Natnael Bedaso

Major Building Certification Systems Used in Finland

Metropolia University of Applied Sciences

Bachelor of Engineering

Thesis

3 December 2018

Helsinki Metropolia University of Applied Sciences

Author Title Number of Pages Date	Natnael Bedaso Major Building Certification Systems Used in Finland 33 pages 3 December 2018
Degree	Bachelor's Degree
Degree Programme	Civil Engineering
Specialisation option	Sustainable Building Engineering
Instructors	Jorma Säteri ,Head of Department Heli Kotilainen,CEO of Organisation Jessica Karhu ,Senior Sustainability Specialist

In this final year project, the aim was to have a detailed description of major building certification systems used in Finland. The project also aims at finding what shared value exists between major certification systems used in Finland. Not only shared value, but also the real performance of certified buildings was among the main targets to be assessed in this final year project. To achieve the goal of the final year project, practical data collection and literature review was done.

The final year project clarified about three major certification systems used in Finland, LEED, BREEAM and Green Building Council's performance Indicators. Since analysing the performance of LEED and BREEAM certified buildings was among the aims of this project, several buildings were selected for the study. Green Building Council's performance Indicators were chosen as an assessment tool for the inspection of the certified buildings.

The final year project revealed that the major certification systems used in Finland all share the same value of guiding projects to operate in an environmental friendly manner. Nevertheless, collecting data to examine the performance phase of LEED or BREEAM certified projects was challenging. The data collected was insignificant in order to draw a conclusion about the performance phase of selected buildings for the study. In the future, more intensive data collection is required to know more about the performance phase of building projects.

Keywords	LEED, BREEAM, certification systems

Contents

List of Abbreviations

ASHRAE- American Society of Heating, Refrigerating and Air Conditioning Engineers

BRE - Building Research Establishment

BREEAM - Building Research Establishment's Environmental Assessment Method

EA – Energy & Atmosphere

GBC Finland – Green Building Council Finland

GBCI - Green Building Certification Institute

IAQ – Indoor Air Quality

LEED - Leadership in Energy & Environmental Design

LEED BD+C – LEED Building Designing + Construction

LEED CS – LEED Core and Shell

LEED ID + C – LEED Interior Design + Construction

LEED NC – LEED New Construction

LEED ND – LEED Neighborhood Development

LEED O+M - LEED Operation + Maintenance

LT – Location and transport

MR – Materials & Resources

SS – Sustainable Site

WE – Water Efficiency

USGBC - U.S. Green Building Council

1 Introduction

The idea of sustainability has lately become a major concern. Plenty of global regulations have been discussed to protect the well-being of the environment we live in. The process of building construction also has an adverse effect on the environment. A survey conducted in 2004 showed that buildings account for 40 percent of the CO_2 emission in the United States of America. The value stands above the emissions caused by transportation or Industry. [1.] This was among the reasons for the foundation of the GBC Finland in 2010. GBC Finland which stands for Green Building Council Finland is a nonprofit organization which helps the real estate and construction industry take a step forward towards sustainability. [2.]

GBC Finland has come up with a tool which helps the real estate and construction industry reach the desired level of sustainability. The tool is called building performance indicator. The building performance indictor has two parts. One deals with the design phase, while the other is used to assess the occupancy phase of a building. The assessment of a project with GBC Finland's tools grants building passport once the process is finished. [2.]

Developed countries have put together several certification systems for building projects. Among the famous ones are LEED V4, DGNB and BREEAM. Although the aim of all certification systems is the same, the requirements vary to some extent. There are buildings which are LEED certified and others that are BREEAM certified in Finland. [3.] LEED and BREEAM both demand lots of information. Since there are different certification systems, a question arises as to which one to choose for the assessment of a project.

2 LEED

LEED stands for Leadership in Energy and Environmental Design. It is a green building certification system put together by the United States Green Building Council (USGBC). With the growing concern on climate change, the demand for sustainability was large. The USGBC was formed to address matters concerning sustainability of Buildings. The USGBC journey started with the launching of the first pilot project in 1993. Stationed in Washington DC, the non-profit organization released the first LEED version in 1998. The content of the certification system grew broader with the release of LEED version 2 in 2000. In LEED version 2, major renovation and building types like schools became eligible for LEED certification. USGBC was the only organization dealing with LEED Certification. That came to an end on January 2008 with the joining of Green Business Certification Inc. (GBCI). GBCI, an independent subsidiary, took control of the matters relating to business. From January 2008 on GBCI took the responsibility of granting the certificate including the necessary documentation process. [3,4] The LEED content kept adapting to the changes in the building sector and demand in sustainability. The recent LEED version is LEED version 4, released in 2014.The previous version LEED V3was launched in 2009.The later version v4 came up with additional categories which are believed to be a better guideline in terms of assessing a project.[3,5.]

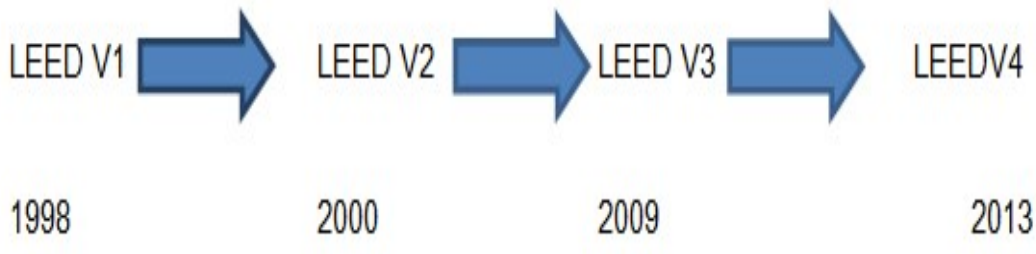

Figure 1. Major LEED Version Changes [5].

2.1 LEED Concept

LEED is a widely accepted green building certification system. At first, LEED was developed for projects which are only located in the Unites States of America. [3] However, LEED obtained major popularity which caused further developments of the certification system in order assess different type of projects across the world. The certification is grated when certain criteria, set up by USGBC, is fulfilled by a building project. LEED is a voluntary certification system which also acts as a tool to advertise the idea of green building to the general public. The target of the certification system is not onlylimited to making sure that a building project is environmental friendly. The certification system also aims to set a guideline for creating a favourable standard for the occupants of a building. LEED standard requires buildings to create a healthier environment by diminishing the adverse effects of a building. [6.]

LEED provides a third-party verification system which is internationally used as an international benchmark for sustainability. The standards set for the certification process of LEED fall in different sectors. Apart from dealing with new construction, LEED addresses different types of building projects. Health care centres, homes, schools and major renovations are among the projects eligible for application of LEED certification. LEED also contains a rating system for neighbourhood development. [7.]

2.2 LEED v4 Rating Systems

LEED has different rating systems which suite wide categories of project types. The rating systems have their own prerequisites that should be fulfilled in order to earn a certification. The project team is responsible for selecting the appropriate rating system by considering a guidance that is setup by the USGBC. The main LEED rating systems are discussed in detail below.

Building Design and construction

The LEED rating system provides a framework in which new building projects can reach an advanced level of energy efficiency, better operating systems and well-being being for the occupants. LEED for building design and Construction is applicable for all project types. There are separate sets of requirements under LEED building design and construction for the following sectors, each of them discussed in more detail below.

1. New Construction and Major Renovation
2. Core and Shell development
3. Schools
4. Retails
5. Data centres
6. Warehouses and Distribution centres
7. Hospitality
8. Healthcare. [8.]

Interior Constriction

Interior construction rating system is perfect for project teams which do not have control over every part of the construction. The rating system allows the project team to focus specifically on interior design and construction. People spend 90% of their time indoor which makes interior design and construction a major issue. Interior design and construction has a major impact on productivity and the well-being of occupants. The interior construction rating system can be used to rate any type of project. Nevertheless, LEED has put together a separate set of requirements under interior construction rating system for the following sectors: commercial, retail and hospitality. [9.]

Building Operation and Maintenance

Building operation and maintenance rating system is applied to existing buildings. Replacing all the existing buildings with new ones not only consumes large amount of resources but also takes long period of time. Therefore, the existing buildings should be driven towards operating in an environmental friendly manner. LEED aims to be the driving force for that purpose through the rating system LEED for Building Operation and

Maintenance. The rating system can be used for the assessment of warehouse and distribution centres, retail, schools, hospitality, data centres and existing buildings. [10.]

Neighbourhood Development

Neighbourhood and development rating system serves as a guide to deliver a neighbourhood which is favourable to the inhabitants. Accessibility of stores, bicycle storages and parks could be mentioned as the tools to examine the neighbourhood. The rating system is bigger than the other rating systems since it targets a bigger picture. Neighbourhoods which are completed before three years of applying for the rating system or new neighbourhoods which are at least 70% complete are eligible for certification through this rating system. [11.]

Homes

Home is an important place in everybody's life. It should be made as comfortable as possible. Homes can be made comfortable in a sustainable way. LEED Homes is developed for homes, multifamily midrise and multifamily high rise projects to follow the guideline set by the certification system. [12.]

2.3 LEED Credit Categories

LEED v4 contains six categories which offer points for exemplary performance in the category sector. The environmental categories evaluate the three phases of the project: The design phase, the construction phase and the operation phase. The six credit categories are location and transportation, sustainable sites, water efficiency, energy and atmosphere, materials and resources and environmental quality. Bonus points can be collected from two additional categories: regional priority and Innovation in design. In order to achieve a point in the categories, the exemplary performance of the project should exceed the benchmarks set by the rating system. Another way to collect a point could be through innovation. This happens when a project practices an innovative way not stated in any of the rating systems. [8,3.] Below, the rating categories are discussed.

Location and Transportation

The category location and transportation could award a maximum of 16 points. The category was formerly included in the Sustainable Sites category of LEED v3. Due to the changing focus points in the Sustainable Sites category in LEED v4, Location and Transportation are now separate category that reward points for projects depending on the location and accessibility of the project. Connections to recreational centres like parks and restaurants will also be considered for the pointing system in this category. In general, how the location of a building is related with the sustainability of a building project is the main concern in the location and transpiration category. [8,13.]

Sustainable Sites

Sustainable sites category focuses on examining the impacts that the site selection and building projects have on the ecosystem. Light pollution and storm water control are among the main requirements for getting points in this category. However not all rating systems have the same definition for the Sustainable Sites category. [8.]

Energy and Atmosphere

Energy and atmosphere category rewards the practice of energy efficiency and energy optimization. Different strategies could be applied to reach the targets. Energy monitoring is one of the strategies that has been used lately. The use of renewable energy production and energy efficient appliances is also a practice that is encouraged in the energy and atmosphere category. Depending on the rating system, either the individual component of the building or the overall functioning in regards with energy usage might be examined. As an example, LEED Commercial Interior analyses individual components like the HVAC components, lighting appliances among others. On the other hand, the overall functioning of the building in terms of energy efficiency is examined in LEED Building Design + Construction Guide. The Energy and Atmosphere category functions in accordance with the standards developed by ASHRE (American Society of Heating, Refrigerating and Air conditioning Engineers). [8.]

Indoor Environmental Quality

One of the basic targets of LEED aims at creating a benchmark for a more healthy and comfortable space for the occupants of a building. The indoor environmental quality category is directly linked with health and productivity of the occupants. Indoor air quality control and environmental tobacco smoke control are set as prerequisites in theLEED version 4 indoor environmental quality category. Points can also be rewarded for controlling sound pollution and for efforts to maintain thermal comfort.[8.]

Materials and Resource

Different material types are used in a building construction project. The material and resource category rewards practices that minimize the adverse effect of the used materials. For example, local materials are appreciated more than imported materials. The reason is because imported materials have a higher carbon footprint when compared to the local ones. The effect of the materials on the occupants of a building is also a key factor in this category. Apart from using sustainable materials, waste reduction and recycling are basic assessment concepts of materials and resources category. Waste reduction causes efficient use of material and resources. This results in leaving abundant amount of resources for future projects. Recycling also facilitates an efficient use of material and saves raw materials used for projects. Recycling benefits because it cuts down the carbon footprint of raw materials transported to work sites by using local and recycled resources. [8.]

Water Efficiency

The water efficiency category aims at minimizing the waste of portable water. Metering of water consumption is one way of control water usage just like metering is used in the energy efficiency category. The amount of water used affects the amount of energy consumed by the building directly. Therefore, the more water efficient the building is, the closer it is to the idea of sustainability. Projects which practice the above concepts will collect points in this category. [8.]

Regional Priority

The regional priority is a credit category aiming to address crucial local environmental issues all over the world with the help of the LEED project team. This credit category drives the project team to focus on local environmental priorities if the team wishes to gain extra points. LEED volunteers from different parts of the world have put together six regional priority credits for every country. The regional priority credits are included in all LEED rating system. In addition to that, every rating system has its own set of regional priority credits, as the environmental impacts assessed by the rating systems are different. LEED voluntary participants were responsible for deciding on the relevance of the environmental impacts caused by both natural and manmade activities. [8.]

Innovation

The innovation credit category gives recognition to creative thinking and implementation of sustainable building practices of a project. A project might execute sustainable methods which might not be included in the LEED prerequisites or categories. Those methods are rewarded in the innovation category. The innovation category encourages the adaptation of new technologies and inventions in projects. [8.]

2.4 LEED V4 Point Allocation

LEED point allocation is based on the assessment of a project using the credit categories that were briefly explained above. Nevertheless, the credit categories are not the only things considered in the point allocation process. The influence of the credit categories on sustainability is measured by a set of seven impact categories. The impact categories are there to evaluate any kind of credit category chosen by the project team and to assess the outcome in regard with the target of the rating system. The seven categories can be seen in the pie chart (figure 2) below. The relationship between the impact categories and credit categories holds the biggest share in the point allocation system. A table is used to show the relation between the credit categories and the impact categories. The cell number is filled with the number zero in cases where there is no relation between the impact categories and credit categories. The rating system does not allow an overlap awarding by setting boundaries to the impact categories. [14.]

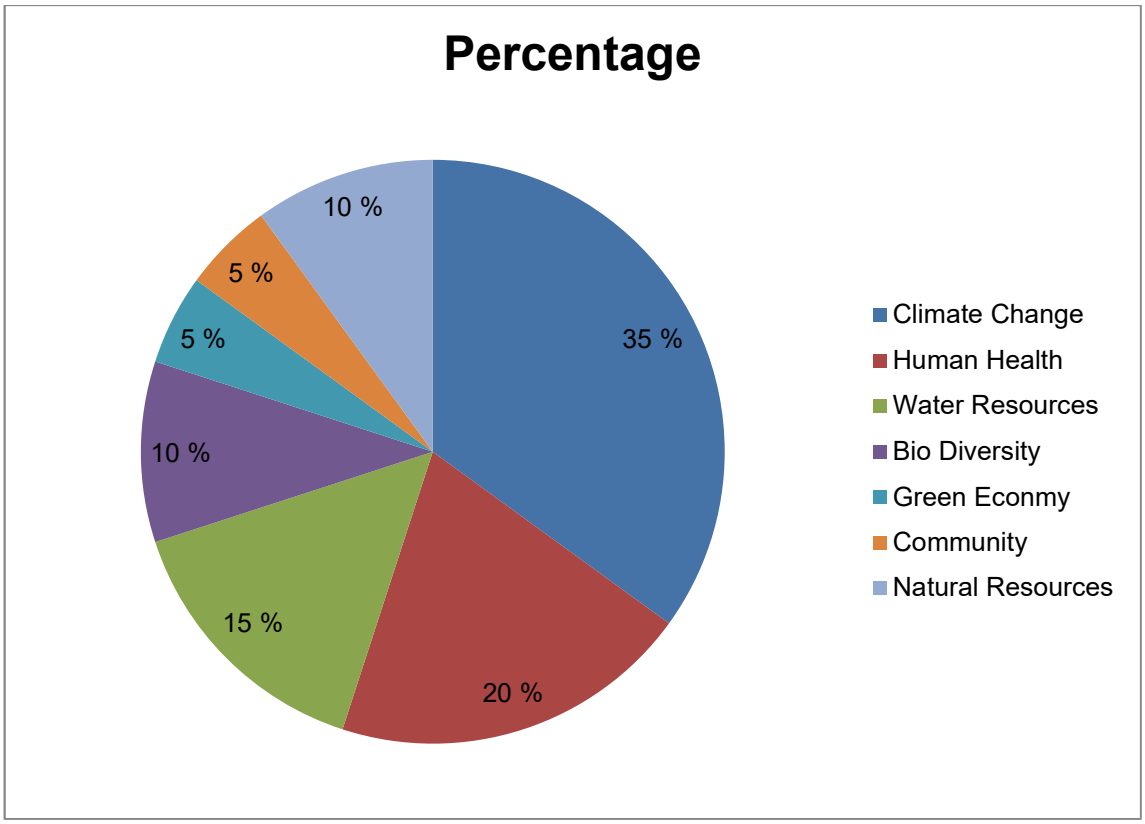

Figure 2. Impact category weighing Layer [14].

Impact Category Weighing Layer

The variation in severity, scope and scale has led to the weighing of the impact categories in the point allocation process. The impact category Climate Change has the biggest percentage in the weighing layer. Impact categories which have a low influence on the built environment will also get a small percentage share in the category weighing layer. The purpose of the weighing layer is to make the pointing system fair according to the scale and amount of positive change brought to the built environment. [14.]

Credit Outcome Weighing

The degree of association between the credit categories and the impact categories defines the amount of collected credit points. Higher association with impact categories guarantees higher points collected for the credit category. The degree of association is mostly measured by quantitative means. As an example it is possible to examine the climate change impact category. Ranking of the category depends on the quantitative

value of the carbon footprint of the building assessed. On the other hand, some impact categories rank the association with credit categories by qualitative means. Impact categories like social equality and green economy are among the impact categories that use the quantitative ranking. The qualitative association is ranked by the words simply low, high and medium ranking. [14.]

2.5 LEED Score Card Development

The weighted values of each credit category are summed up with the maximum point being 100. The minimum point given to a credit is 1. The boundaries for each impact category are clearly stated to make the pointing system easier. The fact that the credit categories are vast in scope is one of the challenges in point allocation. To tackle this problem, impact categories are narrowed down to a division of key indicators. The key indicators are referred to as components in LEED V4. Therefore, the association of the credit categories is made with the key indicators or components as explained to in LEED V4. [14.]

Association Factors

Association factors are tools that are used to scale the degree of association between credit categories and impact categories either quantitatively or qualitatively. The three association factors are: Control, Duration and Relative Efficacy. The final credit outcome weight is found by multiplying the values of the three association factors. [14.]

Control

Control is an association factor that relates the outcome of a credit category with the party who is responsible for the control of building's operating systems. The association weight will show a drop if the occupants are in control of the outcome. This is because occupants might forget to do the required tasks. On the other hand, the association is the highest and would not be discounted if the outcome is system dependent. Meaning if the building's operating systems are controlled by occupants it will lead to collecting fewer points. Whereas, programmed control of buildings operating systems will secure higher points. Passive heating and cooling strategies could be mentioned as an example because the user is not expected all the time. The credit for the outcome of the control

category is rated by choosing between four alternatives which are listed at the end of the paragraph. The choice made is used as a base for the amount of deduction in the association weight as explained above. The association factor under control could be selected as:

1. Occupant
2. Operation and maintenance staff
3. Owners
4. Passive. [14.]

Relative Efficacy

Relative efficacy examines the degree of association between the credit outcome and impact category. The degree to which a credit is related to the impact categories could range from the lower boundary negative association to the upper boundary high association. No association, low association and medium association are ways of describing the association degree of a credit with impact category. [14.]

Duration

Duration is a measure of how long the outcome of the credit would last. The duration of the outcome could be described as: 1- 3 years, 4 – 10 years 11 – 30 or 30+ (community lifetime). [14.]

2.6 LEED Certification Process

The LEED certification process starts with a selection and registration for the LEED rating systems. The registration process happens online by creating an account with GBCI. As discussed above, GBCI governs the certification system, professional accreditation and appeals. The project team applying for a rating is responsible for choosing the appropriate rating system that suits the project. The project is then designed to follow the prerequisite that are set by the categories of the selected rating system. The next step is the submission of the documentation. The document submission is done online through the

account created for the project registration. The submitted documents go through a preliminary review followed by a final review. The preliminary review gives the project team a chance to improve certain parts of the project to get better points. The final review gives the final level of certification and the final points for each category. Once the final points are given, the project team can only appeal if they are no satisfied with the scores. [7.]

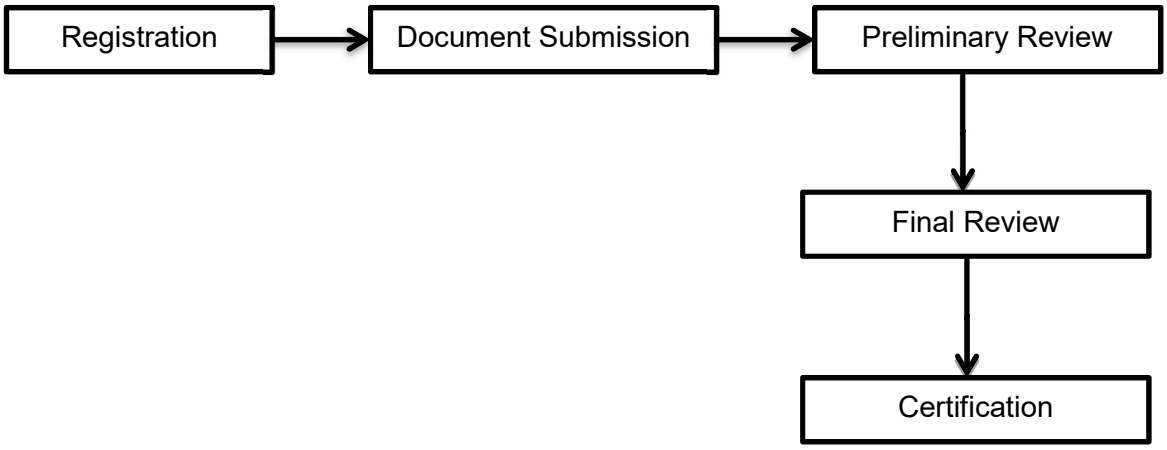

Figure 3. LEED Certification Process [7].

As can be seen in table1, there is a slight variation in the points contained in each category among the LEED rating systems. There is variation in prerequisite and credit points even within the same rating system. As an example, LEED NC has different credit points with LEED CS while both are in the same LEED BD + C rating system. The interior Design rating system skips the sustainable site credit category whereas the rest ratings systems have a defined set of prerequisites. The table clearly shows that the pointing system is dependent on the rating system selected to assess projects.[9.]

Table 1. LEED Credit Categories and Points available [7].

	LT	SS	WE	EA	MR	EAQ
BD+C(NC)	16	10	11	33	13	16
BD+C Retail	16	10	12	33	13	15
BD+C CS	16	10	12	33	13	15
ID + C CI	18	-	12	38	13	17
ID+C Retail	18	-	12	38	14	16
Homes	15	7	12	38	10	16

Although there is a variation in the points contained in the credit categories of the rating systems, there is one common feature. The common feature is that the Energy and Atmosphere credit category contains the highest points in all LEED rating systems. This fact highlights that LEED certification mainly focuses on optimized energy usage and minimizing the adverse effects of buildings on the environment.

2.7 LEED Certification Level

The amount of points collected in in each category will decide the certification level a project gets. The scale for the rating system has no variation. The rating systems work on a 100 point scale, although 10 bonus points are available in each rating system under the following categories: Regional Prioritization, Innovation in Design and Exemplary performance. Apart from satisfying the stated prerequisites in each category, a project should a minimum of 40 points in order to be certified at all. The certification level and the required points are given in table 2 below. [7.]

Table 2. Level of LEED certification and required Points [7].

Level of certification	**Required points**
Certified	40 - 49
Silver	50 - 59
Gold	60 - 79
Platinum	80+

2.8 LEED Projects in Finland

The USGBC has a list of all certified projects across the word. According to the list, Finland has 170 LEED certified projects so far. Among all rating system, the Core and Shell one is the best known in Finland. LEED for existing building is the second most widely used rating system in Finland. However, the rating systems for schools and neighborhood development are not that popular. [15.]

Figure4. Gold certified Sello shopping mall [15].

Sello shopping mall has an area of 102,000m^2 and it is located in Helsinki Finland. The shopping is easily accessible with public transportation. The first phase of sello shopping mall was opened in 2003 while the second phase was later opened in 2005. Sello has shown excellence in its performance and has managed to obtain gold level certification under the LEED for Existing Buildings rating system. [16,17.]

Table 3. LEED project in Finland [9].

LEED rating type	number of projects
core and shell	76
existing building	47
new construction	35
schools	2
retail	2
health care	2
neighborhood development	1
commercial interior	5

There are many projects on the process of getting certified in Finland. Among projects that are already certified, the biggest group is made of projects with the gold certification level, with a total number of 58. The silver level of certification is the second largest group with a total of 23 projects. The number of silver certified projects is close to the number of projects with platinum certification. A few projects have also collected sufficient points to get to the certified level of certification.[9.] The bar chart below in figure 5 gives a graphical representation of the values mentioned above.

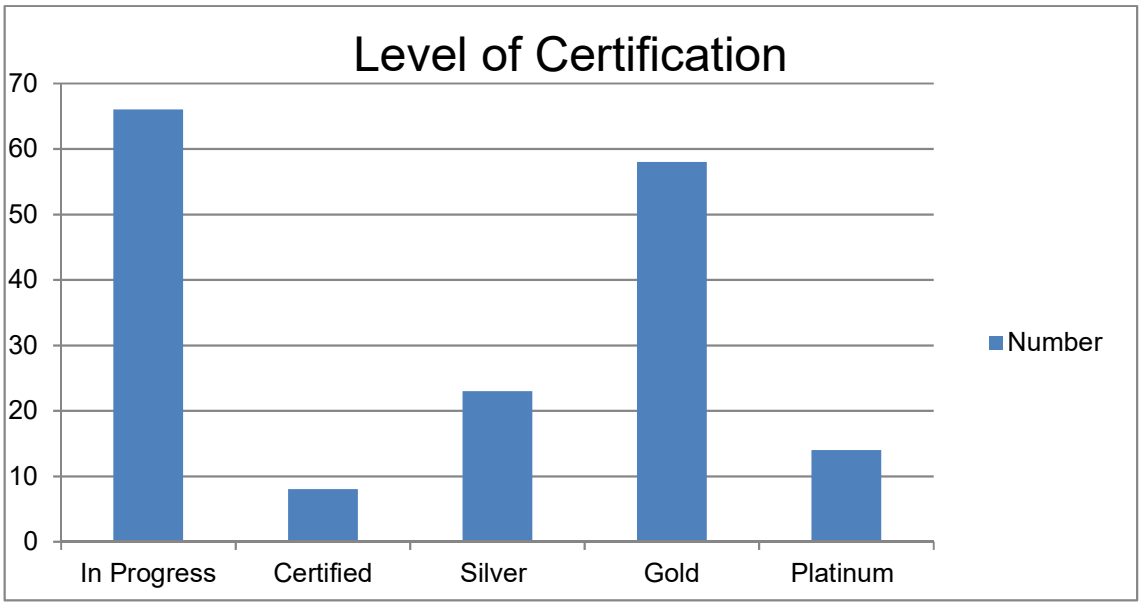

Figure 5. Level of Certification for LEED projects in Finland [18].

As shown in figure 6 below, metropolitan areas have the highest number of LEED certified buildings. Since metropolitan areas have higher number of population, they have higher number of office buildings and shopping malls which are already constructed or in the process of construction. Depending on the desire of the building's project team, the building projects can be submitted for LEED certification. The cities Tampere and Oulu are in second place having 11 LEED certified projects. [18.]

Helsinki - 65
Espoo -25
Vantaa - 21
Tampere - 11
Oulu - 11
Jyväskylä- 5
Hyvinkää - 3
kuopio 3
lappeenranta - 2
Pori - 3
Järvenapää- 2
lahti 2
kauniainen 1
Raisio 1
lohja 1
kouvola 1
Kokkola 1
Joensuu - 1
Turku - 1
Porvoo-1

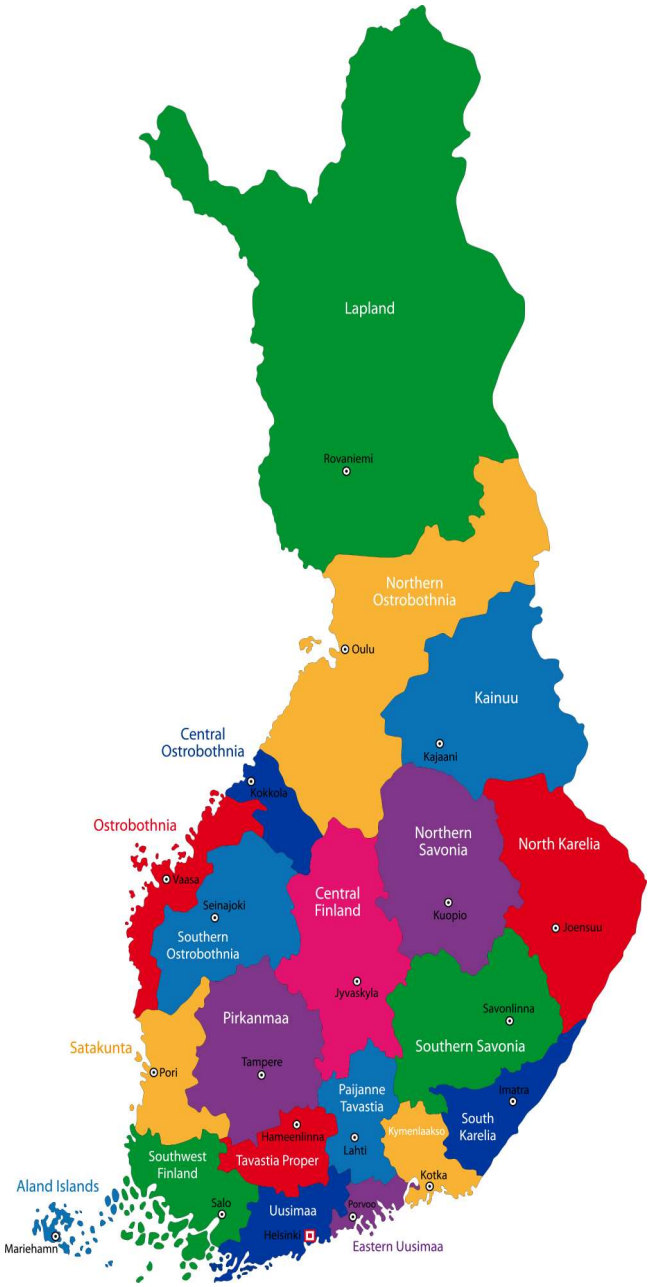

Figure 6. LEED certified Buildings Sorted by Location [18].

In conclusion, LEED is a major certification system with well-defined guidelines of projects across the world. Project teams are responsible for the handling of the certification process of projects. However, contacting the GBCI for the certification is fairly easy as it can be done through the internet. In Finland, there are many projects that have followed the guide lines the of LEED certification system.

3 BREEAM

Building Research Establishment Environmental Assessment Method (BREEAM) is believed to take the lead in paving the way for sustainable building construction by being the first green building certification systems. BREEAM was developed for local use in the United Kingdom by Building Research Establishment (BRE). These days BREEAM is an international tool for benchmarking sustainability. BREEAM turned international when the first project was certified outside the United Kingdom in 2006. BREEAM was released in 1990 although the development started few years earlier. Building Research station was founded in 1921. The goal of the Building Research Station was to set regulation on housing designs and building materials used in construction. Building Research Station which is a state owned business later formed a joint organization called Building Research Establishment (BRE) by merging with forest product research laboratory and fire research station. BREEAM ceased to be a government owned business from the year 1997. The ownership changed BRE to focus more on building certification. 2006 marks the year when the naming BRE certification turned to BRE Global after the certification of the first international project. [3] The Global is part of the BRE group mainly concerned with certification. On the other hand, BRE trust is also part of BRE group funded by the profit of BRE group for research and innovation. Therefore, BRE group is a building science centre with having Bre Global and Bre Trust as a part of it. [3,19.]

BREEAM Concept

BREEAM is the earliest sustainability assessment tool on the market. A third party certification system is applicable for all the construction project phases, from the design to the demolition. Although BREEAM has different schemes, they all share the same value which is used as a benchmark for sustainability. BRREAM aims at decreasing all risks associated with construction project, be it a residential house or a multi- million infrastructure project. BREEAM also targets to make the whole world aware of the concept

of sustainability. BREEAM definitely suits for awareness creation since it is the leading rating tool in total number of projects registered under it. The assessment tool is used in 72 countries. Apart from the recognized values of BREEAM, rewarding innovation in sustainability is among the core concepts of the rating system. [3,20.]

3.1 BREEAM Schemes

Depending on the project type, the assessment procedure and benchmarks for the certification process vary. BRE Global has created four types of schemes to certify projects which are only located only inside the United Kingdom. The four schemes for projects in United Kingdom are BREEAM Communities, BREEAM New Constructions, BREEAM in Use and BREEAM Refurbishment. [3.]

Different types of projects can be assessed by choosing the appropriate scheme. For UK projects, BREEAM has prepared a set of certification systems depending on the use of the buildings. Offices, schools, prisons and health care facilities are among the building types with their own BREEAM certification systems in the UK. The certification systems have names with the word BREEAM followed by the purpose of the building, for example BREEAM offices, BREEAM schools, BREEAM health care. [3.]

Projects outside the United Kingdom have a certification system depending on the location, purpose and type of project. The BREEAM certification systems outside of the UK are not as specific they are in the UK. There are four certification systems called BREEAM International for the assessment of projects outside the UK. They are

- BREEAM International Bespoke: As the word bespoke implies, the assessment standards are individually tailored for each project. Any type of building can use this certification system as an assessment tool.

- BREEAM Gulf: Created for building projects in the Gulf region. Buildings with different purposes could use this certification system.

- BREEAM in Use: Addresses the assessment of existing buildings. The purpose of the buildings could be different but the target of the system is always to guide existing buildings to a set of sustainability standards.

- BREEAM Europe Commercial: Applicable for different types of buildings in Europe, but not in the United Kingdom. [3.]

3.2 BREAAM Phases of Certification

As discussed above, LEED has different rating systems depending on the type and construction phase of the building. Since BREEAM was the first organisation to create a certification system for green buildings, most LEED certification aspects are similar to those of BREEAM. BREEAM addresses different phases of building construction. The phases of construction in the BREEAM certification are Management and Operation, Post Constructions, Fit out and Designs and Procurement.[3.]

Management and Operation is BREEAM's certification system for existing buildings. The operations of existing buildings, including policies followed, are assessed. Design and procurement on the other hand, applies for new construction. The planning phase is assessed with the sustainability benchmarks that are set by BRE. Post Construction phase is the follow up assessment of the design and procurement phase. Post Construction is an assessment that checks if the design phase was put to practice in a proper manner. [3.]

3.3 BREEAM Sections

BREEAM sections address the sustainability of a project under well-defined boundaries in each section. As credit categories are for the LEED certification system, sections serve as the base for the point allocation process in the BREEAM certification system. There are 10 sections defined in the BREEAM certification system. Most sections share the same value with LEED credit categories. This is because LEED is a certification system which followed the framework set by the first green building certification system BREEAM. The weighing of each section is different, which shapes the projects towards the aim of the certification system. The section energy efficiency weighs the highest when compared to the other sections. [3.] The BREEAM sections and the weighing are presented in table 4 below.

Table 4. Weighing of BREEAM's sections [3].

BREEAM Section	**Weighing (%)**
Management	12
Health and Well being	15
Transport	8
Energy	19
Waste	7.5
Materials	12.5
Land Use and Ecology	10
Water	6
Pollution	10
Innovation	10

BREEAM Rating and Benchmarks

The rating system BREEAM is dependent on specific benchmarks as it was mentioned above. These benchmarks determine on which BREEAM rating a project will get after the assessment. A project should fulfil all the minimum requirements set by the BREEAM rating system. Apart from that, the environmental section weighing and credits influence the BREEAM rating a project will achieve at the end of the assessment. The summation of the collected points will be compiled to give a final overall percentage; the BREEM rating will be given accordingly. [3.]

Table 5.Required percentage for BREEAM ratings [3].

BREEAM Rating	**Percentage Requirement**
unclassified	<30
Pass	≥ 30
Good	≥ 45
Very Good	≥ 55
Excellent	≥ 70

Table 5 shows the percentage requirement for the listed BEEEAM rating levels. A project which scores less than 30 percent out of the total is categorized as unclassified. While projects which score more than or equal to 30 percent but less than 45 percent are classified as Pass Rating level. Projects which have a minimum of 45 percent but less than 55 percent out of the total are classified as Good rating Level. Projects which have more than 55 percent are classified as Very Good whereas Projects with more than 70 of the total re classified as Excellent rating level. [3.]

3.4 BREEAM Projects in Finland

There are 90 BREEAM certified project in Finland. The BREEAM certified projects can be seen in the GREENBOOKLIVE database unless there is an issue with privacy. Among the BREEAM certification schemes, BREEAM in Use is widely applied as an assessment tool in Finland. The BREEAM Commercial Offices has the second largest number of projects with 21 certified projects so far. Only some projects are certified under the schemes International Bespoke, Commercial Retail and Commercial Industrial. [21].The bar chart below (figure 7) shows a pictorial description of the BREEAM certified buildings according to the BREEAM schemes.

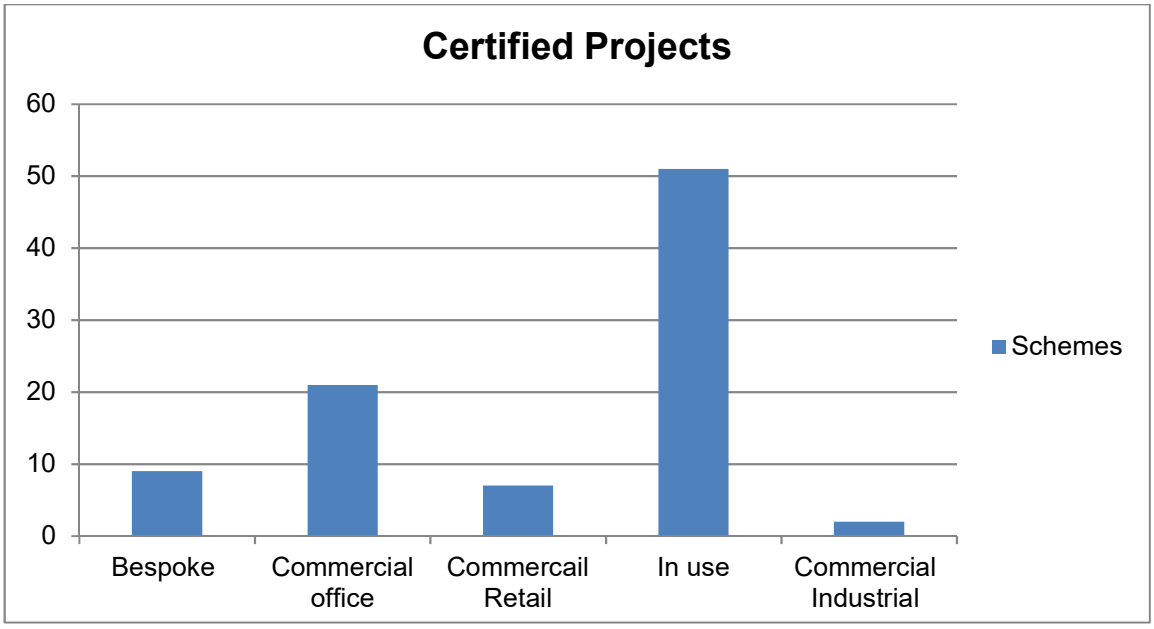

Figure 7. BREEAM Schemes of certified buildings in Finland [21].

The total number of BREEAM certified projects shows that BREEAM certification system is widely used in Finland. The use of the certification system has shown an increase throughout the years. LEED is the only certification system that has managed to register more certified projects than BREEAM in Finland. [21, 18]

Table 5. BREEAM rating of Certified Buildings in Finland [21].

BREEAM Rating	**Number of projects**
Unclassified	2
Pass	2
Good	38
Very Good	46
Excellent	2

The overall percentage shows that, most projects in Finland have managed to get a good or very good BREEAM rating once assessed. Two projects in Finland have managed to get an excellent rating by achieving over 70 percent of the overall percentage. Table 5 above describes the BREEAM Rating of projects in Finland.

Figure 8. Veturi Shopping mall with Excellent BREEAM rating [22].

Veturi shopping mall is among the biggest shopping centres in Finland and it is located in Kouvola. The shopping mall has a total area of 48,000m^2 with more than 80 shops and different restaurants in the building. The project showed great architectural excellence and has been named as a leading character in building lighting system. The Veturi shopping mall has managed to obtain Excellent BREEAM rating level for its outstanding building features. [22.]

4 Green Building Council Finland Indicators as an Assessment tool

4.1 Building Performance Indicators

The building performance indicators are tools which help to check the actual performance of a building through a comparison with the benchmarks set by the Green Building Council Finland. The performance indicators are free of charge to use targeting to analyse both the design phase and the use phase of building projects. Occupant wellbeing, energy efficiency, life cycle cost and environmental impacts of buildings are the main concerns to be evaluated with the performance indicators. [2.]

The performance indicators are believed to be paving the way for a sustainable building legislation in the near future. Green Building council states that the performance indicators are based on the European CEN/TC family of standards. CEN/TC 350 family is a set of standards that are meant to assess the sustainability of buildings throughout their life cycle. The standards use both qualitative and quantitative approaches to measure the degree of sustainability. The performance indicators are mainly divided in two phases, the pre design and the occupancy phase. Both phases include four indicators, a total number of eight performance indicators. The performance indicators have been tested in successful pilot projects. The Green Building Council together with major actors in the construction industry has created a tool to establish the practice of sustainable development principles. A project could use the performance indicators as an assessment tool under the design phase or the use phase. The collected data is organized in a presentable manner. The data collected from the indicators is helps in making better decisions to reach the desired sustainability values in a project. All the necessary information, including the images and major facts, are gathered together. The above collection of information on a property results in an accessible visual tool known as the building passport.[2,4.]

4.2 Design Phase Indicators

The design phase indicators are calculated depending on the design value of a building project. Early analysis of alternatives in the design phase is beneficial for building an environmental friendly and cost efficient project. The design phase indicators are E value, Life cycle carbon Footprint, Life Cycle Cost and Indoor Air Class. [2.]

4.3 Use Phase Indicators

The use phase indicators are values which clarify the actual performance of a building. Since this thesis aims at analyzing the actual performance of LEED and BREEAM certified buildings, the use phase performance indicators are an ideal tool for the purpose. The four use phase indicators are calculated for the selected LEED and BREEAM certified buildings. The performance indicators are defined below. [2.]

- Operational Carbon Footprint: The operational carbon footprint measures the greenhouse gases produced when the building is used. The operational carbon footprint consists of optional and mandatory input values in the calculation stages. All the values used for the calculation are measured to give a precise result of the use phase carbon footprint. The emissions caused by the energy consumption of the building are inevitable in the calculation steps of the carbon footprint. If assumed values are used at any instance, a briefing about the assumptions should be given. The calculation steps are adopted from the GHG protocol. The GHG protocol is an international standard which sets guidelines on reporting greenhouse gas emissions. The GHG protocol includes three scopes of which of which scope 1 and scope 2 are compulsory. Activities to be assessed in scope 1 and scope 2 are already defined in the GHG protocol. On the other hand, the company can choose activities to be included in scope 3. [2,14.]

- Measured Energy Consumption Indicators: The measured energy shows the total amount of purchased energy consumed by a building using KWH as the unit of measurement. On site energy production from renewable sources such as solar and wind power are left out from the assessment. This indicator can assess

the consumption of the property both with the user consumption included, or the property energy consumption alone. As the heating energy used for a building depends on the number of cold days, the measured energy consumption indicator takes the location of the building in to consideration. The weather -normalized values obtained from calculations can be compared with the simulated consumption in the design phase. The measured energy indicator is an essential tool to set goals by taking factors like person- years, occupancy hours and total area in use into account. [2.]

- User satisfactions Indicator: The user satisfaction indicator depends on a survey consisting of questions to evaluate five different areas of a buildings indoor environment comfort. The survey aims to evaluate the long span use of the building rather than a couple of days or a short while. Indoor environment is a major concern as it affects the wellbeing and productivity of occupants. The five areas of user satisfaction included in the survey are thermal comfort cooling (summer), thermal comfort heating (winter), lighting comfort, acoustic comfort, and indoor air quality. The rating for the survey is scaled from -3 to +3. Negative numbers represent unsatisfied users while the positive ones mean that the user is satisfied with the evaluated subject. -3 stand for very unsatisfied and, in the opposite end +3 represents very satisfied users. Average values can be calculated to give a final percentage of satisfied and dissatisfied users. The average value of satisfaction should reach at least 75% to say that the indoor environment is in a good shape. [2.]

  If the users give a negative score in the survey, they are asked to give a clarification of the experienced problem. The clarification of the problems will help the responsible party to make decisions on what to improve to raise the user satisfaction. This in turn will prevent any permanent damage to the building or stop occupants acquiring health problems because of the fault. The user satisfaction survey is also helpful for the owner by giving clear information about the state of the property. The maintenance company working on the property could also benefit from the survey. They would know what to improve in the coming service. Therefore, the user satisfaction indicator helps to build a bridge which connects the owner, the user or tenants and the maintenance company for a comfortable indoor environment. [2.]

- Baseload Demand indicator: Base load is defined as the energy consumed by a building when it is not occupied by users. The times when there are no users in a building, such as weekends in an office building, are known as vacant hours. One would expect the vacant hours to consume only a small amount of energy, but the reality is the opposite. Vacant hour consumption is a big share of the total energy consumption. This could one of the reasons to enhance the use rate of buildings rather than wasting energy for no service. [2.]

5 Major Findings of the Project Work

The data collection phase started by selecting 20 buildings with a higher level of certification in LEED and BREEAM, of which half are BREEAM Certified buildings while the rest are LEED certified buildings. The list was later on narrowed down to 11 buildings, six LEED certified buildings and four BREEAM certified buildings and one Zero Energy building. Table 6 below lists the selected buildings, their level of certification and construction year. [2.]

A detailed data collection was planned to be done for the buildings shown in the table above. Unfortunately, some of the buildings were not equipped in a way that makes it possible to get values such as the baseload demand of the building. The analysis phase would have been highly accurate had it been possible to obtain all the planned data. The aim of the data collection phase was to obtain the following parameters for the selected certified buildings:

1. E-value or ET value (before 2013
2. Total electricity use in 2015 in kWh
3. User electricity consumption
4. Heating in 2015 in MWh
5. Cooling in 2015 in MWh
6. Brutto size in m^2[2.]

Table 6. Selected certified buildings.

Building	Certification Scheme	Certification Level	Building Year
Myyrmanni	BREAM	Good	1994
Iso Omena	BREAM	Very Good	2001
Alberga - office	BREAM	Very Good	2015
Dixi	LEED	Platinum	
RuoholahdenAnkkuriSponda	LEED	Gold	2013
Iso Omena extention + Old part	LEED	Platinum	2001 / 2016
Itämerentori 2	LEED	Silver	2000
Hiitti (SRV)	LEED	Platinum	2013
Innova 2 - Technopolis	LEED	Platinum	
Auerkulma			2016
ViikkiEnviroment Centre			2011

Measured Energy Consumption Indicator for the Selected Buildings

As discussed above, the measured energy consumption indicator implies the total energy consumption of a building. The measured energy consumption indicator is a value that corresponds with the purchases amount of energy. Renewable on site energy production indicator is not included in calculation.[2.]

Measured Energy Consumption Indicator= district heating + district cooling + electricity use, property

The Energy consumption indicator uses weather normalization when comparing buildings situated in different regions. Since heating energy depends on the temperature and the number of cold days in the building's weather region, a normalization factor is clearly

necessary. However, the normalization factor was not used in this thesis when the energy consumption indicator was computed for the selected buildings. This was because the buildings are in the same weather region. [2.]

The analysis expected to find a correlation between the total amount of energy consumed and the level of certification. The certification schemes use the design data to reward points for the corresponding certification scheme. In this case, the real energy use is available to make a proper assessment. The certified energy buildings are also compared with the Viikki energy efficient building.[2.]

Table 7. Selected certified buildings.

Building	Total Energy Consumed in KWH	Total Heated Area in m^2	Total Energy per Area	Level of certification
Myyrmanni (BREEAM)	4 346 001,15	88 270	49.23	Good
IsoOmena (BREEAM)	7 528 210	153562	49.02	Very Good
Alberg –office (BREAAM)		1249.5		Very Good
Dixi (LEED)	608556	10744	56.6	Platinum
RuoholahdenAnkkuriSponda (LEED)	297000	11385	26.08	Gold
IsoOmenaextention + Old part (LEED)	10042	221872		Platinum
Itämerentori 2 (LEED)	2 089 861	38154	54.77	Silver
Hiitti (SRV) (LEED Platimium)	329785	7223		
Innova 2 - Technopolis	481207	10000	48.12	Platinum
Auerkulma				Platinum
ViikkiEnvironment Centre	174500	6700	26.04	

As can be seen in in table 7, the data collected for the selected buildings in not detailed at all. Furthermore, the fact LEED certified projects outnumber BREEAM certified projects in Finland led to selecting only few BREEAM certified buildings for the study. Buildings with incomplete data for the study were left out of the list.

4 Discussion

The goal of the data collection phase was to gather all data that describes the building performance of the LEED and BREEAM certified buildings. The data was collected to specifically evaluate the use phase of the buildings. The tools used for the use phase analysis were the green building council use phase indicator tools. The data collection-phase started with an inquiry to the responsible person of the selected buildings. The data collection was, however, not successful regarding a major part of the required data of the buildings. The green building tools mentioned above are discussed in more details with the calculation steps for the analysis of the use phase of buildings.

Operational Carbon Footprint:

The operational carbon footprint of a building is calculated as the sum of all the sources for CO_2 emissions. Possible sources for emissions considered in the calculation in this are thesis are district heating and cooling, fuels for heating and electricity used by both the property and the users.

The target was to include all the use phase parameters defined by GBC. However, it was not possible to get the listed values of the selected buildings. With an incomplete data on the emission sources, the operational carbon footprint calculation would be unrealistic.

Measured Energy Consumption Indicators

Among the desired data of the selected buildings, total energy consumption of the building was the only data that was accessible for all of the buildings. The measured energy consumption was calculated by dividing the total energy consumption by the total energy consumed by the gross area of the building. Green building council also states that the intensity of use of the buildings should be taken into consideration. The selected buildings have nearly similar intensity of use for the office buildings. Nevertheless, the shopping centers among the selected buildings have more intensified degree of use.

Base load Demand indicator

The base load demand indicator reveals the building performance when the building is not in use. It was impossible to find out the actual base load demand for any of the selected buildings. Large energy consumers can request a description of their hourly consumption. Unfortunately, none of the selected buildings had a description of their hourly consumption. Another way to find out the hourly consumption would have been an electrical hourly consumption measuring tool.

5 Conclusion

This thesis started with a great ambition of analysing the use phase of LEED and BREEAM certified buildings. The reality was that it takes a more advanced level of data collection phase in order to come to a conclusion about the relationship between the level of certification of a building and how it operates.

Checking the performance of LEED and BREEAM certified buildings through GBC Finland's use phase parameters faced problems. As an example, a platinum level LEED certified building, should have an hourly description of the energy consumption in order to allow a comparison of base load demand to that of ordinary buildings. The lack of hourly consumption record will makes it impossible to use GBC Finland's base load demand indicator tool. Since the buildings are not interested in keeping data that is not relevant for them, it was almost impossible to proceed to GBC Finland's use phase indicators. Energy used for cooling, energy used for heating, electricity used by the people and electricity used by the property are the necessary values in order to calculate the carbon footprint of a building. From the data collection phase, the selected buildings with LEED and BREEAM certification all had a value that only showed the total energy consumption of the building. The only value that was easily obtained was the total energy consumed. Using the total energy consumed, it was possible to calculate the total energy per area. However, those values did not show any pattern according to the level of certification. Surprisingly, Vikki Environment Centre, which was neither LEED nor BREEAM certified, had the lowest energy consumption per area.

All in all, this thesis established the requirements and proceedings in getting a building certified. The main points of discussions were LEED, BREEAM and GBC Finland's Building performance indicators. Another finding of the thesis is that data collection of buildings should be planned with the owners of the building. Data collection for the use phase of a building might even require new instruments installed on the building. Mutual agreement and share of interest with the owner about finding the real use phase of a building performance will lead to more detailed findings.

References

1 Environmental and Energy Institute [online]. Building and Climate Change. URL: http://www.eesi.org/files/climate.pdf . Accessed 05 January 2010.

2 Green Building Council Finland [online]. Building Performance Indicators. URL: http://figbc.fi/ .Accessed 15 Dec 2107.

3 Ebert T, Ebig N, Gerard H. Green building certification systems: Assessing sustainability International System Comparison Economic impact of Certifications. Munich: Architecktur- Documentation GmbH & co.

4 Institute for Environmental Entrepreneurship [Online] Green Building Aetrospective History of LEED Certification. URL:http://enviroinstitute.org/wp-content/uploads/2012/09/GREEN-BUILDING-Aetrospective-History-of-LEED-Certification-November-2012.pdf . Accessed 22September 2017.

5 Sustainable Investment Group [Online]. LEED History. URL: https://www.sigearth.com/leed-history/. Accessed 17 October 2017.

6 Meisel A. LEED materials A resource guide to green building. New York: Princeton Architectural Press; 2010.

7 Cotrell M. Guide book to the LEED Certification process. Hoboken, New Jersey: John Wiley & Sons: 2011.

8 U.S Green Building Council [online]. LEED Credits. URL: https://www.usgbc.org/guide/bdc#lt_overview.Accessed 17 April 2018

9 U.S Green Building Council [online].Getting to know LEED. URL:https://www.usgbc.org/articles/getting-know-leed-interior-design-and-construction-idc. Accessed 12 April 2017.

10 U.S Green Building Council [online].Getting to know LEED. URL:https://www.usgbc.org/articles/getting-know-leed-building-operations-and-maintenance-om. Accessed 17 April 2017.

11 U.S Green Building Council [online].Getting to know LEED: Neighbourhood Development.URL:https://www.usgbc.org/articles/getting-know-leed-neighborhood-development. Accessed 17 April 2017.

12 U.S Green Building Council [online].Guide to Certification: Homes. URL: https://new.usgbc.org/cert-guide/homes. Accessed 17 April 2017.

13 U.S Green Building Council [online].LEED for New Construction and Major Renovations (v4). URL:https://www.usgbc.org/dopdf.php?q=scorecard/new-construction/v4. Accessed 17 January 2017.

14 LEED V4 [online]. LEED Impact Category and Point Development. URL: http://studio4llc.com/wp-content/uploads/2011/01/LEED-v4-Impact-Category-and-Point-Allocation-Process_Overview_0.pdf .Accessed 10 June 2107.

15 U.S Green Building Council [online].Kauppakeskus Sello. URL:https://www.usgbc.org/node/2574428. Accessed 24 October 2017.

16 Green Building Council Finland [online]. Sello Shopping Canter. URL:http://figbc.fi/en/building-sector/sello-shopping-center/. Accessed 15June 2017.

17 SIEMENS[online].Sello Shopping Mall. URL:https://www.buildingtechnologies.siemens.com/bt/global/en/references/energy-efficiency-references/pages/sello-shopping-mall-espoo-finland.aspx. Accessed 10 October 2017.

18 U.S Green Building Council [online].Projects. URL:https://www.usgbc.org/projects?keys=finlandAccessed 12January 2017.

19 BreTrust [Online]. Our History.URL: https://www.bre.co.uk/history. Accessed 25 May 2017

20 Bre [Online]. BREEAM.URL:https://www.breeam.com/Accessed 12 January 2018.

21 GreenBOOKLIVE[Online].Finland. URL: http://www.greenbooklive.com/search/scheme.jsp?id=202 .Accessed 14 January 2017.

22 Performance in Lighting [Online]. Shopping Centre veturi. URL: https://www.performanceinlighting.com/fi/en/einkaufszentrum-veturi . Accessed 20 October 2017.

23 Green House Gas Control [online].Tools on Built GHG Protocol.URL:https://ghgprotocol.org/. Accessed 14 November 2017.