrators at SGBC reviews the application and check if something more is needed. The application is then reviewed by the GreenBuilding committee.
4. **Clarification**
   The applicant gets a notification whether or not the application needs further information or not.
5. **Certification**
   The application is sent to the EU for final control.
6. **Publication**
   When the building is certified SGBC publish the building onto their webpage.
7. **Verification**
   The yearly energy savings should be reported to SGBC.

3.5.3 Certification costs

Table 9. GreenBuilding fees according to SGBC (2012)

Registration fee	
All type of buildings	4000 SEK
Review fee	
Existing building	5000 SEK
New building	8000 SEK
New complex building	12000 SEK
Transfer fee	
Transfer of certified building	4700 SEK
Additional fees	
Late complementary	5000 SEK
Grasp complementary	3000 SEK
Extended review fee	5000 SEK
Other	700 SEK

4 Comparison of the certification systems

To make a comparison between the different systems we have chosen three types of buildings for comparison. One smaller building type consisting of single homes, one type of mid-size buildings for multi-residential buildings and one for larger projects such as several multi-residential buildings or larger malls. This enables us to compare the different certifications in terms of process, education and cost. The process overlooks the whole chain of steps that is needed in order to certify a building. A company that is going to start a project and aim for a certification should have a person that has the right education for managing such a project. We compared the different educational fees for one person so that he or she can evaluate the project and help the company to reach their goals.

4.1 Cost

Three buildings with different size have been compared and the cost of certifying them. Miljöbyggnad is the cheapest one while LEED seems to be cheap for smaller buildings they are almost four times as expensive as Miljöbyggnad for larger buildings. GreenBuilding is considered for two types of industrial factories, one simple and one that is more complex such as hospitals. These costs are only for registration and certification; all costs regarding design and documentation are excluded.

Table 10. Certification cost for different square meters

	1000 m²	**15000 m²**	**60000 m²**
BREEAM	31000	38000	53000
LEED	21000	49000	157000
Miljöbyggnad	13500	32000	41000
	New building	**New complex building**	
GreenBuilding	12000	16000	

4.2 Education

BREEAM and LEED have their own courses that they offer both online and with a teacher, Miljöbyggnad have two different courses offered by SGBC. SGBC also offers courses in BREEAM and LEED, but those are just basic courses and not for assessors and accredited professionals. BREEAM is the only system where it is required to have an assessor in the building project, however LEED and Miljöbyggnad recommends that you use a certified person in the project to overlook the process from the design phase to the review. According to SGBC (2012), projects with a certified person have a higher success rate.

Table 11. Education for the different systems

	BREEAM	**LEED**	**Miljöbyggnad**	**GreenBuilding**
Title	Assessor	Accredited Professional	Certified Environmental Coordinator	N/A
Time	3 day course	Online course	2 day course*	1 day course
Cost, SEK	16000	2700 + 300 renewal fee (every 2 years)	7400*	3700
Mandatory	Yes	No	No	No

**Sweden Green Building Council offers two courses in Miljöbyggnad, one basic course and one advanced course to become a coordinator.*

4.3 Processes

The processes are similar, even if there are more steps do not mean that it takes more time to get an assessment. Miljöbyggnad and GreenBuilding have verification after the certifications have been completed to ensure that the buildings meet the requirements post construction. All systems require that you register the project to the specific organization that handles the certifications.

Table 12. The certification processes

BREEAM	**LEED**	**Miljöbyggnad**	**GreenBuilding**
Decision phase	Decision phase	Registration	Registration
Contact assessor	Registration	Application	Application
Pre-assessment	Submit application	Review	Review
Registration	Review	Approval	Clarification

Certification	*Certification*	*Certification*	*Certification*
GreenBookLive listing		Verification	Publication
			Verification

5 Findings from interviews

Four interviews were carried out with different types of organizations involved in the Swedish construction industry. The interviewees all had a long career in the construction industry. One interviewee worked as a project manager and building leader for a nation-wide housing company. Two of the interviewees worked in two of the major construction companies in Sweden, which are active, both domestic and internationally. And one interview with an office manager at a Nordic consultancy firm was carried out.

During the interviews a semi-structured interview guide were used, this allowed the interviewees to speak more freely about the topic and also enabled follow-up questions that were not taken into consideration before the interviews. Each interview guide consisted of 35-40 questions divided into several topics such as; background, personnel, project process, energy, material, documentation and comparison. The interviews took place at the respective interviewee's offices and lasted for 45-60 minutes.

5.1 Education and adaptation

All interviewees claim education is an important part of performing environmental certifications. The manager at the housing company says they have had several different educations during the projects both within the company and for the entrepreneurs. "When we started this project we understood that it was very important that everyone involved in this project knew what we were going to do. It is important that the people in our sales department knows what they are selling for e.g."

Construction company 2 have a certain division that takes care of the actual certification, but the involved employees are always educated within the system. Some new routines have been implemented in the company's management system. Construction company 2 also educates the tenants in the certified buildings environmental certification with a binder they get when they move in to their new home.

The project manager at construction company 1 believes that it is important to keep the knowledge within the company and they do not use any consultants for these types of projects. They have a technical division that have the responsibility of learning and teaching about the different systems. She feels this enables them to have a holistic view of the projects and environmental systems. They educate their customers and tenants through their website where they have an application that teaches the tenants how to use their property to its full potential.

Consultancy firm don't have people educated in BREEAM and LEED in Gothenburg but in other offices. In Gothenburg they only have people educated in Miljöbyggnad and the office manager thinks they need to create a new position for someone as an environment coordinator in order to deal with these issues. Their consultants in bream and LEED are more expensive than those for Miljöbyggnad since it cost several hundred thousand for a company to learn the system and it is expensive to keep people certified. With LEED and breed it also takes more hours to complete a project.

5.2 Marketing

The PM at the housing company thinks that it is a good way of promoting the company if you are involved in different type of environmental work.

Construction company 2 have selected their certifications through their costumers and educated them self in what the customers wants. This is considered to be a competitive advantage against the other actors in the industry. The civil engineer from construction company 2 stated that it is the demand from costumers that determine which systems/certification that the company adopts. Construction company 2 claims to have higher ambitions than what the system requires, but that can be hard to communicate to the customers. It is god to have a system to rely on and refer to when they explain the environmental alternatives.

The project manager from construction company 1 says that clients are starting to demand that projects should be certified, but the customers lack the knowledge about the systems. Sometimes the demands are too high and they have to explain that it´s impossible to reach those goals. If client wants to sell the property on the international market and they want to use an environmental certification that is suited for these types of projects. There are limitations on what type of projects you can use the different systems.

The office manager at the consultancy firm believes environmental systems are a good marketing tool both for builders and property owners. However she thinks that if residents are going to pay extra for a certification they need to see the advantages with an certification such as lowering energy cost and that some costumers demands an environmental certification. They have several projects with environmental systems on-going today and she claims there has been an increase in demand for environmental systems in the last years.

5.3 Value

One argument that the PM at Housing company stated was that you have to consider what is more important in specific situations. For e.g. if it's worth going back every five year for maintenance or if it's more valuable to invest in something that is more durable but worse for the environment. According to the PM the board took the initiative to introduce Miljöbyggnad because they wanted to produce better houses and try to increase the brand equity. The organization set new aims during 2008-2009 when they wanted to be the leader of environmental construction on the national market for housing companies.

One of the big construction companies in the Swedish construction industry (here on called Company 1) started working with environmental certification work because it is a good way of organising the environmentally work and communicating environmental work to customers.(construction company 2)

5.4 Comparison between different systems

Housing company have 5 different values in their policy which are; indoor environment, energy, materials, chemicals, transportation and waste. Three out of these five are included in Miljöbyggnad and the other parameters are also taken into consideration. Since the housing company is active on the Swedish housing market they have chosen to work with Miljöbyggnad since it is the certification best suited for their needs on the domestic market. Housing company's first certified project began in 2009 and it is estimated to be completed in the fall of 2012. According to the PM, some of the requirements in Miljöbyggnad can be a bit tough to reach but not all of the requirements are hard to meet.

According to the project manager at construction company 2, GreenBuilding is only for commercial buildings and LEED is not very suitable for housing projects

The project manager at the construction company 1 says that when it comes to picking a system you have to consider what the different systems prioritise, what you feel are the most important parameters and how much money you want to spend. At their own-developed housing projects they always use BREEAM

The office manager at Consultancy firm considers Green building to be an out-dated certification system since it only considers energy and the office managers believes that you will regret only using green building in ten years since we today have better and more holistic alternatives. The office manager said that the construction industry is constantly moving forward and most companies was focusing on energy 10 years ago and today the companies also need to focus on other areas like material and biological diversity. They use BREEAM, LEED and Miljöbyggnad but not Svanen. They don't use Svanen since it is limited and is not connected to the Swedish environment regulations and you only get a certification, meaning that just because you get a certification it is not certain that you for fill the legal environmental requirements. With Svanen you also need to use products approved by Svanen which limits the range of products.

If the building is for Swedish tenants the office manager don't believe there is any point in using BREEAM or LEED and that Miljöbyggnad should be used instead. Since Miljöbyggnad is based on Swedish regulation the office manager thinks all project managers should have the knowledge to get bronze. However she believes one of the advantages of using bream or LEED rather than Miljöbyggnad is that it can be easier to get extra points for a higher grade because Miljöbyggnad is very strict and not that flexible in order to get extra points to compensate for low points in one area. The office manager also says she heard when it comes to materials you will get gold in BREEAM and LEED just by following the Swedish regulations but not with Miljöbyggnad which requires more.

5.5 Energy

According to the environment coordinator at construction company 2 energy is the most important parameter in environmental work.

The project manager at construction company 1 thinks it is important not to lower the quality of the indoor environment in order to reduce the energy usage. They have been working with the reducing energy usage along time, even before environmental systems, which made it easier to reach the requirements from the different systems.

The office manager at Consultancy firm claims that most clients want to reduce the energy consumption by 25%, (green building requirement), anyway since it will save more money than it cost.

5.6 Documentation

The environment coordinator at construction company 2 feels that documentation is a category which can be tricky to deal with, for example sometimes it can be easier to use concrete walls instead of wood since the documentation can be harder for wood.

The project manager at construction company 1 says they used a lot of documentation before they started to work with the environmental certifications but she believes that the documentation they used before was less extensive then for a certification.

The office manager at the consultancy firm thinks there should be as much documentation in all projects as there are in Miljöbyggnad and that the documentation in BREEAM and LEED is far more extensive. However she believes the documentation will be easier when the Swedish versions become available.

5.7 Materials

Construction company 1 uses a special database in order to evaluate materials in projects. The suppliers register their own products in the database. There are a lot of things that can be developed in the different systems, construction company 1 work a lot with documentation and the substance in chemical products. The project manager at construction company 1 considers materials as one of the more important parameters and the project manager also thinks that you can make a lot with it in the construction industry. When construction company 1 do "green" tenders they try and buy from local suppliers but it's usually more expensive and unfortunately it is the cost that motivations the long transports in the construction industry.

The office manager at Consultancy firm prefers SundaHus rather than Byggvarubedömningen since it contains more articles and it is easier to introduce new ones.

5.8 Problems

There are a few problems associated with the certification systems and the Environmental Manager at construction company 2 thinks that all of the systems still have children's disease and that there are some differences in the regulation about

materials and you perform the project. The office manager at housing company also identifies some problems such as the cost and she claims that due to the cost, certifications are not used in refurbishments of residential buildings.

6 Discussion

This section covers different topics that are important for companies that are willing to implement environmental certifications into their organisations. It compares and combines information from the previous sections and elaborate on the topics that the authors considers being most relevant.

6.1 Cost

According to Udall and Schendler (2005) a LEED certification normally ads 1-5% to the project cost, but just the paperwork of LEED-certifying a building could result in a cost increase of as much as 75 000$. Since building green and choosing green alternatives is expensive this would have a major effect of the project cost. The office manager at Consultancy firm also confirms the high cost of LEED documentation. She claims that the documentation of LEED and BREEAM is far more extensive than that of Miljöbyggnad. According to Bonde et. Al (2009) the high cost of certifying a building can have an adverse effect when choosing environmentally friendly alternatives. This result in some builders choosing to spend money on green alternatives rather than using a certification system.

There are problem when assessing the cost of certifying buildings, since some of the cost could both be counted as normal project costs and a cost for the certification. For e.g. BREEAM and LEED have specific requirements regarding elevators and the elevators that meet the requirements might be more expensive than a regular elevator. This means that the certification have added a cost to the project but it is hard to assess the actual cost increase since it is not certain which elevator you would have used otherwise. This is just one example of materials that might change during a project and will affect the end cost of the project. Certifying a building will also increase the cost for hours spent during the planning phase, however this is also hard to evaluate in actual cost. The only way to accurately determine the cost of certifying a building would be to design the same building with and without an environmental certification.

6.2 Time

In our findings we presented that GreenBuilding is the overall fastest system to certify with since it only considers the energy usage of the building. Miljöbyggnad is also fast since it only covers three areas, while using BREEAM and LEED are more time consuming since the application needs to be reviewed by the respective organizations. We think that it does not really matter if you get a certification after e.g. two months instead of four.

6.3 Process

The processes for the applications are similar. Miljöbyggnad and GreenBuilding have a verification period after completion where you have to re-measure the buildings performance in order to keep the certification. We think that the verification is a good think since it will enable a sustainable sector and reduce cheating. There are also some slight differences when it comes to the actual applying of the certification. For e.g. it is required to involve a professional coordinator in a BREEAM project in order to make the assessment available and the coordinator will help the project team to evaluate their work.

6.4 Education

The courses that are available for the different certifications are either a one day or a two day course. LEED even have an exam online in order to educate their Accredited Professionals. Is there really enough time to learn the whole extent of a certification in 24 or 48 hours? In order to become a LEED Accredited Professional it is required that you participate in a LEED-project before you can apply for the position. It is important to get a holistic approach to the certification and LEED's requirements are very good. This enables the applicant to have a basic understanding of what is necessary in order to deliver a certified project. The other certifications educations courses are a bit vague. Is it only a turning paper course or is there some actual learning about the systems structure?

6.5 The systems have different qualities

LEED and BREEAM are certifications that consider more aspects of the building, not just the construction of it but also the surroundings. There are some aspects that might end up wrong in the priority list if you choose to work with LEED or BREEAM. For the Swedish construction industry we think that Miljöbyggnad is more suitable since it is developed for the Swedish market. A wider thinking is good if you do it the right way, Miljöbyggnad have a very detailed structure and is continuously improved by feedback from projects. The children's decease will sooner or later disappear and the system will work at full capacity. Miljöbyggnad only consider the building and not at the surrounding community, this could be a good feature to add, but we think that in the long run people will not use such a certification just because of the land developing process. Since you will get lower overall points if you plan to build on an area that has not been exploited yet.

BREEAM is under development for Swedish legislation and regulation and will be finished in 2014. When it have been applied to the Swedish industry we think that it can be hard for companies to choose, but SGBC says that it will take longer time for a building to become certified if you use LEED and BREEAM since their organizations must review the application and not just SGBC. While Miljöbyggnad seems to be very popular right now and there are a lot of project that want to be certified SGBC have made a special committee just for Miljöbyggnad to make the process quicker. (SGBC, 2012)

GreenBuilding is only a verification that you have reached the goals and we think that GreenBuildings requirements should be completed on all building projects that are non-residential. According to SGBC (2012), today it is "easy" to reach those goals according to the consultant and one project manager that we interviewed.

6.6 Energy

The purpose of the energy category in all systems is to reduce the negative impact on the environment by unnecessary use of energy. This is an important if not the most important part in all four systems. This is especially important in green building where it is the only category. The focus on energy is not just a way of improving the environment but it also has a direct impact on the cost of the buildings running cost. According to the office manager at the consultancy firm lowering the energy consumption by 25% will save more money than the extra initial cost of extra insolation and more efficient heating system. According to the US department of energy (2010) 39% of the energy used in America is consumed by buildings, which

means that a reduction by 25% would have a huge impact. According to Newsham et.al (2009) LEED buildings on average used 18-39% less energy than their counterparts but this wasn't true for all buildings and 28-35% of the LEED certified buildings actually used more energy than their conventional counterparts.

However in a response to the article Scofield (2009) argues that the mean energy consumption was not lower if measured in square feet including all buildings relative to their size. The reason for the different result is that in Newsham's study there were a few smaller buildings with low energy consumption used as "trophies" where it could be justified to spend extra money in order to get a very environmentally friendly building where the energy savings did not compensate for the initial cost. However with some of the much larger buildings the cost/benefit was more important. Therefor the energy usage was the same as in a conventional building. Scofield (2009) also claims that in the larger buildings the design team used cheaper solution in order to receive LEED points such as bike racks and employee showers. This standpoint is also supported by the office manager at the consultancy firm, who argues that with BREEAM and LEED it is easy to get extra points without significant environmental effect to compensate for lower points in other areas.

This is further supported in a survey conducted by Udall and Schendler (2005) a respondent stated, "We received one point for spending an extra $1,300,000 for a heat recovery system that will save about $500,000 in energy costs per year. We also got one point for installing a $395 bike rack. This must be corrected."

6.6.1 Source of energy

The certifications do not just consider the amount of energy consumed but also the origin of the energy where renewable sources, such as sun and wind are promoted. Sometimes however this does not work as you would think. According to Udall and Schendler (2005), when using a geothermal heating system they were not allowed to compare it to alternative such as gas-fired heating system (which they could have installed), instead they were forced to compare it to a different geothermal heating system. This means their system of choice would score lower than an efficient gas-fired system, which clearly was a worse alternative for the environment.

6.7 Materials and waste

The overall intention with the materials category seems to be that LEED, BREEAM and Miljöbyggnad promotes locally produced materials with a low degree of dangerous substance. To keep track of all materials the interviewed companies uses different types of databases in order to check what materials that is suitable for their projects. The databases are often third party companies that collect data from the manufacturers or let the manufacturers apply for their products. In Sweden there are some domestic databases called BASTA, Byggvarubedömingen, SundaHus etc. which are widely used in the industry. The databases track all substances in the materials and also grade the materials. The client which was interviewed in this thesis worked with Miljöbyggnad and had chosen SundaHus as their database. Together with SundaHus the client had compiled a list for their contractors where they could use products that had a specific grade or higher.

Waste management is also an important parameter when it comes to material usage. LEED advocate the importance of providing easily accessible areas for storage, recycling and collection of materials. BREEAM promotes usage of materials with long durability to avoid replacing material before it is needed.

"Reducing construction waste is becoming a key environmental issue in the construction industry. Construction waste reduction should be considered at an early stage and by all parties involved in the building process." C.S. Poon (2007)

6.8 Legitimacy

LEED and Miljöbyggnad are operated by national green building councils in corresponding countries, while BREEAM is now days operated by a private foundation. GreenBuilding is the only certification that is operated by an organization that is not founded by branch organizations. The board of the different green building councils have members from construction companies and that might be an issue if the board decide to lower the requirements in order for more companies to reach their goals. If the organizations behind the green building council pushes the board into this there might be a problem in the future.

6.9 Marketing

Customers are becoming more and more environmentally aware. From our interviews we got answer that the clients often have unreasonable demands on the construction companies and that the clients did not have enough knowledge about the systems in order to make a good estimation for the projects. The interviews thought it was nice publicity to use a certification system and it will also be a part of most companies environmental profiles. One issue of this could be the fact as we mentioned earlier that for e.g. Miljöbyggnad have daylight as a aspect for their certification of indoor environment and if the building is placed near tall buildings that will reduce the daylight this might cause problems with the certification level of the building. It also seems to be a good think to use GreenBuiling on non-residential buildings since the companies we interviewed tries to reduce the energy in accordance with GreenBuilding even if they do not certify the buildings. This is something that can be good for marketing a company.

6.10 Rents

According to (McGraw Hill Construction (2010). Green Outlook 2011) occupancy rates are higher with LEED due to people preferring to live in a place they can be proud of and "Bragg about". The higher rents is also supported by Fuerst and McAllister (2008) who examined rent levels between LEED and Greenstar versus conventional buildings while taking location, occupancy rates, and building age in consideration. They found rent levels to be 11,5% higher with certified buildings. However according to Udall and SCHENDLER (2005) this effect might just be temporary since more and more buildings are becoming LEED certified.

6.11 Regulations

The Swedish government have decided to handover a society where the large environmental problems are solved to the next generation in 2020 (boverket). This means that the construction industry will have to adapt to these new requirements and construct buildings in a more environmentally friendly way. If construction companies start working with tougher environmental issues before the regulations are introduced they will have an advantage towards competitors who wait. According to a study by Fiedler and Deegan (2008) when companies collaborate with environmental organizations the pressure from the government will decrease and it will increase the companies' credibility. Working with environmental certifications is part of corporate

social responsibility in which corporations introduces rules stricter than those of the law with an intent, among other, to reduce introduction of new stricter laws. If the local government believes the industry to be reliable they are more likely to allow companies to be self-regulatory. (Albareda 2008).

However regulations can also be an advantage for companies according to Costantini and Crespi (2008). Introducing tougher regulations can create a competitive advantage for a country's companies since it forces the companies to be more efficient and create better products and processes this is also supported by Gann et.al (2010) who claims that construction regulations can encourage and drive innovation in construction.

6.12 Theoretical frame

There are some problems for SMEs to when introducing environmental systems both regarding the limited resources of the companies and the incentive to do so. The two problems are related since the cost creates a substantial risk either if the implementation fails or if there is no demand for that type of service. However due to the inefficiency of the construction industry and the attention environmental work receives today lack of demand for constructing more efficient building should not be a problem. A more crucial issue is to implement a system that is suitable for the company's resources and is widely used in the area the company normally operates in or wish to enter. This is to ensure that the company have use of the system and they do not integrate a system mainly used for commercial buildings if the normally builds smaller residential buildings.

7 Conclusion

This thesis has tried to guide small and mid-sized companies in the Swedish construction industry in how to choose an environmental certification system. It can be hard for companies to choose the right certification depending on what type of project they are planning. There are many factors in determining what certification is best suited. The most important criteria is the customers demand, if the customers want to build residential buildings, then GreenBuilding is not an alternative since it only deals with non-residential buildings. However if the goal is to build an office build for e.g. and get an environmental certification at a very low cost and with lower requirements, then GreenBuilding is an alternative, since it only considers the energy consumption.

Another important aspect is the cooperation with other companies, if a certain system is widely used by companies that often are involved in the same projects, implementing that system will ease the cooperation and also increase chances for future projects. Investing in environmental certifications is a good strategic move for most companies, since environmental regulations and the demand for environmental certifications only increases and it can be hard to catch up if a company falls to far behind in environmental work.

In order to not fall behind other companies, small and mid-sized companies may copy successfully implemented strategies in larger construction companies for dealing with environmental certifications. An important aspect is that small and mid-sized companies do not have the same kind of resources in their organisation and therefore they need to adjust their organisation to environmental work that is most suitable for their organisation.

Research questions

What certification system is best suited for small to mid-sized companies?

Today Miljöbyggnad is the most suitable certification for most small to mid-sized construction companies and residential buildings today since it is easy to use, not as expensive and largely based on the Swedish construction regulations. BREEAM and LEED are more extensive systems and based on UK and U.S. regulations. This means that it is harder to learn the requirements for certification and there can sometimes be a conflict between the certification and the legislation and common practice in Sweden. However when the Sweden Green Building Council have adapted LEED and BREEAM to the Swedish legislation and regulations it will ease the certification process.

In what type of projects could it be better with a different certification?

If you want to build a commercial building for international costumers it could be better to use BREEAM or LEED since it is widely known trough out the world and some companies demand a BREEAM or LEED certification for their offices. However it is more expensive and time consuming, GreenBuilding can be an alternative to use when the goal is to get a certification on a budget.

Further studies

Due to difficulties in separating normal project cost from certification project cost it can be hard to get actual numbers for resources spent on implementing an environmental certification this is a good area for further studies. In order to get a holistic view of the cost of certifying a building, a good starting point would be to investigate several similar building projects and track and compare the costs of the regular buildings and the certified buildings.

The Swedish Green Building Council is ready to launch Swedish versions of LEED and BREEAM and it will be interesting to study the converted certifications and match them against Miljöbyggnad. Svanen, which is another domestic certification system in Sweden have not been taken into consideration in this thesis. It would be interesting to compare this system further after the evaluation of the four systems included in this thesis.

There are 281 buildings certified in GreenBuilding and 43 certified in Miljöbyggnad, however over 400 buildings are registered to become certified in Miljöbyggnad and 300 for green building. It is not clear why there is such a considerable difference for Miljöbyggnad between registered and certified buildings. Some of the difference is probably due to buildings that are not yet completed. However there are probably some buildings that register for a certification and later choose to skip the certification and some buildings that did not pass the examination. This could be an interesting area to study and to investigate what percentage of buildings that intends to be certified in the planning stage but for some reason are not certified in the end. It would also be interesting to research for what reasons buildings are not certified.

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