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The relationship between user satisfaction and sustainable building performance

The case study of Leiderdorp's Town Hall

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Little steps for big dreams....!

To my parents and my beloved late grandfather

Acknowledgments

During these two years in Delft, I experienced the excellent education level and the way interrelationships are built between students and professors. The intimate and close interaction that I had with my supervisors was a big and pleasant surprise for me, compared to the one that I had while I was doing my diploma thesis in Greece, which was quite typical. Therefore, I feel committed to express my gratitude to my supervisors, to other people that were involved and helped inside the project and of course, the people, friends and family that was close to me during the whole time.

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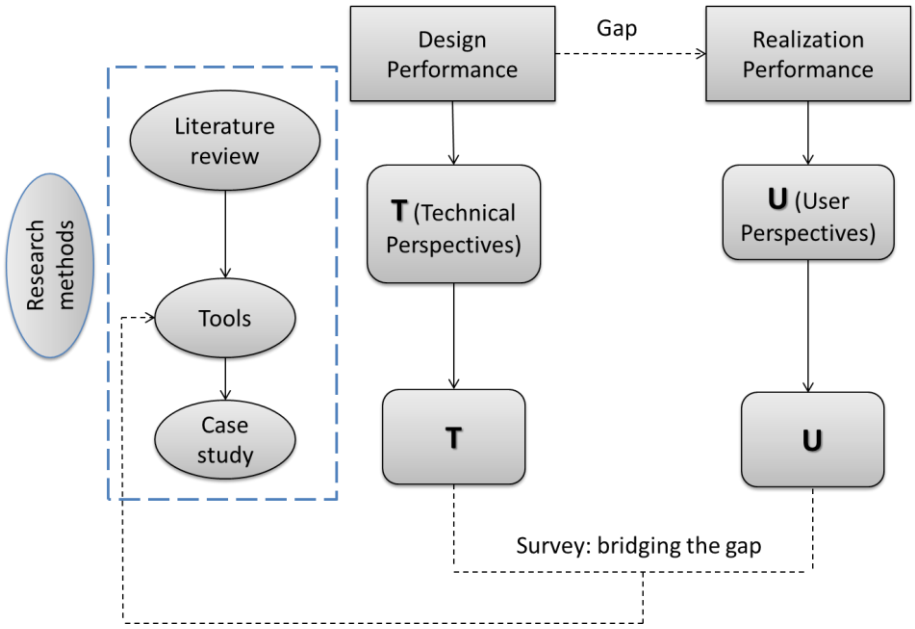
Summary

Introduction

In recent years, there is a steady stream in constructing and realizing sustainable town halls in the Netherlands. It seems, as a logical follow-up, that the focus is shifting from the design and construction of these sustainable buildings to the performance of buildings in use. There is extensive evidence through literature to suggest that buildings usually do not perform as well as predicted. This fact introduces the phenomenon of the performance gap, which is the gap between design performance and realization performance and the missing link between technical and user perspectives inside a sustainable building. Design performance is more influenced by and focused on technical perspectives/criteria, while realization performance that takes place during occupancy, is affected in addition by user perspectives.



Problem Statement

As mentioned before and indicated in the above figure that shows the structure of the whole research, problems arise when it is found that the actual sustainable performance does not comply with the one expected. Somehow, this gap has to be explained. Two main possible reasons, considered as initial hypotheses, could be the failure of the building systems and the extent users are satisfied. The main problem is that literature on how the sustainable performance of a building influences the user satisfaction and how user satisfaction is formed, is limited.

The research will try to explore this problem and it will do so by literature studies on assessment tools that evaluate sustainable building performance and on the interaction between users and sustainable building performance and by studying the case of the newly constructed sustainable town hall of Leiderdorp, a town in the western part of the Netherlands.

Research Questions

The above-mentioned problem statement leads to the formulation of the main research question **''What is the relationship between sustainable building performance and user satisfaction?''**. In order to answer this question, it was considered that the main research question entails two parts. One part consists of the sustainable building performance and the other the user satisfaction. These parts should be first evaluated and then combined. Based on this division, further sub research questions are formulated, which are entailed in the two parts and that are answered separately in each chapter, as it will be described in the next paragraphs.

Q1: How can sustainable building performance be monitored and measured?
Q2: How can sustainable building performance be evaluated?
Q3: How can user satisfaction be evaluated?
Q4: What assumptions can be formulated after combining these evaluations?
Q5: How can these assumptions be tested?

Literature review of evaluating sustainable building performance

The first literature review is on methods and tools, used for the process of evaluating the sustainable building performance. It is divided into two chapters (Chapter 2 and 3). The first chapter answers to Q1. Chapter 2 focuses on worldwide used assessment tools that aim at achieving and maintaining the sustainable performance. The choice, based on the most widespread, reliable and up to date tools, is LEED, GPR, DGNB, Open House and BREEAM NL. Their main frameworks and features are described. The finding of this review is that assessment tools measure building performance from a sustainability point of view and aim to raise the sustainable ambitions of the client (more according to technical perspectives), but lack of including criteria regarding users' involvement and satisfaction (user perspectives).

According to Q2, basic characteristics from evaluation frameworks, as Building Performance Evaluation (BPE) and Post Occupancy Evaluation (POE) are introduced in Chapter 3, explaining also what a sustainable building performance is. These provide the bigger picture of how a building can be evaluated. Finding of this chapter is that evaluation frameworks indicate that sustainable building performance is not limited to energy conservation, the functionality of buildings and the operation of sustainable building systems. It also focuses and needs to continue to focus on users' perceptions of buildings.

Literature review of evaluating the interaction between users and sustainable buildings

The second literature review concerns the interaction between sustainable buildings and users and is covered in Chapter 4. Connections to user behavior, sustainability, sustainable performances and user satisfaction in particular, are made. Findings of this review, which answer also to Q3 are that there is a clear two-way correlation between user satisfaction and good performance of the building and that there are factors that influence the interaction and perspectives of users towards sustainable building systems and their satisfaction and comfort. These factors refer to values, needs, background, motivation and attitudes of the users, as for instance that users are much less satisfied when they cannot see how things are supposed to work, or are subject to interventions by technologies over which they have little or no control, or that green users are more satisfied with green buildings.

Connection of these reviews and formulation of assumptions

The connection of these reviews, which is covered in Chapter 5, reveal the importance of users' satisfaction and the need of the formulation of more specific hypotheses regarding factors that can define this satisfaction and in general the user influence on the operation of building systems, which also miss from the assessment tools. These hypotheses

H1: Users are more satisfied if they are 'green' users,

H2: Users are more satisfied if they have or think that they have control over the systems of the building and the building in general,

H3: Users seem to forgive and be more tolerant if they are familiar with the building and know how it works and operates (forgiveness factor)

are formulated and at the same time answer the Q4. Finding of this chapter is that a case study is needed in order to explore this interaction with the building systems, the above-mentioned occupant's satisfaction and comfort and test the hypotheses. A mean to do that is with an occupant comfort/satisfaction survey that takes into account in its questions all of the above and is created in detail in this chapter.

The case study: Description, analysis, conclusion

The case selected is the town hall of Leiderdorp. The description, analysis and conclusions of this case are included in Chapter 6. The methods used within this case study are interviews with some employees of the town hall and a survey with a detailed questionnaire towards all employees, which was described and formulated in the previous chapter. First, a research is made on the sustainability of the building and its systems, before and during occupancy, the design and current performances are in detail described, in order to understand the range of the performance gap inside this case. Failure of sustainable building systems and operation problems are identified, feedback from interviews give a first insight into users' perspectives and the existence of a gap between sustainable building systems (technical perspectives) and users (user perspectives). These, along with the aforementioned hypotheses for influential factors on users' satisfaction, led to the implementation of the survey that will explore, in depth, the factors that mostly affect the satisfaction and comfort of users towards the building systems. In this way, these hypotheses would be tested (answer to Q5).

The finding of this survey, after a statistical analysis, is that three influential factors stand out; how 'green' users are (their environmental awareness), the control they have over the sustainable building systems and the available knowledge and information they have on the systems and the building. The correlations show that inside a sustainable building the more these factors increase, the more satisfied users are. The findings from the town hall in total provide evidence from a real case study that can be used in order to formulate some actions and suggested solutions. The reflection of the evidence and the suggested solutions is discussed in the reflection section.

Conclusions

One of the main conclusions of this research (Chapter 7) is that assessment tools, which evaluate the sustainable building performance, lack of criteria involving users and their satisfaction and comfort. This could be a cause for the performance gap perhaps because evaluating users satisfaction itself, leads to a higher satisfaction. The use of a case study and a survey contributed to another conclusion by specifying which factors can affect this involvement and this satisfaction (user perspectives) towards sustainable building systems and performance (technical perspectives) as a result. The above-mentioned factors that stood out can work as stepping stones and mechanisms for maintaining the sustainability of a building inside an organization. User satisfaction can affect the perspectives of users

towards the building performance and this may affect a possible performance gap, a missing link between technical and user perspectives inside a building. In addition, these factors indicate also how the sustainable building performance (the operation of the sustainable building systems, 'green' features inside the organization) may influence vice versa the user satisfaction. The mentioned conclusions indicate the interrelationship between sustainable building performance and user satisfaction that can be shaped by the mentioned factors, which function as stepping stones of maintaining sustainability.

Recommendations – Suggested Solutions

Furthermore, after having described this relationship, the suggestion is an evaluation model that will include concepts as BPE and POE and an outline of some basic criteria, based on the results from the survey and the literature reviews, for monitoring and maintenance strategies. These extra criteria are described theoretically, and even if they are based on personal and not generalized findings, it can be said that can help in the evaluation of sustainable building performance (Chapter 8). These criteria symbolize users' involvement and as described in the thesis, include factors that affect users' satisfaction and similar surveys, as the one applied on the case study that can repetitively evaluate occupancy comfort and users' satisfaction.

Reflection

After concluding this research study, it is crucial to reflect on the process, the research methodology and the limitations that appeared (Chapter 9). To be critical on the use of the case study, it has to be indicated that not so much technical information was available for the current sustainable performance of the town hall. However, through interviews and walkthroughs in the building and talking to responsible people of the operation of building systems, the needed information to identify a performance gap or not, was gathered. Moreover, it has to be noticed that even if the results come out from one case study only and cannot be generalized for all sustainable town halls for instance, they can work as evidence for conclusions and help in the formulation of recommendations how to bridge the gap (between technical and user perspectives and design and realization performance). In addition, the role of the survey was two-fold. It functioned as research method to explore factors that influence user satisfaction and the interaction between users and building systems, but also as a part of the solution to the main conclusion that assessment tools lack of criteria regarding users' involvement. Suggestions for future research are the use of more case studies in order to have more evidence and be able to generalize the three factors that popped out form one case study. Furthermore, it could be interesting enough to include case studies with sustainable buildings that perform as promised and find out which factors pop out then that affect user satisfaction.

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1 Introduction

1.1 Background

Sustainability and sustainable/green buildings are keen concepts and widely used in many fields of everyday life. There could be, though, different interpretations of these concepts due to the vagueness of their definitions as described through literature (Sustainable measures, 2010 and Evans, 2013). Sustainable or green buildings refer to all kinds of buildings or construction with a traditionally smaller environmental load or in other words, a way of building without harmful effects during the whole life cycle of the buildings and towards future generations (van den Dobbelsteen, 2004). There might be many benefits in sustainable buildings and sustainable design as environmental, economic and social. According to these benefits and the need for energy principles that will define the best energy-effective choices for the future, sustainability is continuously gaining importance in the construction industry. Energy consumption of buildings accounts for around 20–40% of all energy consumed in developed countries (North America, Western Europe, Japan, Australia and New Zealand). Global organizations, like the US. Green Building Council (USGBC), Green Building Challenge, etc., have made great efforts over the last decade to promote sustainability in built environments by investing also significant resources, as capital or research (Juan, Gao, & Wang, 2010).

The Netherlands, as one of the countries that want to promote and keep up with sustainable aims, has realized innovative constructions but also with implementing policies that promote sustainability. According to this fact and the influence of flexible or activity based working -''Nieuwe Werken'', it is commonly recognized that ''governments have taken up the responsibility to put sustainability on the political agenda, translating it into management techniques, policy and coupling it into targets'' (van Houten, 2010). One example in the Netherlands of the implementation of such policies is the trend of building new sustainable offices and town halls, because from 2015 and on all government buildings should be sustainable (Rijksoverheid, 2012).

Because of the growing tendency of sustainable building, methods and tools started to be introduced into the market of sustainability in order to measure performances. As Lord Kelvin quoted ''If you cannot measure it, you cannot improve it'' (BPIE, 2011). Significant effort worldwide has therefore gone into the development of such systems to measure the performance of buildings. Since 1990, there has been extensive development of building environmental assessment methods - tools, many of which have subsequently gained considerable success, such as LEED and BREEAM (Alyami & Rezgui, 2012). These tools aim at providing a high level of sustainability and an energy certificate, as a proof for the guarantee of sustainability, during the design and construction of a building and before its delivery to the clients. Nowadays, some of these design tools have been extended with a module and further guidelines for existing buildings or the new buildings in use, which mainly refer to operation and maintenance.

In addition to this stream of sustainable construction and performance measurements, it seems, as a logical follow-up, that the focus is shifting from the design and construction of these sustainable buildings to the performance of buildings in use. From some first literature reviews that will be indicated in detail later in the report, there is extensive evidence to suggest that buildings usually do not perform as well as predicted. This fact introduces the phenomenon of the performance gap, which is commonly defined as the gap between design performance and realization performance. Design performance is more influenced by and focused on technical perspectives/criteria, while realization performance that takes place during occupancy, is affected in addition by user perspectives. Therefore, apart from the above meaning, the definition could be broader by saying that it is also the missing link between technical and user perspectives inside a sustainable building in use.

1.2 Problem Statement

As it is described in the introduction, Dutch municipalities and organizations are trying to adopt sustainable policies and this is reflected in sustainable buildings in the Netherlands. While constructing a sustainable building, it is expected to keep the building's sustainability until the end of its life cycle (Figure 1.1). Problems may arise during the process of trying to create a building with a high and ideal performance or while trying to improve this performance. Such problems should be found, investigated and solved. The reason is that they may create obstacles in the use phase of the building and lead to early and inevitable renovations or demolitions. The main problem that this research will try to state and solve will be described in this section.

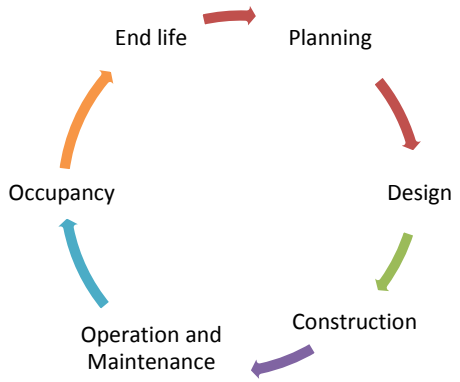

Figure 1.1: A building's lifecycle

As indicated in the introduction, there is extensive evidence to suggest that buildings usually do not perform as well as predicted (Menezes, Cripps, Bouchlaghem, & Buswell, 2012). Many researchers name this problem as the **'performance gap'**. To explain this phenomenon, the concepts of design performance and performance in use should be introduced. In the first phases of planning and design, the performance that the building should achieve and maintain throughout its lifecycle is determined. This design performance is based mostly on the desired operation of all building features and systems (technical perspectives), which means in this case guaranteed high levels of sustainable performances throughout the whole life cycle. Performance in use is the performance that the building acquires in reality during its occupancy. The problems though may arise when it is found that the later performance does not comply with the one expected from the design. Two main possible reasons, considered as initial hypotheses, could be the problematic operation or failure of sustainable building systems, regarding technical perspectives and the extent users are satisfied, regarding user perspectives. The main problem is that literature on how

sustainable building performance and user satisfaction are linked is limited. Methods and tools should be found in order to explain and alleviate the phenomenon of the performance gap.

This research will try to explore this problem and it will do so by literature studies on assessment tools that monitor and evaluate sustainable building performance, on the interaction between users and sustainable building performance and by studying the case of the newly constructed sustainable town hall of Leiderdorp, a town in the western part of the Netherlands.

1.3 Research Questions

Based on the problem statement given in the previous section, the main research question for this research can be formulated and is the following:

What is the relationship between sustainable building performance and user satisfaction?

In order to answer this question, it was considered that the main research question entails two parts. One part consists of the sustainable building performance and the other the user satisfaction. These parts should be first evaluated and then combined. Based on this division, further sub research questions are formulated, which are entailed in the two parts and are answered separately in each chapter, as it will be described in the next paragraphs. The research questions with their sub-questions are presented below:

1. How can the sustainable building performance be measured and monitored?
    a. Which tools are widely used worldwide? What do they measure?
    b. What is the relationship between these tools and sustainability?
    c. What factors do these tools include that refer to users' perspectives/satisfaction?

2. How can sustainable building performance be evaluated?
    a. What is sustainable building performance?
    b. Which evaluation frameworks exist?

3. How can user satisfaction be evaluated?
    a. What is the interaction between users and sustainable buildings and sustainable building performances in particular?
    b. Which factors influence the user satisfaction?

4. What assumptions can be formulated after combining these evaluations?
    a. What comes out of this combination?

5. How can these assumptions be tested?
    b. Which are the results after the testing?

The below figure indicates how these research questions can be answered during the research thesis. It also indicates how research is a cyclical process and that in the end, the findings and results should answer to the first phase.

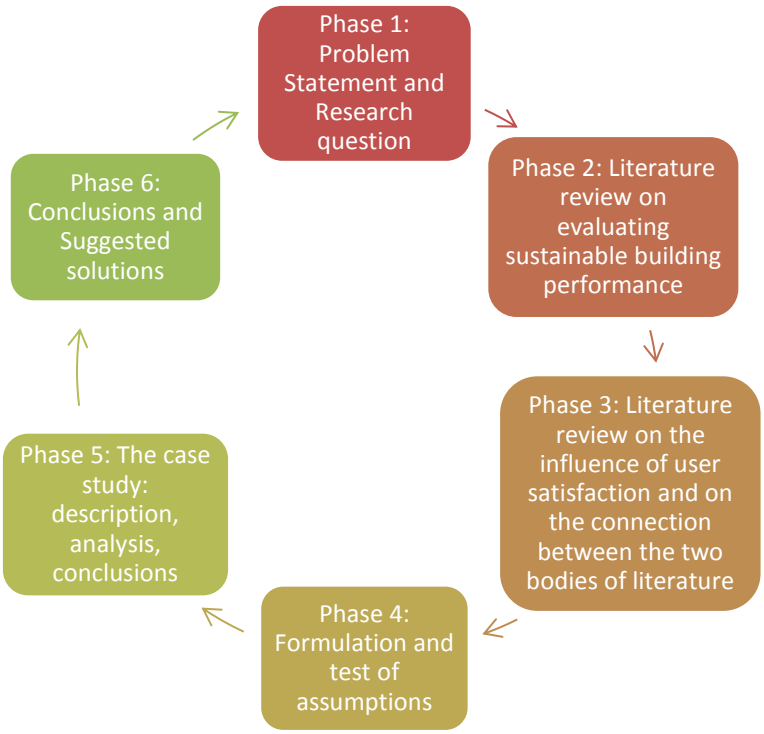

Figure 1.2: The research of the thesis in phases

1.4 Research Methodology

In this section, the research methods to find the answers to the five research questions are presented. For the whole research, desk research, literature review, interviews (standardized, open-ended interviews) and a survey with a questionnaire were the primary research methodologies. Moreover, academic papers, proceedings of conferences, books and reports were used as sources. To find these sources the internet was used, as well as several scientific databases and the TU Delft library. For each research question a separate paragraph will be provided in which some, more specific methods were used to answer their sub questions.

1. How can the sustainable building performance be measured and monitored?

For this question, first an additional literature review was conducted. The choice, based on the most widespread, reliable and up to date tools, is LEED, GPR, DGNB, Open House and BREEAM NL. It was indicated that these tools are aiming at measuring the building's performance during the design and construction phase and are of little help during occupancy. However, their extensions, BREEAM NL In Use, LEED In Use and GPR In Use are focused on existing buildings during their usage and in general, they already acquire some criteria that could be useful. First their main framework and their main features are in question but the focus shifts on their relationship with sustainability, their references to monitoring and evaluating the building performance and to what extent they take into account the users.

2. How can sustainable building performance be evaluated?

The approach to answer this question is to formulate first a description of what is a sustainable building performance. The methodology of this question refers to an evaluation and through literature and scientific papers the most appropriate concepts for building

performance evaluation are researched. While searching for evaluation, assessment frameworks for sustainable buildings, the concepts of Building Performance Evaluation (BPE) and Post Occupancy Evaluation (POE) were chosen and their analysis will contribute to the process of the research. Both concepts are looked into and this question and its sub questions will be answered.

3. How can user satisfaction be evaluated?

The answer for this question is a literature research, which is conducted on the interaction between buildings and users, how users influence buildings and their performance with their behavior and actions, which role sustainability plays, how satisfied they are etc. Connections to user behavior, sustainability, sustainable performances and user satisfaction in particular, are made.

4. What assumptions can be formulated after combining these evaluations?

The connection of these reviews reveal the importance of users' satisfaction and the need of the formulation of more specific assumptions and hypotheses regarding factors that can define this satisfaction and in general the user influence. After the formulation of specific assumptions, the needed methodology is a study case. In general, the methods used to understand users' behavior, measure their satisfaction and evaluate them, are interviews and questionnaires on occupant comfort. These methods are applied on a case study, which is the town hall of Leiderdorp.

5. How can these assumptions be tested?

The case study of Leiderdorp will be the main method to answer this question and test the assumptions. The description, analysis and conclusions of this case are included. The methods used within this case study are interviews with some employees of the town hall and a survey with a detailed questionnaire towards all employees. First, an extensive literature is made on the building, its main sustainable systems (heating, lighting, ventilation, and acoustics), its design performance and its current performance. It is tried to find out if a performance gap can be identified. Furthermore, interviews are conducted with the users of the town hall. The group of users is limited only to the employees of the town hall and not visitors. Their satisfaction, the amount of control they have on building systems and their relation to sustainability are explored. For the statistical analysis of the results from the questionnaire, the program of SPSS will be used.

Results from this analysis along with the analysis of sustainable building performance evaluation will give feedback and input for defining the relationship between user satisfaction and performance.

A general conclusion can be that the questionnaire and some interviews along with literature research will be the main methods to answer all the research questions. Most of the interviews will be qualitative, standardized and open – ended.

1.5 Thesis Outline

The outline of the thesis will be based on the division of the main research question. The introduction will present the subject, the problem statement, the research objective, the main research questions and the research methodology. The five research questions provide

a good framework for the schedule of the thesis. Mainly every question will be dealt with in a separate chapter. This would result in the following layout.

Chapter 1: Introduction
Chapter 2: Monitoring and Measuring the Sustainable Building Performance
Chapter 3: Evaluation of Sustainable Building Performance
Chapter 4: Evaluation of the interaction between user perspectives and sustainable buildings
Chapter 5: Connection of the evaluations and formulation of assumptions
Chapter 6: The case study
Chapter 7: Conclusions
Chapter 8: Suggested solutions and Recommendations

2 Monitoring and measuring the sustainable building performance

2.1 Introduction

After having introduced the main research questions of this thesis, which focus on the performance of sustainable buildings, it is necessary to begin the research of analyzing how the sustainable performance can be evaluated. To begin with, a distinction should be made. This distinction has to do with the words monitoring, measuring and evaluating. Monitoring and measuring do not involve the aspect of judgment, while evaluating does. The research of this thesis starts with describing first how the sustainable building performance can be monitored and measured.

This chapter is focused on the assessment tools that monitor and assess the building performance in quantitative and qualitative ways. The tools cover different phases of a building's life cycle and consider different environmental issues. 'These tools are global, national and, in some cases, local. A few national tools can be used as global tools by changing the national databases. Different tools are used to assess new and existing buildings' (Haapio & Viitaniemi, 2008). For this section of the chapter, the most widely known and applicable tools will be described. To create a common research framework for analyzing and describing these tools, some questions were first formulated in order to sum up their basic characteristics and features that will contribute to combine afterwards the most relevant and important criteria for this thesis. These questions are as followed:

- Who organizes/owns the tool?
- Who participates in this assessment/certification process? What are the conditions or requirements for participation?
- Who decides about the content?
- Who uses the tool? Are there any costs involved? Is there any training or is it required?
- To what extent/In which fields is the tool more ambitious than national/regional/local regulations?
- Is Government involved in the development/use of the tool? If so, how?
- How widely has the tool been used?
- Is the use of the tool monitored or even enforced? How, by whom and why?
- What is the time scale at which monitoring results are being delivered? To whom are these results delivered? Are there any further recommendations for these results?
- Are there any minimum project requirements and prerequisites?
- Which of the tool's variables are referred to occupant's comfort?

These questions were initially formulated in order to conduct a primary literature review and gain some basic knowledge on these tools. Therefore, only the answers that clearly fall within the scope of this research are described below and the rest is included in Appendix A. The following answers mostly refer to criteria and guidelines, which describe monitoring and measuring the building performance and how they consider occupant comfort and users. It was decided to choose only these answers because their focus is on finding how these tools and their specific criteria are developed and how they contribute to evaluate and maintain the performance on a sustainable level and furthermore to what extent they include users in their framework.

2.2 LEED (U.S.A.)

2.2.1 Introduction

One of the main assessments tools is LEED. LEED, which means Leadership in Energy and Environmental Design, was founded in 1995 and it is a 'voluntary, consensus-based, market driven program that provides third-party verification of green buildings'. LEED provides to interested parties, building owners and operators the tools they need to influence their building's performance, while providing healthy indoor spaces for the occupants of the building. LEED projects have been successfully established in 135 countries (U.S. Green Building Council, 2013).

LEED has categories as Green Building Design & Construction, Green Interior Design & Construction, Green Building Operations & Maintenance, Green Homes Design & Construction and Green Neighborhood development. It is divided in the following sections: Sustainable sites, Water efficiency, Energy and atmosphere, Materials and resources, Indoor Environmental Quality, Innovation in operations and regional priority. The focus of this research is on the third category, which describes LEED for Existing Buildings: Operation and Maintenance (U.S. Green Building Council, 2013). The performance strategies of LEED for Existing Buildings aim at providing operational benefits throughout the life cycle of the building. If these strategies are continued, a building can maintain and even improve its performance over time.

2.2.2 Monitoring and enforcement of LEED

Building performance has to be measured and monitored continuously. In this context, projects are obliged to monitor their performance and can comply with either reporting performance data annually or allowing USGBC to access the information directly from utilities, or by earning certification under the LEED platform for existing buildings and re-certifying every two years. Performance data should be disclosed publicly. It is stated by the USGBC that 'this sort of a rule creates a greater awareness of building performance that will help owners and managers fine-tune their properties, which often operate with less efficiency than is possible. Full disclosure of performance information is one of the most effective ways to achieve energy efficiency. It gives every building a public incentive to improve energy performance, and that is really powerful' (U.S. Green Building Council, 2013).

2.2.3 Time scale of monitoring, results and recommendations

LEED EB requires routine and continuous inspection regarding many building aspects and systems, as ventilation systems, air quality control systems, thermal comfort and occupant comfort. There is no specific time scale or limit when to deliver the performance data but the measurement and deliver has to be conducted on an annual base and the inspection and monitoring continuously. Concerning monitoring, LEED provides suggested actions, means and examples about credits of LEED. In these actions, user and occupant comfort is taken seriously into account, as it will be noted later it is closely related to all building systems.

LEED offers some examples about certain systems inside the building, as heating, ventilation and lighting, which are worth noticed. To monitor and assess heating systems, it is important to monitor them with up to date monitoring software systems, but also by following and observing occupants' comfort. To verify thermal comfort, it is agreed to implement a thermal comfort survey of building occupants within a period of 6 to 18 months after occupancy. This survey should collect anonymous responses about thermal comfort in the building including an assessment of overall satisfaction with thermal performance and identification of thermal comfort-related problems. Then after this survey, LEED agrees to develop a plan for corrective action if the survey results indicate that more than 20% of occupants are dissatisfied with thermal comfort in the building (U.S. Green Building Council, 2013).

For ventilation from the technical perspective, there is installation of permanent monitoring systems that provide feedback on ventilation system performance to ensure that ventilation systems maintain design minimum ventilation requirements. Another LEED direction for measurement and monitoring is an installation of a BAS System (Building Automation System) that monitors and controls HVAC and lighting systems. The minimum BAS functions for HVAC include monitoring the status of sensors and controlled devices, scheduling equipment off when not in use, scheduling set points and setbacks, and trending equipment status. The minimum BAS functions for lighting, includes scheduling lights to turn off during unoccupied times. Furthermore, adding lighting controls is a great strategy for reducing energy consumption and improving occupant comfort and productivity. They allow occupants to adjust lighting levels to their specific needs, rather than relying on a broadly over-lit space. (U.S. Green Building Council, 2011). Furthermore, ASHARE Level I Walkthrough Energy audit is one proposed measurement. It can include a graph of annual energy end use breakdown – Energy Efficiency Best Management Practices. According to LEED, a BAS system (Building Automation System) is required, which along with System Level Metering can contribute to Performance Measurement.

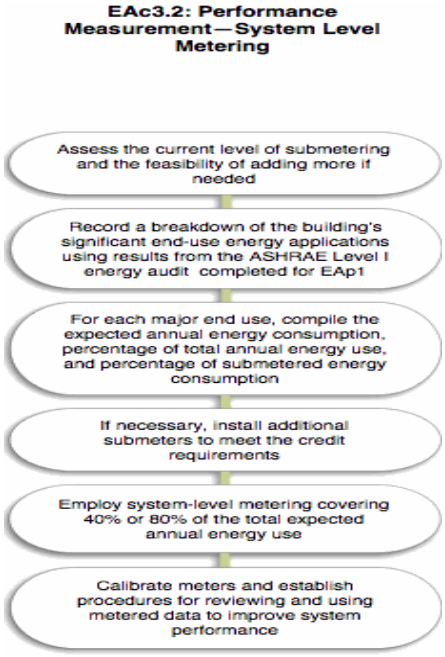

Figure 2.1: Performance Measurement (LEEDuser, 2009)

In addition, measurement techniques that include sub metering are based on the International Performance Measurement and Verification Protocol (IMVP), which provides an overview of current best practice techniques available for verifying results of energy efficiency, water efficiency, and renewable energy projects. It describes in detail measurement techniques for systems as temperature, runtime, electricity etc. It may also be used by facility operators to assess and improve facility and building performance (U.S. Department of Energy, 2002).

2.2.4 Variables and criteria for occupant comfort

LEED has some variables that refer to users and occupants of the buildings. In the category of Indoor Environmental Quality, there are three credits that mention directly and indirectly users' satisfaction. The first is EBOM-2009 IEQc 2.1: Occupant comfort – Occupant Survey, the second is EBOM-2009 IEQc 2.1: Occupant comfort – Thermal comfort monitoring and the third is EBOM-2009 IEQc 2.2: Controllability of Systems – Lighting, which indirectly aims at occupant's satisfaction (LEEDuser, 2009). For each one of those, the process that can be followed is schematized as the following example with the figure for occupant comfort and occupant survey.

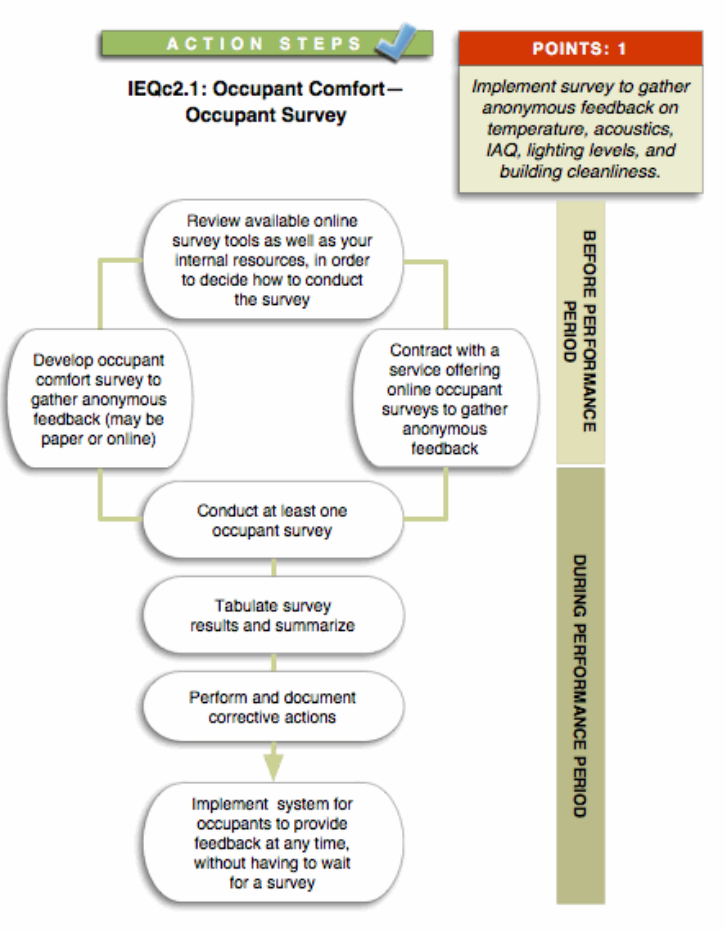

Figure 2.2: Occupant comfort – occupant survey (LEEDuser, 2009)

For the above process, a survey, a standardized questionnaire is also created by the Center for the Built Environment (CBE) by Berkeley University, investigating Indoor Environmental Quality (IEQ).

As a general remark, it should be noticed that this section and standards refer to LEED for Existing Building. Normally, these buildings are already certified by LEED and the next step is to be recertified. Even if this does not fully match the case of a town hall that is not certified from the beginning, the entailed requirements and suggestions of the tool can be used. This could be done by integrating some of the above criteria into an evaluation process/model that will be applied on a used building (a town hall). An example could be the frequent implementation of an occupant comfort survey.

2.3 GPR (The Netherlands)

2.3.1 Introduction and description

GPR software is an assessment tool helping into the evaluation of sustainability. It is a clear view on the sustainability of real estate and urbanism. It has four main domains: GPR Urban

Planning, GPR Specials, GPR (Buildings), GPR Maintenance. The interest of this thesis is focused on GPR Buildings (GPR Gebouw) and GPR Maintenance. GPR Gebouw is an assessment tool measuring sustainability performance for construction types, residential and commercial. These types can refer to new construction, existing construction and major renovations. GPR can be used at any phase during a project, thus in policy, design and realization. It is a web-based tool, where the project details are completed and reports are made with the subject performance. GPR is simple, accurate and easy to use (GPR Gebouw,2012).

A building is rated on five indicators on a scale of 1 (worst) to 10 (best). The key performance indicators are Energy, Environment (assessing the environmental impact), Health, User Quality, and Long Term value (assessing the building quality). Each indicator is divided into several sub-indicators. When assessing a building, its building performance is rated per indicator. Some of the most important benefits of GPR Gebouw are its quick insight into sustainability for new and existing buildings, its competitiveness and its low fares (GPR Gebouw, 2012).

2.3.2 Monitoring according to GPR

A monitoring procedure is required during the use of GPR, starting from the initial phase of the lifecycle of a building. Even if guidelines exist, they refer to initial phases, namely during the design (Appendix A). Even if this monitoring procedure applies on the design phase and even if the version of GPR for Existing Buildings is not yet completed, it is logical and necessary that such a kind of monitoring shall exist also during the use phase of the building.

2.3.3 GPR and occupant comfort

As it is mentioned in the introduction of this tool, it has five main domains, which are also shown in the next figure.

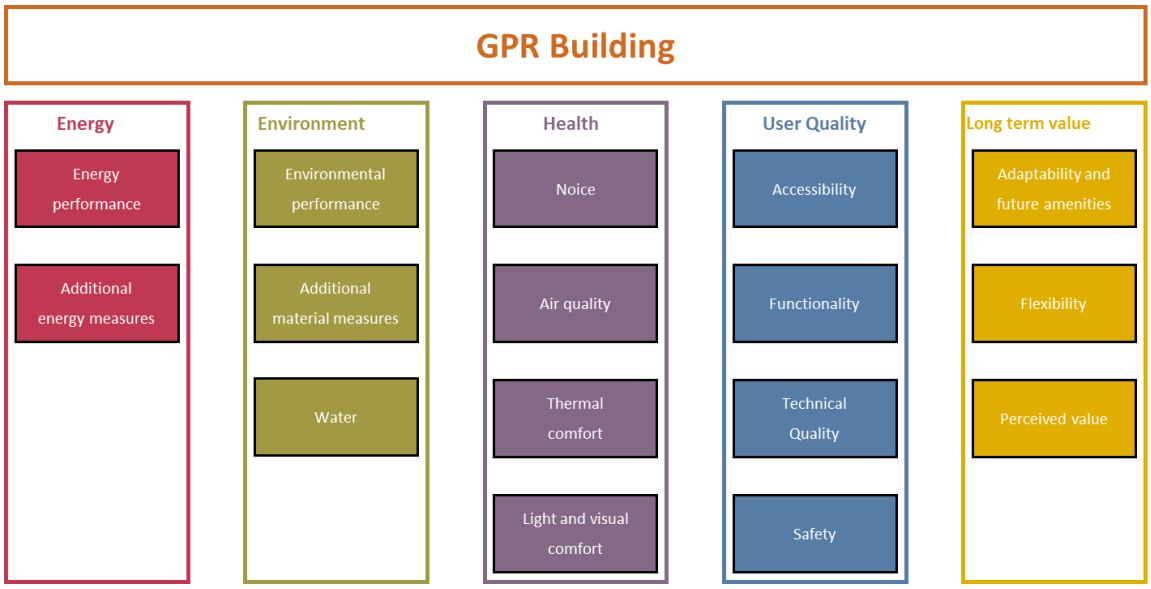

Figure 2.3: The tool GPR(W/E, 2011)

The domains of Health and User Quality are closely related to occupant's comfort. Noise control, air quality, thermal, lighting and visual comfort are basic and significant interests of the users. The aim of health is the realization of healthy buildings in which users can live and work. Reducing noise, sufficient fresh air, comfortable ventilation and natural light are included in this aim. Moreover, the goal of user quality is functional and accessible buildings,

with an excellent technical quality, surrounded by a safe environment. These are also of great importance for the users' satisfaction.

The above paragraphs refer to the GPR Gebouw, which is a tool that aims mainly at measuring and monitoring performance before and during the design for the construction of new buildings. The focus of this research is more on GPR Maintenance and GPR for Existing buildings. After a quick look on the limited available information in English about GPR Maintenance, the conclusion is that GPR Maintenance does not fit with GPR for new buildings because they use different criteria and requirements. The version of GPR for existing buildings is now in progress. Nevertheless, some information about it was found and are indicated in the next paragraph.

2.3.4 GPR for Existing Buildings

GPR Gebouw for Existing Buildings compares the sustainability of an existing building with the same building after refurbishment. It looks at both the environmental aspects (energy, materials) as the living quality related aspects (health, user friendliness). It uses the EPBD for the Energy module (EU-directive) and LCA-methodology for Materials (GPR Gebouw, 2012).
Reducing energy consumption and eliminating wastage are among the main goals of the European Union (EU) and this is the reason of the introduction of new legislation. A key part of the new legislation is the Energy Performance of Buildings Directive (EPBD), which is going to be used by GPR. It requires all EU Member States to tighten their building energy regulations and to introduce energy certification schemes for buildings. Member States shall ensure that, when buildings are constructed, sold or rented out, an energy performance certificate is made available to the owner or by the owner to the prospective buyer or tenant and it has to be maintained over the years through inspections and monitoring (Concerted Action, 2011).

2.4 DGNB System (Germany)

2.4.1 Introduction and description

Due to the rising demand for green buildings in Germany and the rising "Corporate Social Responsibility", which will be explained also later, certifications according to DGNB are becoming more and more important. This is because they make the "greenness" of buildings visible, which also leads to more prestige. The most popular certification in Germany is DGBN certification, which is being developed in 2007 by the German Sustainable Building Council (DGNB). The DGNB certification system assesses the new building itself as well as the life cycle of the building and besides that, existing buildings can also be certificated (DGNB, 2010).

Not only in Germany but also in all around the world, the construction and real estate sector are subject for innovation and changes. For that reason, the flexibility of the DGNB is a big advantage. This makes it possible to develop new systems and outlines for various types of buildings. At the same time, the existing schemes are continuously refined as well. Currently, the DGNB System can be used to certify some 15 different schemes in Germany and

internationally. It includes existing and new office, administrative, commercial, residential and mixed-use buildings. The committees of the DGNB constantly work on new schemes. This thesis is focused on the scheme of Office and Administrative Buildings under new construction. In the context of DGNB, the term of new construction remains until the first three years of operation. This certificate is available for all buildings used mainly as offices or for administrative purposes. Aside from environmental and economic aspects, the focus of the assessment is also on user comfort – such as noise, temperature, and appearance – which greatly affect the performance and motivation of workers (DGNB System, 2013)

2.4.2 Monitoring performance

Auditors and consultants, who have been assigned by DGNB, monitor the correct implementation of DGNB System. They are responsible for the results of planning and realization phase and they are trying to improve the performance by monitoring. Unfortunately, there are no specific standards regarding the phase after the building is completed. Some standards that could be related to monitoring and measuring performance are included in maintenance and management that is described in the last paragraph.

2.4.3 DGNB and occupant comfort

DGNB System has 6 areas of evaluation and 49 criteria. The areas of evaluation are shown in the next figure:

Figure 2.4: DGNB areas of evaluation (DGNB, 2010)

The Topic of Social Quality is the most important and relevant to occupant comfort. The criteria for the area of Sociocultural and Functional Quality are: Thermal comfort in the winter (Nr.18), Thermal comfort in the summer (Nr. 19), Interior hygiene (Nr. 20), Acoustic comfort (Nr.21), Visual comfort (Nr.22), User control possibilities (Nr.23), Exterior quality as affected by the building (Nr.24), Safety and risk of hazardous incidents (Nr.25), Handicapped accessibility (Nr.26), Space efficiency (Nr.27), Suitability for conversion (Nr.28), Public access (Nr.29), Bicycling convenience (Nr.30), Assurance of creative and urban development quality in a competition (Nr.31), Percent for art (Nr.32) (DGNB, 2010).

2.4.4 Maintenance and Management

According to the maintenance and management after the implementation of DGNB during the occupancy phase of the building, a suggested creation of conditions for optimal use and management are preparation of maintenance, frequently inspections, operation and maintenance detailed instructions, maintenance and repair plan for individual target groups. Moreover, adapting the plans, documents and calculations of the realized building and creating a user manual are further suggestions for the usage phase. Furthermore, regarding the quality of construction, some suggestions are the documentation of materials and the

creation of Material Safety Data Sheets, quality control measurements, measuring the airtightness, thermography and measurement of sound insulation (Hartwig, 2012).

2.5 OPEN HOUSE (European Union)

2.5.1 Introduction and description

The overall objective of OPEN HOUSE is to develop and to implement a common European transparent building assessment methodology, complementing the existing ones, for planning and constructing sustainable buildings by means of an open approach and technical platform. OPEN HOUSE will develop a transparent approach to be able to apply on all organizations across the EU. This approach will be communicated to all stakeholders and their interaction and influence on the methodology will be assured in a democratic way. The baseline will be existing standards (both CEN/TC 350 and ISO TC59/SC17), the EPBD Directive (this is used also by GPR for existing buildings) and its national transpositions. It is composed by 20 organizations covering 11 countries. It has been configured with a contribution of large companies with strong research capabilities, research organizations, end users and policy makers(Peyramale, 2013).

Figure 2.5: Organizations and companies of the consortium (Peyramale, 2013)

2.5.2 The need for OPEN HOUSE

There is a need at European level of a methodology that could be embedded in policies, a methodology that would gradually come in the mainstream, in the everyday of the construction business. That could at the end even assume the shape of a “label” allowing sustainability to become a visible, comprehensible and, why not, a marketable open asset (Peyramale, 2013).

2.5.3 Categories of OPEN HOUSE

The categories of the tool are indicated with the next figure:

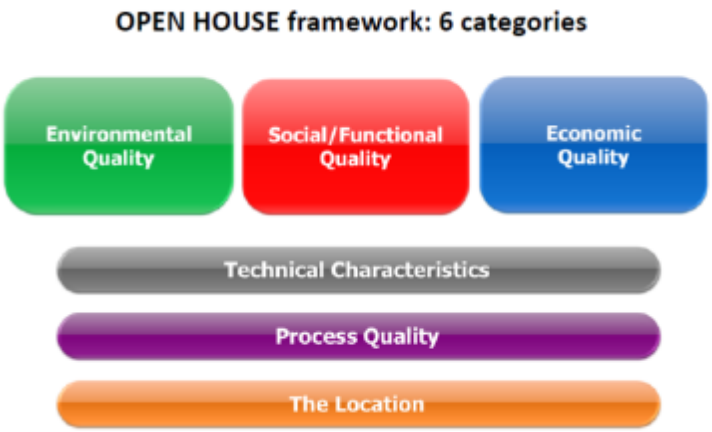

Figure 2.6: OPEN HOUSE categories (Open House, 2013)

Each of the above categories has some criteria, which are indicated in Appendix A. It has to be indicated that not all of the criteria are relevant. At this point, a very important factor-tool that is included in the Environmental Quality, is the implementation of Life Cycle Assessment (LCA). This tool helps in maintaining all the features, systems and values of the building through its life cycle. The relevant document describing and analyzing the method can be found in Appendix A2.

In the category of Social/Functional Quality, all of the criteria are useful and well founded, especially on the area of occupant comfort and user satisfaction. As DGNB was one of the systems used for the creation of Open House, it can be said that many of the criteria are similar. However, the criteria of Open House are more extensive, in detail and cover a bigger range. Examples of these criteria are the Indoor Air Quality, Service Quality, Public Accessibility and Operation Comfort. An example of how these criteria are assessed and on which standards they are based, can be found in Appendix A2.

The category of Process Quality includes guidelines and criteria for the planning of the project. Furthermore, it includes also one criterion that is applicable on the case study of this research and in general, on the focus of the research, which is Monitoring Use and Operation. Its description can be found in the Appendix A2, along with the criterion of Optimization and Complexity of the Approach to Planning, which includes additional features for optimizing and maintaining quality in a building by monitoring and measuring the performance.

At this point, it should be noted that due to the importance of OPEN HOUSE and an obvious preference to it, it was decided to cite some of its criteria analytically in the Appendix A2. The interested organization can easily look into these criteria and use the most suitable.

2.6 BREEAM NL (The Netherlands)

2.6.1 Introduction and description

BREEAM is an instrument for assessing the sustainability of buildings. BREEAM was developed by the Center for Sustainable Construction. BREEAM stands for Building Research Establishment Environmental Assessment Method. BREEAM NL is developed and managed by DGBC licensed by BRE Global Ltd (UK).

The demand for sustainability of buildings has been constantly increased over the years. In the Netherlands, requirements for sustainable buildings were not harmonized and standardized under a common concept until recently. By implementing BREEAM, makes it possible for a good assessment framework to be available. BREEAM NL is based on the BREEAM International system. BREEAM-NL latest version 2.0 is in consultation with interested groups established in September 2010, submitted to the Advisory Group of the Dutch Green Building Council (DGBC) and adopted by the Board of the Dutch Green Building Council (DGBC, 2010). BREEAM is the world's leading and most widely used environmental assessment method for buildings, with over 115,000 buildings certified and nearly 700,000 registered. It has become the standard measure used to describe a performance of a building. It has ten categories according to performance and credits are awarded to these categories, as it will be described also alter on. These credits are then added together to produce a single overall score on a scale of Pass, Good, Very Good, Excellent and Outstanding (DGBC, 2010).

A BREEAM standard covers issues in categories of sustainability as Management, Health and Well Being, Energy, Transportation, Water, Materials, Waste, Land Use and Ecology and Pollution. Each category consists of a number of issues and criteria (Appendix A). Each criterion contributes to accomplish the main aims and objectives by defining a target performance and assessment criteria that should be met in order to confirm that the target has been achieved.

2.6.2 User guide contents (Towards users and managers)

In BREEAM there are some criteria and credits that concern users and in general services and aspects that relate to users. These aspects are categorized regarding the kind of management and strategies that are recommended and needed and according to the main categories of BREEAM NL.

- **Building services information**

Users should get general information about the heating, ventilation, cooling, lighting (for example: which plants are present in the building, how the operation works and where are the buttons found or tips on not covering radiators, use blinds, etc., with underlying 'strategies' on draft). In addition, they should be informed on the temperature and they should receive a report draft for inconveniences or pitfalls (broken doors, etc., dealing with lighting, cooling, heating). Moreover, the person responsible for monitoring performance that could be called the Building Manager should be informed and responsible for all of the above plus a non-technical summary of the management and maintenance of building facilities, including the building management and a summary of the operating instruments (DGBC, 2010).

- **Energy and Environmental Strategy**

This should give owners and occupiers information on energy-efficient features and strategies relating to the building, and provide an overview of the reasons for their use. For the user of the building information on the operation of innovative features such as new heating systems, modern acoustics, automatic blinds, lighting systems etc. A crucial factor is the guidance on the impacts of strategies and so the determination of control that is provided the user. These strategies can cover adjusting thermostats, window opening and the use of blinds, lighting and heating controls (DGBC, 2010). Moreover, these impacts and more technical information concerning energy consumption, energy savings and building performance are the responsibility of someone being designated as Building Manager or Facility Manager. In these responsibilities, energy targets and benchmarks for the building type, information on monitoring such as the metering and sub-metering strategy, and how to read, record and present meter readings, are included (DGBC, 2010).

- **Water use**

Both users and the responsible managers should be notified about details of water saving features and their use and benefits, e.g. aerating taps, low flush toilets, leak detection, metering etc. and especially managers could be able and urged to give recommendations for system maintenance(DGBC, 2010).

- **Transport Facilities**

It would be a great help if the users would be provided with details of car-parking and cycling provision, local public transport information, maps and timetables and information on alternative methods of transport to the workplace, e.g. car sharing schemes; local 'green' transport facilities(DGBC, 2010).

- **Materials & Waste Policy**

Creating an environmental and waste policy and stimulating an environmental friendly behavior from the users is something that could first contribute to the building performance and to the lasting life cycle of the building. Information on the location of recyclable materials storage areas, on their usage and in general all existing recycling possibilities should be provided. Managers could also provide examples of Waste Management Strategies and any cleaning/maintenance requirements for particular materials and finishes (DGBC, 2010).

- **Reporting Provision**

For a well-organized communication between users and administration, the contact details of the facility or building manager or the person responsible for all above mentioned and of the maintenance team should be provided to users and be available to be found anytime. Furthermore, the creation of a help desk facility that can provide such kind of information anytime is suggested. The upper layer managers should also acquire information and contact details of suppliers/installers of equipment and services and their areas of responsibility for reporting any subsequent problems (DGBC, 2010).

- **Training**

Apart from the details that users and managers should have, training from the contractors and suppliers should be requested if it is not being suggested by them. This training can include demonstrations in the use of the building's services, features and facilities that will be needed. Suggestions for users, are training or information evenings in the use of any innovative/energy saving features and for managers or responsible persons for maintenance

are in addition training in emergency procedures and setting up, adjusting, and fine tuning, the systems in the building (DGBC, 2010).

- **General**

All of the above should be included in a guide. This guide should be informative, equipped with all technical and non-technical needed data and easy to understand from any user of the building (both general users and managers). Due to this reason, it could be useful to divide this guide in two parts. Regarding BREEAM NL, one part is called Operation and Maintenance Manual and the other is the Building User Guide. The later contains the necessary details about the everyday operation of the development in a form that is easy for the intended users to understand (DGBC, 2010).

The importance of such a guide or guides should be further explained. Without the provision of adequate information and guidance, it is likely that the building will be used inappropriately leading both to the dissatisfaction of occupants and jeopardizing the performance of the building. For example: Users may tend to take initiatives and try to adjust their personal workspace by adding partitions or moving the furniture which may sound obvious and satisfying for them but ventilation or lighting systems can be impaired by these actions. The result can be causing inefficiencies, discomfort (in contrast with the first impression of creating comfort) and poor performance. The general aim is to ensure that design features are used efficiently and that changes to office space are managed in the most appropriate manner.

At this point, it should be noticed that even if all of the above mentioned aspects seem to be applicable only on the design phase, they can apply on an existing building. If these aspects are not taken into account from the beginning in a new building, then changes and adjustments to building systems have to be made. Therefore, an effort has already begun to create BREEAM NL In Use, which will consider further criteria and aspects during the usage of buildings.

BREEAM In-Use is designed to reduce operational costs, enhance the value and marketability of property assets, provide a transparent platform for owners and tenants to identify and exchange opinions and perspectives on building improvements, and provide a specific framework to compliance with environmental legislation and standards. Moreover, it can stimulate and enhance commitment with staff in the identification of productivity improvements and sustainable business practices and provide a way to evaluate and improve Corporate Social Responsibility (CSR)(Lee & Burnett, 2008).

According to the Dutch side, some information has been revealed and publicized on the aims of BREEAM NL In Use and on its possible framework. It is designed for the above reasons, plus to provide opportunities to improve staff satisfaction with the working environment. This is conducted with the potential for significant improvements in productivity, in organizational effectiveness and it tries to provide a genuine badge of proven sustainability (DGBC – BREEAM, 2010).

2.7 Overview

After gathering all information on various tools that are used worldwide (answer to the research sub question '' Which tools are widely used worldwide? What do they measure?''), it would be efficient to summarize the most important in a table. The literature research was extensive. It included information about the tools that resulted in gaining the whole picture

of each tool. In addition, it made the understanding of their contribution easier. Each tool has its advantages and disadvantages in different fields. Nevertheless, the focus of this research is on aspects concerning the sustainable building performance and the processes of monitoring and measuring it in the occupancy phase, in particular. Therefore, the criteria and guidelines that refer to that are presented in detail and answer to one sub question ''What is the relationship between these tools and sustainability?'' and partly to the whole second research question ''How can the sustainable building performance be measured and monitored?''.

At the same time, the focus is shifted also on the extent to which users are considered in these criteria and guidelines. There are some criteria that refer to occupant comfort and social quality and can answer the third sub question of the second research question ''What factors do these tools include that refer to users' perspectives/satisfaction?''. However, hardly any of the above tools seem to take seriously into account the aim of occupant comfort and users' satisfaction, which will be addressed also later.

Furthermore, the most critical aspects from the studied tools, in order to achieve efficient levels of performance and maintain these levels, are selected and indicated in the next table. Then, for the above-mentioned tools, it is indicated if these tools include such aspects in their framework or not. Aim of this table is to show which sustainability issues are addressed in existing tools for measuring and monitoring building performance.

	LEED	GPR	DGNB	OPEN HOUSE	BREEAM NL
Energy performance					
Subcategories	7 (Sustainable sites, Water efficiency, Energy and atmosphere, Materials and resources, Indoor Environmental Quality, Innovation in operations and regional priority)	5 (Energy, Environment, Health, User Quality, and Long Term value)	6 (Environmental Quality, Economical Quality, Social Quality, Technical Characteristics, Process Quality, Quality of the location)	6 (Environmental Quality, Economical Quality, Social/Functional Quality, Technical Characteristics, Process Quality, The location)	9 (Management, Health and Well Being, Energy, Transportation, Water, Materials, Waste, Land Use and Ecology and Pollution)
Rating	Certified, Silver, Gold, and Platinum	Scale of 1 (worst) to 10 (best)	Gold, Silver, Bronze	Points (0-100)	Pass, Good, Very Good, Excellent and Outstanding
Annual performance reports	✓				✓
Inspections and audits	ASHARE Level I Walkthrough Energy audit				✓
Thermal Comfort		✓	Different systems for winter and summer	✓	Heating controls and monitoring systems (adjusting thermostats)
Thermal performance	BAS system		✓		✓
Temperature control	Monitoring sensors		✓		✓
Ventilation			✓	✓	✓
Air quality	Installation of permanent monitoring systems + Inspections	✓			
Acoustics	Exterior noise control	Noise control	✓	Noise protection	✓
Lighting		✓	✓		Lighting control systems (window opening and the use of blinds)
Sensors	Lighting controls				

Necessary access to daylight	Daylight and views				✓
Location			✓	Image and condition, options of transportation	
Accessibility	Alternative Commuting transportation		Bicycling convenience	Public accessibility and bicycle comfort	Car sharing schemes; local 'green' transport facilities
Office layout					
Possibility of changes		Flexibility	Space efficiency, suitability for conversion	Conversion feasibility	
Building Management Systems (BMS)	✓			Monitoring Use, Operation, Optimization and Complexity of the Approach to Planning	✓
Instructions for facility managers					✓
Interaction user – building (User Behavior)		Functionality and safety		Acoustic, visual, operation comfort, indoor air quality survey	Training of the staff, manuals with any kind of information
Thermal comfort Survey	✓			✓	✓
Occupant comfort survey	✓				
User control possibilities			✓		
User manual					✓
Help desk facility	✓				✓
Aesthetics			Percent of art		

Table 2-1: Overview of the main criteria of the reviewed existing monitoring tools

2.8 Conclusions

After this extended literature review in the most frequently used assessment monitoring tools, it is obvious that hardly any of the tools take into account the user factor or user perspectives in determining their criteria or they considers it but in a very superficial way.

Therefore, the question is why the user factor and user perspectives are not involved enough and what can be done to include them and fill the gap and the missing link between technical and user perspectives that can lead to the performance gap. Monitoring tools worldwide have been developed in such a way that

- Their frameworks and criteria focus more on the phases of design and in general before the occupancy phase
- They pay more attention on technical perspectives and standards and try with them to achieve quality that equals to sustainable building performance
- Inside the concept of an evaluation process and regarding monitoring and measuring building performance, there are only a few of them that have considered the factor and perspectives of users as influential and worth to be researched

The main finding of this review and chapter is that assessment tools measure building performance from a sustainability point of view and aim to raise the sustainable ambitions of the client (more according to technical perspectives), but lack of including criteria regarding users' involvement and satisfaction (user perspectives). At this point, the aspect of judgment is imported and leads to the needed concepts of evaluating sustainable building performance, which are described in the next chapter.

3 Evaluation of Sustainable Building Performance

3.1 Introduction

After having described how a sustainable building performance can be measured and monitored, it is of huge importance to understand what a sustainable building performance is and based on which aspects can be evaluated. The next figure indicates how sustainable building performance can be defined inside the concept of this thesis.

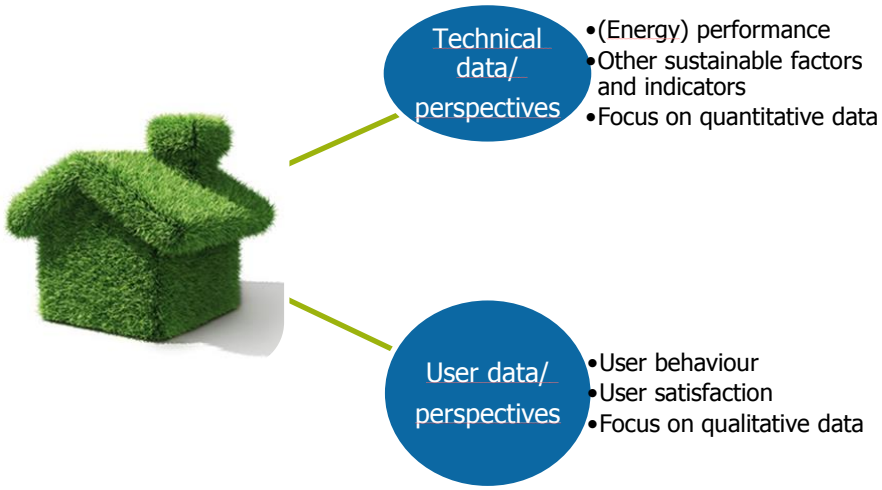

Figure 3.1: Definition of sustainable building performance

It is very important to understand that building performance and especially the sustainable building performance has two main aspects, according to which can be evaluated. The aspects that can also be referred as data or perspectives of assessment are both quantitative and qualitative and are divided into technical and user. Technical data/perspectives consider the assessment of the forthcoming building energy performance. This assessment may include calculations, energy certificates (BREEAM, LEED, GPR etc.) and monitoring strategies as the ones from the analyzed tools in the previous chapter. In addition this aspect includes other sustainable factors and indicators (for instance sustainable indicators, KPIs) and focuses on quantitative data. 'Many studies highlight the necessity of the identification and consideration of sustainable energy performance indicators in the environmental evaluation and any green implementations. In this regard, the building energy efficiency, the thermal performance of buildings and the material efficiency are considered as significant indicators

of sustainable energy performance to be fully taken into consideration during the performance evaluations' (GhaffarianHoseini et al., 2013).

The second main aspect refers to data and perspectives regarding the users of the building. It includes factors as user behavior, user satisfaction and focuses more on qualitative data. After the given problem statement, the relationship between users and performance of the building is important to be researched and evaluated. Therefore, sustainable building performance apart from the monitoring and measurement, which is something more impartial and is described in the previous chapter, it should be evaluated qualitatively regarding users' perspectives and users' satisfaction in particular. The rest of this chapter focuses on the second aspect, the concept of evaluation and how it can be implemented.

In order to develop requirements and criteria for an evaluation process that can be used, building performance acts as a stepping-stone. Many definitions have been found through literature, although the most common and precise is this one: 'Building performance evaluation is the process of systematically comparing the actual performance of buildings, places and systems to explicitly documented criteria for their expected performance' (Preiser & Vischer, 2005). The next figure shows a more complex concept, which introduces the performance criteria and their relevance to the building performance.

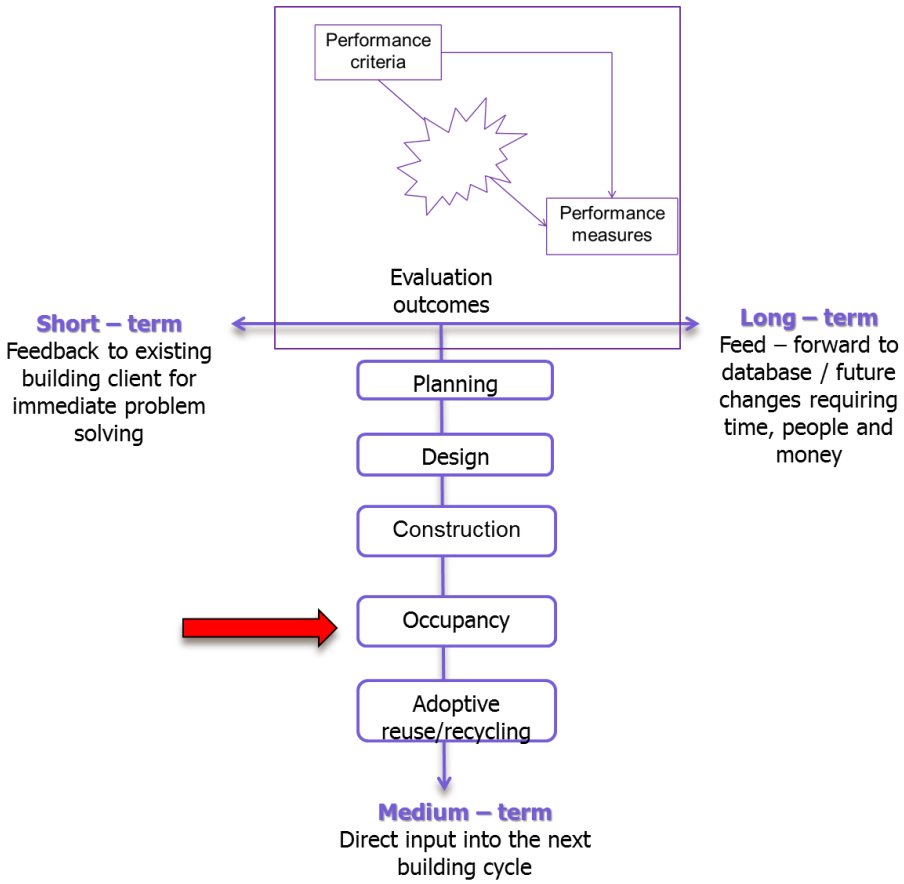

Figure 3.2: The performance concept and the building process

The above concept represents a basic feedback system that compares explicitly stated performance criteria with the actual, measured performance of a building. Inside this concept, there are three perspectives, one short term, one medium term and one long term.

Short-term outcomes include feedback from users on existing problems in their building that affect the building performance and furthermore identification of appropriate solutions for these problems. Through the process of evaluating the building performance, successes and failures in the performance are identified by stressing the importance of human factor and of the interaction between designed physical settings and building systems. Among other things, it should be emphasized that building performance evaluation contributes to the up-to-date knowledge of environmental design research. The six phases of BPE (Building Performance Evaluation) are indicated in the above figure, namely strategic planning, design, construction, occupancy and adaptive reuse or recycling. The focus of this research is pointed with a red arrow and this is the phase of occupancy, which leads to the concept of Post Occupancy Evaluation that will be described later on this chapter.

3.2 BPE and Sustainability

The European Union is requiring energy labeling of buildings in order to achieve the construction of more and more energy efficient buildings. This fact is closely related to the indispensable existence of BPE and to the increasing phenomenon of the 'performance gap', which is introduced at the beginning. 'There is still a significant gap between predicted and actual energy consumption in non-domestic buildings, which can be called as performance gap' (Menezes et al., 2012). Directives and standards have been developed in order to reduce this gap between predicted and in-use building performance. This results in the need of enhancing also the processes of measuring and monitoring the building performance during all the building phases and the development of sustainable indicators and criteria that will serve this mean, as seen also in the previous chapter.

Apart from the Directives and standards, efforts have been made from various organizations, governmental or not, that resulted in concepts linked to sustainability. 'Corporate Social Responsibility (CSR) is a movement based on the growing realization of the significance of the virtuous circles associated with improved building performance and the significant market advantages of do well by doing good' (Preiser & Vischer, 2005). A way of thinking influenced by CSR, encourages companies and other organizations to combine profitability and their goals and ambitions (monetary or not) with sustainability by making this a cornerstone of the way they operate and engaged to their policy.

Nevertheless, to achieve the above-mentioned combination between building performance evaluation and sustainability, changes should be made in some fields and sections. The starting point in the context of BPE should be the client's goals (G). For instance, a goal relevant to this research (that applies later on the case study) could be ''I want the most sustainable town hall in the Netherlands''. The way this goal is expressed could be stated that it is too vague. Even if there is a common impression on what is sustainable and even if there are many guidelines for sustainable building, this goal does not clarify for which parties this will be the most sustainable town hall. Owners, engineers-technicians and users may perceive differently the meaning and value of ''the most sustainable town hall''. For these groups, their goals could be profit, sustainable measures and quality respectively. This can create a big confusion and the solution could be the creation of criteria. The first thing is to understand what the key issues are, for achieving a green town hall in the Netherlands (C), and to set appropriate indicators (O) and benchmarks (P), and targets of performance in relation to those local and regional sustainability issues (C) (Preiser & Vischer, 2005).

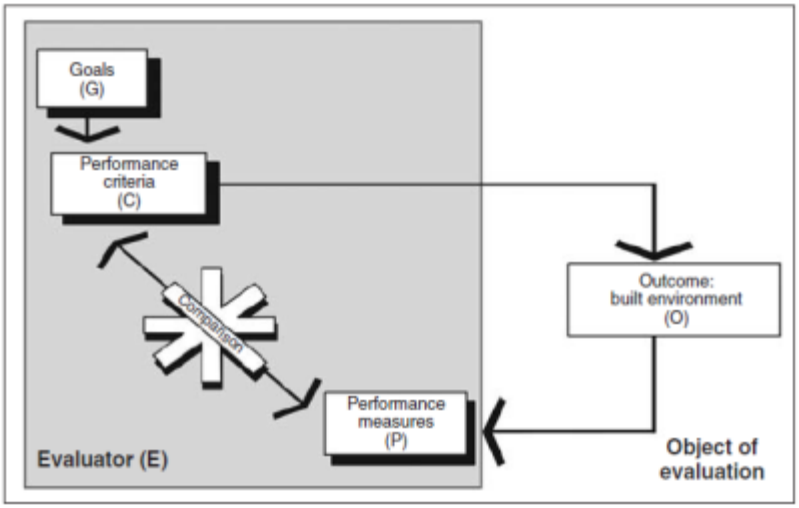

Figure 3.3: Performance concept and sustainability (Preiser & Vischer, 2005)

Usually, it is found through literature that core values of sustainability, which are linked also to the humans' everyday life, can be expressed in the phrase ''not exceeding the capacity of our planet to support our life styles'' (Preiser & Vischer, 2005). This phrase includes not only the aspect of physical resources such as fossil fuels and materials, but also the aspect of human resources, trying to ensure that quality of life of individuals and communities are optimized through the mainstreaming of sustainability. Therefore, in order to achieve the client's goal and incorporate sustainable criteria, the BPE should be able to answer to the following questions. These questions have been drawn after being applied through the years on several case studies (Preiser and Vischer, 2005). This information was a great help also in further chapters in the thesis, where most of them were adjusted and applied on the evaluation of a specific building and its users.

- ''How much energy does the building use? What are the 2050 targets it should work towards?''
- ''How much CO2 does the building produce?''
- ''How much water is used per capita?''
- ''How much waste is produced from the building?''
- ''How happy are the building's occupants? How much happier can they be made and how?''
- ''How much pollution does the building generate?''
- ''How does the building affect biodiversity in the region?''
- ''How sustainable, durable, replicable, maintainable are the materials the building is made of?''
- ''How adaptable is the building for other functions over time?''

The majority of the above questions refer to the environment and only one question refers to the users and occupants of subjected buildings. It is important to remember that the physical and technical performance of buildings is directly linked to the building qualities perceived by occupants. This is why during the occupancy phase performance criteria and sustainable indicators should not be created only according to environmental impacts and issues but also according to the users' needs, expectations and perspectives. This is the job of Post Occupancy Evaluation.

3.3 Post Occupancy Evaluation (POE)

Post Occupancy evaluation (POE), which is a sub process of BPE, can be defined as 'the act of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time' (Preiser & Vischer, 2005). Sometimes POE is confused as another technical evaluation of buildings. It is believed by some that it is an evaluation during the use of buildings, where their systems are being evaluated. However, it is not a pure technical evaluation and differs from main technical evaluations in several ways because it focuses on the role of the human factor and the users. It addresses the needs, activities, goals, expectations and perspectives of the people and organizations using a building, including maintenance and building operations. Measures used in POE include indicators related to performance. This performance can be divided regarding organizational and occupant aspects, as satisfaction and regarding the building performance itself, which can be summarized in the building systems as heating, ventilation, lighting, acoustics, etc.

The origins of POE were in UK. While building evaluation theory is not new, the concept of POE probably was created from the need to base buildings and construction with more scientific guidelines in the 1950s and 1960s. 'In its 'plan of work for design team operation', the Royal Institute of British Architects broke down the sequence of briefing/programming, design, specification, tendering, construction, completion and use into clearly defined stages. This included a final Stage M (feedback), when the architects would examine the success of what they had done' (Preiser & Vischer, 2005).

In the beginning, POE seemed to be successfully integrated. Later on, and even if there were signs that such an evaluation concept could be useful in the construction industry by evaluating and improving buildings, it was left aside for many decades. The causes were numerous. No capital or other resources were invested in building projects after being delivered. Neither the owners nor the designers nor the project managers were willing to invest in feedback mechanisms or concepts as POE. The most important cause is maybe the high impression of possible costly consequences. Other causes, except for the lack of money at the end of a project that led to no further involvement in the occupancy phase, were the lack of extra time due to another upcoming project and the importance of undertaking huge risks and responsibilities if things went wrong. The years have passed and nowadays, after having realized the problem of the 'performance gap' and while users' needs have increased over time, the focus has started to turn on the users as a crucial factor and their influence more than ever.

As it is stated in the beginning, criteria and indicators should be built during the whole building cycle. Taking into account the fact that performance criteria at each stage are constituted of both quantitative and qualitative performance evaluation, it is necessary to utilize qualitative and quantitative research. For instance, expected building performance in an area, such as temperature levels inside a building, can be compared with levels of thermal comfort as rated by users. Users can give feedback on either feeling too cold or too hot and this could seem vital for the system to make this comparison. Although for this comparison to be effective, both the expected and actual performance must use the same or comparable units of measurement. This is where indicators and criteria have to be integrated and function as comparable units. 'One of the challenges of the BPE approach inside the phase of occupancy is, to encourage more precise measures of users' experience of environmental comfort than have conventionally been used'(Preiser & Vischer, 2005). Conducting occupant comfort surveys may give answers to many questions that POE includes (How is the building working, How can it be improved, How can future buildings be improved) and to the huge question of the 'performance gap'.

An occupant comfort survey provides a quantitative rating (for instance statistical analysis) of what is essentially a qualitative measure. It can be conducted for several conditions as thermal comfort, air quality, acoustic comfort, lighting quality and spatial comfort. These conditions are closely related to the building itself as they correspond to the building systems of heating, ventilation, acoustics, lighting and office layout respectively. The next figure indicates the most usually addressed topics in occupant satisfaction surveys. A more thorough analysis of such topics and a survey itself will be described later in this research. These related topics (Figure 3.4) and the following figure of frequently used criteria (Figure 3.5) along with the previous questions inside the framework of BPE and sustainability, contribute as input information to create a picture of how users perspectives can be evaluated.

Content	Topics	User satisfaction related topics that are addressed by survey questions:	
		1. Access	2. Orientation
		3. Accessibility	4. Overall assessment
		5. Acoustic	6. Parking
		7. Air quality	8. Privacy (general)
		9. Background Personal	10. Process
		11. Building/grounds	12. Productivity
		13. Design and colour	14. Recycling
		15. Details	16. Safety/security
		17. Ergonomics	18. Storage
		19. Flexibility of space	20. Supporting spaces
		21. Floor plan/layout/area	22. Survey comments
		23. Furniture	24. Technology
		25. Humidity	26. Temperature/thermal comfort
		27. HVAC	28. Visual privacy
		29. Light/natural and artificial	30. Wayfinding
		31. Maintenance problems	

Figure 3.4: User satisfaction related topics (Preiser & Vischer, 2005)

Furthermore, considering the large amount of existing topics, the challenge is to select performance indicators and criteria from a myriad of possible indicators available at the building level, which will constitute the comparable units in order to monitor, measure and evaluate the building performance. During the occupancy phase, while conducting a POE, it is important to identify and categorize the most useful criteria that will help answer similar questions as the ones raised above. Case studies have been conducted in the Netherland in order to find out how occupants can easier accept innovative concepts in offices and in addition, what makes occupants satisfied. The result of the case studies was the identification of criteria that should be included in a POE. Some of them are less or more frequently measured.

Frequently measured	Less frequently measured
• Employees' characteristics (gender, age, education, occupation) • Characteristics of working processes (what are people actually doing, when, where) • Characteristics of old and new workplaces (location, layout, desk sharing or not) • User satisfaction on accessibility of colleagues (physically, by phone or email), communication, concentration, privacy, thermal comfort, use and experience of facilities • Most positive and most negative aspects • Overall satisfaction • Perceived productivity • Critical factors in successful implementation and management of building-in-use	• Occupancy level • Actual behaviour (e.g. frequency of desk rotating, claiming a favourite desk) • Psychological aspects such as status, territoriality, social contacts and personalization • Organization's characteristics such as strategy, corporate culture, vision of the future • Employees' health and safety • Image, i.e. effects on attracting and retaining employees and clients • Actual productivity • Economic value added • Facility costs • Adaptability and future value

Figure 3.5: Common criteria measured in POEs of innovative offices (Volker and van der Voordt, 2004)

All of the above criteria contribute to the determination of the final performance criteria, which will constitute first the basis of POE and further of BPE. Efforts have been made in the last decades to create principles for a universal design performance evaluation framework that could apply on every type of building in any country. 'Building performance evaluation can be structured according to three levels of performance criteria pertaining to user needs. The first level is health, safety, and security performance, the second functional, efficiency, and workflow performance and the third psychological or social, and cultural performance'(Preiser & Vischer, 2005). For different type of goals, performance levels may interact, overlap and conflict with each other, requiring appropriate solutions. These solutions depend a lot on the type of goals that a client may have (as the example earlier 'to build the most sustainable town hall in the Netherlands'). The relationships and correspondence between evolving performance criteria and the principles of creating also a universal design framework that can be implemented in any office building around the world are shown in the next figure.

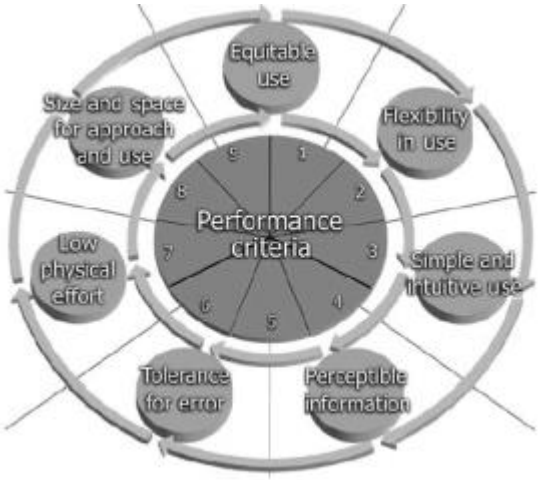

Figure 3.6: Universal design principles and performance criteria (Preiser & Vischer, 2005)

Having in mind the research goal of this thesis, the most important criteria from the above figure, are the criterion of tolerance for error, which can also be called the 'forgiveness

factor' and will be analyzed later in the thesis, and the criterion of flexibility in use. Users are not always open and receptive to innovation or new technologies imported in new sustainable buildings and offices. They tend to develop new behaviors, they may feel insecure in an unknown working environment and this is when the need to adjust appears. 'Flexible work patterns have spawned many innovations and changes in workspace layouts, furnishings, systems and equipment. Most employees, however, view workspace change apart from insecurity, with concern and suspicion. Questions as 'Are we downsizing?' 'What if I don't understand this new technology?' are the most possible fears of the occupants' (Preiser & Vischer, 2005). Integrating innovation into office design requires careful management that should focus on the aspect of change. Changes need to be introduced in a balanced way both top-down and bottom-up in an organization. Therefore, buildings and working environments should be flexible but in a well thought and proven way.

The link to flexibility comes with the concept of flexible working, which has been introduced and formalized in many countries. In the Netherlands, it has become a trend in its construction industry. 'There has been considerable policy among European Union members over job quality and the need to create not only more but better jobs. It might be expected that since flexible working affords a degree of choice to employees, it would affect positively on their perceptions of job quality' (O'Sullivan, Keane, Kelliher, & Hitchcock, 2004). Flexible working includes open plan or group offices for communication and routine work, cockpits for concentration, coffee corners for breaks and informal meetings, formal meeting rooms, touch – down places for short time activities such as checking emails and in general places for the users and occupants to feel more comfortable. 'It has proven from conducted surveys that people working under this concept tend to plan more of their activities in advance, which has improved their effectiveness' (Preiser & Vischer, 2005).

In other words, the factor of the user and occupant plays a very crucial role in the whole evaluation process. Sustainable building performance is not limited to energy conservation, life cycle costing, and the functionality of buildings. It also needs to focus and already does, on users' perspectives on buildings.

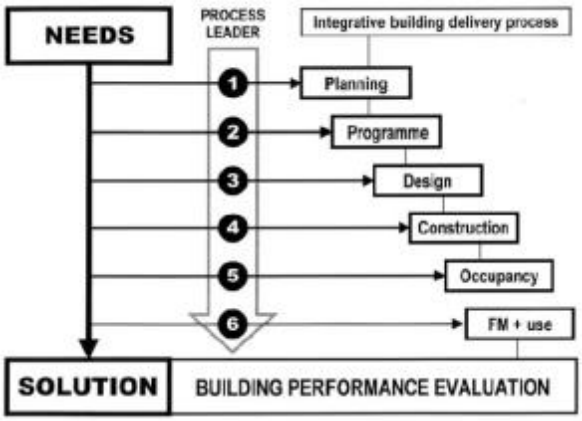

Figure 3.7: The human element in the building process and the solution for the users' needs (Preiser & Vischer, 2005)

POE results can be used to identify issues and problems in the performance of occupied buildings, and identify ways to solve them. Moreover, 'POEs are ideally carried out at regular intervals, that is, in two- to five-year cycles. It has been recommended from many surveys and case studies that the results of a POE should be communicated to the interested parties and stakeholders that are involved in the project' (Preiser & Vischer, 2005). The results could be included in team meetings and discussions, internally and with clients, in general in

formal and informal communications, websites and newsletters. Evaluation results should also be available and processed by the whole organization and by the senior executive, middle management and staff levels. The desired goal is to integrate an ongoing evaluation into everyday work and processes.

3.4 Conclusions

First, the answer to the research question 'What is the sustainable building performance?' is given within the first paragraphs. It is explained that sustainable building performance contains two main aspects, which refer to technical perspectives/data and user perspectives/data. Then, the focus of the chapter shifts to the second aspect, with integrating at the same time successfully the judgment in it. Then, the value and importance of BPE and POE in the building process have been emphasized, which give the answer to the research sub question 'Which evaluation frameworks exist?'.

To sum up, processes as POE and BPE are indispensable when trying to evaluate a sustainable building performance. The remarks that should be kept in mind are the need for creating performance criteria, taking into account the occupant satisfaction as one of the most important indicators and that conducting occupant comfort surveys may give answers to many questions. 'The indicator of user satisfaction reveals a very close relationship between the social aspects of sustainable development and technical, economic or financial considerations' (Shika, Sapri, Jibril, Sipan, & Abdullah, 2012). Therefore, as indicated above the physical and technical performance of buildings is directly linked to the building qualities perceived by occupants. It is of high importance to conduct evaluation processes and keep improving based on the results, in order to maximize building life cycles and at the same time keep users satisfied.

One general finding of this chapter is that evaluation frameworks indicate that the factor of the user and occupant plays a very crucial role in the whole evaluation process. Sustainable building performance is not limited to energy conservation, life cycle costing, and the functionality of buildings. It also focuses on users' perspectives of buildings. After all of these findings have been considered, a literature review on evaluating the interaction between users and sustainable buildings is needed and follows within the next chapter.

4 Evaluation of the interaction between user perspectives and sustainable buildings

4.1 Introduction

The previous chapters describe how the sustainable performance of a building can be monitored, measured and evaluated. The analysis in the previous chapter is made inside the concepts of Building Performance Evaluation (BPE) and Post Occupancy Evaluation. As stated, during an evaluation process, the factor of users should be researched in detail and this chapter starts with the investigation of the interaction between users, buildings and building performances.

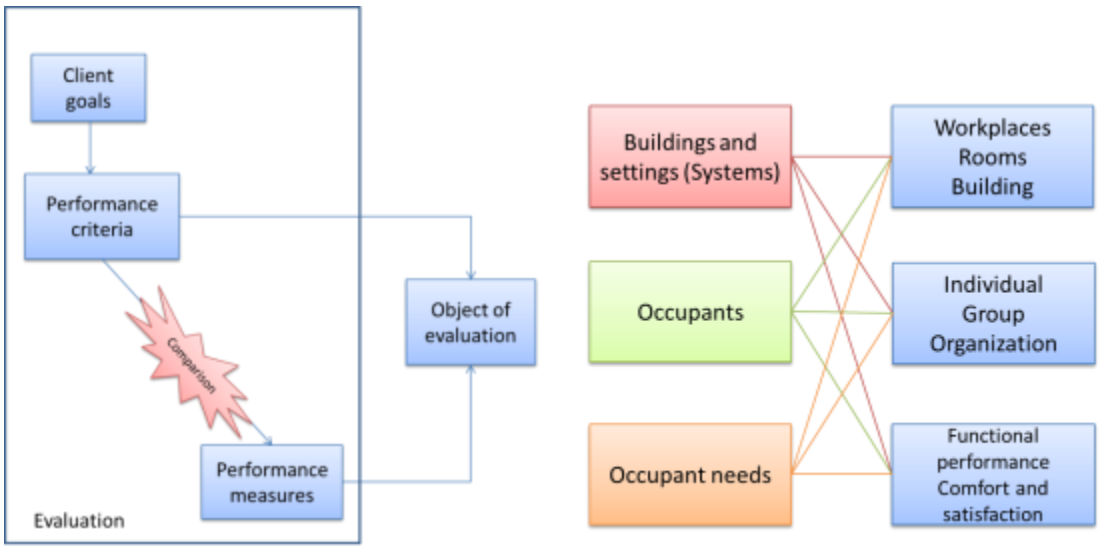

Figure 4.1: Feedback system and interrelationships between buildings, occupants and occupants needs (Preiser & Vischer, 2005)

The above figures show how this research is moving with implementing a loop by evaluating the preliminary performance criteria according to the current measures and to occupants and users of the town hall. The left figure indicates how building performance can be evaluated, thus with measuring and monitoring of sustainable performance, which refers to technical perspectives and with feedback from evaluating the users, which refers to user perspectives. The right figure introduces the concept of occupant needs and how the interrelationships are between buildings and occupants. Multiple interfaces exist, between occupants (as individuals or groups or the whole organization) and building (as its rooms, systems, or workplaces). These interactions give a meaning to the relationship between users and building performance.

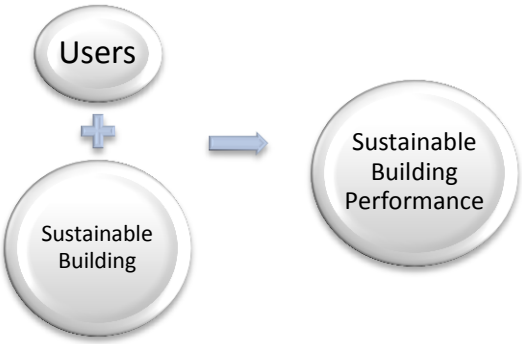

Figure 4.2: Interaction of building and users towards building performance

The above smart chart tries in a very simple way to picture the relation and interaction between buildings and users. The plus sign indicates that both users and the sustainable building contribute to define and form the sustainable performance of the building. The critical question is how the users can affect this performance and how the sustainable performance can affect them. The answer is with their behavior and their level of satisfaction. Even if the systems of the building and so the building itself works and operates flawlessly and according to design and technical standards, it may not work and operate well enough in the eyes of its users. The relation between building and user has to be investigated, problems and their sources have to be identified and factors that influence the level of satisfaction have to be determined.

4.2 Users and Sustainability

This thesis is focused on sustainable buildings, town halls (offices) in particular and the introduction of sustainability makes the relation between users and buildings even stronger. A first impression is usually that a sustainable building is better than a conventional building from economic, environmental and social perspectives, in fields as operation, efficiency, maintenance, aesthetics, cost and lifetime. Even if this impression can be proved true, the way a user interacts in a sustainable building is something that needs more research. 'It would be nice if everyone was happy all the time, but because individual circumstances, backgrounds and behaviors differ so much this is usually impossible' (Leaman & Bordass, 2007). Occupant behavior and satisfaction may influence the effectiveness of sustainable building techniques and systems and this is why users should be evaluated. User evaluation can be achieved through a survey.

Conducting a survey during the occupancy phase of a building is crucial and the most important questions that have to be investigated are the level of satisfaction, the indirect effect of sustainability on a building user and how in return the user affects the building and its performance. Studies have found a clear correlation between satisfaction and technology dissemination and good performance of the building (Emerald, 2012). At some point there has to be a clear correlation also with the design of the building. Many buildings are designed with a 'green' intent but this intent is not always reflected on the occupancy phase and further on the user satisfaction. Sustainable systems and features may not perform as they are supposed to according to the design either due to technical flaws or due to misinterpretations of what performance should be according to users. This is the reason why user participation is recommended. Employee participation during making the new design of a workspace appears to influence the office concept as well as the satisfaction with it (Maarleveld, 2008). The later aims more at the design phase, but coming back to the occupancy phase, in order to keep satisfaction intact, where conditions are more varied, it is

important that 'building systems respond quickly and to the occupants' liking when comfort thresholds are breached' (Leaman & Bordass, 2007) and this is also why monitoring of performance is needed. As mentioned many times, the most important factor, as a benchmark of a building's success in meeting the design objectives, is the level of user satisfaction (Wilkinson, 2011). Post Occupancy Evaluation has become an important tool for the improvement of building design and operations in order to solve misinterpretations and fill the gaps often found between client and design expectations for a specific performance level (Deuble & De Dear, 2012).

Many surveys have been conducted regarding user satisfaction and many of them indicate that 'users tend to not worry about comfort as such, but discomfort' (Leaman & Bordass, 2007). This means that there is an increased possibility for users in paying attention more in factors that influence them negatively and offer them discomfort than in factors that put them in a comfort and advantageous position. If people understand how things are supposed to work and what they are for, like the window controls or thermostats, they tend to be more tolerant if things do not turn out quite as well as they should (Leaman & Bordass, 2007). The clearer the design intent is to the user and to what extent it is 'green', the more likely users are to make sacrifices or compromises. Users are much less satisfied when they cannot see how things are supposed to work, or are subject to interventions by technologies over which they have little or no control (Leaman & Bordass, 2007). The forgiveness factor is introduced in many researches, which is explained as an attempt at quantifying how occupants extend their comfort zone by overlooking inadequacies of their thermal environment (Deuble & De Dear, 2012). To understand the way users interact with buildings, it is vital to understand how users think, which are their values and how they tend to conclude if they will be forgiving or not and if they will work and behave in a way that it can contribute to maintaining or improving the building performance. One theory of the process of thinking is based on the next figure.

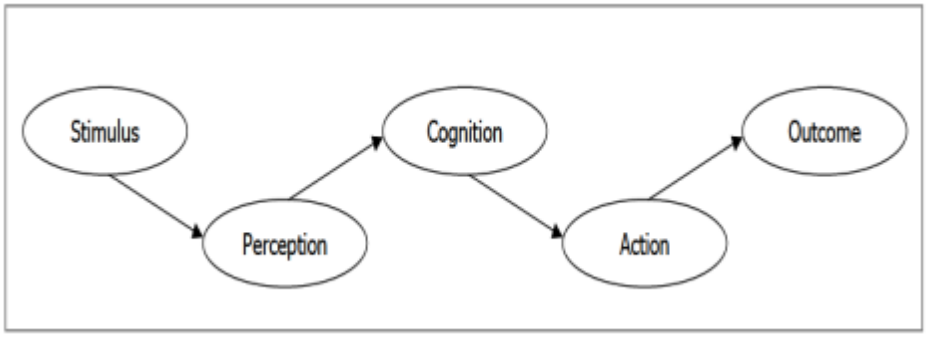

Figure 4.3: From Stimulus to behavior (Soldaat, 2006)

First, users get the stimulus from their environment. A stimulus could be whatever users can hear, see or experience inside the building. Then with perception, they select and organize in their minds whatever they find useful or important. Somehow, they filter all the information they get and then through cognition they elaborate all this information and conclude to decision making. This leads to the actions that users are prepared and willing to do after their decisions. Outcome is the result of the actions and in general of this process (Bonapace, 2002). This framework should be taken into account, while deciding on understanding the user behavior and their interactions.

One of the most famous surveys is based on the identification of satisfaction gaps, while evaluating user satisfaction on aspects such as Internal Environmental Quality (IEQ). IEQ includes many aspects as thermal comfort, air quality, lighting, acoustics and maintenance

(Abbaszadeh, Zagreus, Lehrer, & Huizenga, 2006). This survey was created by the University of Berkeley in California and is being used on conducting occupant comfort surveys in LEED rated and other green buildings (CBE, 2009). Another survey is the BIU (Building In Use) assessment system, which is a validated and reliable standardized survey that can be administered to occupants of any office building in order to collect simple reliable measures of their comfort in regard to environmental conditions (Preiser & Vischer, 2005). An important theme in these surveys in the update of sustainability in office buildings is to maintain and 'increase sustainable building performance whilst maintain and enhancing comfort levels of users' (Wilkinson, 2011). An outcome of such surveys that could be evaluated and used is factors that influence user satisfaction. These factors along with the feedback from monitoring and measuring building performance, can contribute to the result of determining the relationship between performance and user satisfaction.

Moreover, studies have also shown that occupant behavior is connected with certain types of building characteristics and systems. Studies also conclude that it is significant to define the user profile and in addition the behavior patterns, which can be determined by the values, needs, background, motivation and attitudes of the users. All these factors can influence the energy use and the performance of the building with the use of all systems (heating, ventilation, appliances, spaces) (Santin, 2011).

4.3 Conclusions

This chapter has focused on the relation and interaction between the building and its users. Furthermore, the importance of conducting surveys has been indicated. This chapter has indicated the crucial influence that users have on their buildings and on their performances. Moreover, some significant findings were that users usually pay more attention on discomfort variables and that knowledge of the building and its systems may increase satisfaction levels. One additional finding was that attention should also be paid on the extent that the green design will be communicated to the users and even involves them. These findings answer also to the research questions of 'What is the interaction between users and sustainable buildings and sustainable building performance in particular?' and 'Which factors influence user satisfaction?' In general, this chapter answers to the research sub question 'How can user satisfaction be evaluated?' by indicating the importance and usefulness of evaluating users with a survey.

To sum up the main findings of this review, are that there is a clear two-way correlation between user satisfaction and good performance of the building and that there are factors that influence the interaction and perspectives of users towards sustainable building systems and their satisfaction and comfort. These factors refer to values, needs, background, motivation and attitudes of the users, as for instance that users are much less satisfied when they cannot see how things are supposed to work, or are subject to interventions by technologies over which they have little or no control, or that green users are more satisfied with green buildings.

Therefore, the following chapter continues with the connection of the above literature reviews, the formulation of assumptions and the search for the best research method in order to proceed in the research by testing the findings from these reviews.

5 Connection of the evaluations and formulation of assumptions

5.1 Introduction – Connection of the reviews

The connection of these reviews and evaluations, which are covered in the previous chapters, reveal the importance of users' satisfaction and the need for formulating more specific hypotheses regarding factors that can influence this satisfaction and in general the user influence and involvement on the operation of building systems, which also miss from the assessment tools.

From the evaluation of the interaction between users and sustainable buildings and sustainable performances in the previous chapter, it can be seen that some factors that affect users and their satisfaction stand out. These distinct factors are the background of users regarding their environmental awareness, their willingness to have as much control as possible inside the building and the relation between users' knowledge, being familiar with the building, being kept updated and their willingness to forgive. Moreover, the previous evaluation indicated the importance of a survey that can evaluate users and investigate such factors. The necessity of such a survey was first introduced when evaluating, monitoring and measuring the sustainable performance. A survey at this point, can work as a part of the solution to the fact that assessment tools lack of criteria regarding users' perspectives and involvement and as a research method to explore the factors that influence user satisfaction and the interaction between users and building systems.

Before creating a survey and investigating how it can be implemented, first the main goals and clear assumptions/hypotheses have to be formulated. One of its goals is to draw a certain profile of the desired group of users. The other goals are:

1. to find out how prepared and willing users are to overlook and forgive less – than – ideal conditions
2. if there is a possible link between occupant satisfaction and environmental attitudes
3. if being a 'green' user has any correlation

Moreover, a goal is to investigate how users are dealing with the amount of control they acquire. This comes along with the hypothesis from many studies that users are more tolerant of conditions where they have more control, which could be related to the above goal as combining the fact that control may lead to willingness and forgiveness. Users appear to be more satisfied if they understand how the building is supposed to work either because the design intent is made clear or because the controls are easy to understand and work well (Deuble & De Dear, 2012).

It is important to formulate hypotheses beforehand in every conducted survey. Then, with the results of the survey, it is tried to accept or reject these hypotheses. The test of these hypotheses will contribute to the main goal, which is to identify the relationship between user satisfaction and sustainable building performance. The main hypotheses that are going to be tested in detail are:

- H1: Users are more satisfied if they are 'green' users
- H2: Users are more satisfied if they have or think that they have control over the systems of the building and the building in general
- H3: Users seem to forgive and be more tolerant if they are familiar with the building and know how it works and operates (forgiveness factor)

5.2 Creating the structure of the occupant comfort survey

After formulating the hypotheses, the next step is to formulate a survey with a questionnaire that will include these hypotheses and in general other factors inside the working environment that may satisfy the users. It is also clear that the survey that will be created in the next paragraphs should be applied on a case study in order to test the hypotheses and collect real time answers and results. The choice of the case study and the building will be discussed later.

Moreover, a structured questionnaire consists mainly of closed questions and its creation is more difficult than the formulation of questions for interviews. This is the case because questions in questionnaires should be unambiguous, refer to just one topic at a time, the sentence structure should not be difficult, the language usage should be appropriate for the respondents and the questions should not be suggestive. All of the above have been taken into account while formulating this survey.

Additionally, this survey is anonymous and examines the satisfaction levels and comfort levels of sustainable building users about their workplace and their building. The questionnaire was designed in line with the examples of IEQ (Internal Environmental Quality), BIU (Building In Use), and personal ideas and findings and was divided into three sections, which are the user profile, working environment – user comfort (thermal comfort, ventilation comfort, noise comfort, lighting comfort, office layout comfort and other building features comfort) and general comments. The questions were derived from the literature review.

Section one (Gebruikersprofiel), in the survey, is about defining the profile of the user. The personal details (gender and age) are first to be determined. **Age** could be a contribution factor to the survey because it may influence aspects as the flexible working policy, implemented by the municipality and the willingness to learn, understand and control new things. In an older age, old-fashioned way and conventional thinking could be a hindrance (for example towards new technologies). **Level of education** could play a role in determining if more university degrees contribute to understanding more sustainable concepts and building features and thus being more prepared and tolerant. **Working years for the organization** specifies how committed and close a user is to its organization. If the users trust the organization, then it is more likely for them to believe that the organization will deliver them a good building. **Working hours and time spent** in the workspace could explain more or less understanding and satisfaction from users depending on how much time they spend in the building or for outside services and from home. Furthermore, it has to be specified in which part of the building each user works concerning aspects as if he/she works

together with others, has a private office or works in spaces as the reception/restaurant. A question about where users want to spend their free time, aims at categorizing the **most favorable spaces** in the building. In addition, the question about rating almost all spaces aims at investigating how occupants feel and what they think about almost all the spaces and rooms and how often they use them.

One important factor about **being a 'green' user** or not, has to be investigated. According to literature review, there is a hypothesis that green users are more tolerant and green buildings work best with green occupants (Deuble & De Dear, 2012). This affects the building performance in a positive way. With the two questions of what transportation mean someone uses to go to work and what is the distance between work and home, it is tried to get a first impression of the user. The most crucial question is the one referring to environmental awareness. It includes rating of expressions as ''I turn off the lights when I leave a room'', ''I have devices (devices powered by solar energy, saving faucets, energy efficient lighting etc.) at home that contribute to sustainability'' and their willingness for recycling or waste separation either at their home or at work with agree or disagree. This contributes to create the profile whether the user is green or not and whether this helps with the building or not. There are many questions that could be included in defining environmental awareness, however the most friendly and precise to the users were chosen (Olijve, Smit & De Vries, 2004).

Section two (Werkomgeving) asks respondents about their levels of satisfaction with their office building environment. This section is divided into two sub sections. First users are being asked about how satisfied they are with the amount of control they have on the building. The amount of control users have on temperature, lighting, ventilation, windows and doors is being rated if users are satisfied or not. The next sub section asks to what extent users agree on the features of the building. These features concern the most important systems inside the building:

- **Thermal Comfort**: it is of great importance to explore first how users respond to the temperature, if they are feeling hot or cold, which can cause big gaps in satisfaction levels.
- **Ventilation Comfort**: similar with the thermal comfort, the ventilation system has to be explored and find out how it affects users. Air quality and air freshness are the two most important aspects of ventilation.
- **Noise Comfort**: acoustics and noise are aspects that have gained ground over time. Many sustainable buildings are designed with innovative office concepts with open spaces, column free spaces, wing floors and this may influence the acoustics of a building in a negative way. Noise level, sound privacy (ability to have conversations without your neighbors overhearing and vice versa), background noises from heating, ventilation systems, other devices, working in silent rooms or not are key characteristics.
- **Lighting Comfort**: important aspects are visual comfort of the lighting (glare, reflections, contrast, etc.) and access to daylight
- **Office Layout Comfort**: Users have to be satisfied with their personal workspace and its surroundings and this can be investigated by asking about the amount of space available, their personal storage space, ease of interaction with co-workers, available spaces for meeting with colleagues and visitors, visual privacy and flexibility of the workspace (possibility of changes).
- **Other Building features and Services Comfort**: some other factors that may influence the satisfaction and comfort of the users and could not be included in the previous systems of the building are the maintenance and cleanliness of the

building, the image and aesthetics of the building, its safety, parking and handicapped accessibility.

Section three (Algemene opmerkingen) focuses on general factors, which are determined depending on how much users are satisfied. These could not be included in the second section, as they do not relate to the building systems. Primarily, two factors that affect user satisfaction are the **knowledge and familiarity** that each user has of the building and the **information provided** to him/her about the sustainability of the building and its systems. As indicated above, surveys show that the more the information and the knowledge on the building are, the more forgiving and tolerant users can get. Furthermore, it is important to explore if the users know where they can report a malfunction of a system or just their complaints. This research is about sustainable office buildings/town halls, it is important to ask the user what his /her perspective and opinion is on how sustainable, and **energy efficient** the building is.

One last factor is the satisfaction that users may gain from the implementation of flexible working ('Nieuwe werken'). Like a modern trend, flexible working or the new way of working that includes working from home and hot desking, have been widely applied on many organizations in the Netherlands. With a short definition, the new way of working is ''a vision for making work more effective, efficient, pleasurable and valuable for both the organization and the individual. Giving employees more freedom on how, where and when, with what and with whom they accomplish their work'' (Bijl, 2009). This is a freedom and a concept on what users should state the level of their satisfaction.

Additionally, a question that pushes the user to think all of the above is to answer if he/she is satisfied with the building overall. Finally, with the last question, users have the chance to express any more comments they have, as giving recommendations.

In general, a five-point scale was used to rank the levels of satisfaction and agreement from 1 to 5 and the complete questionnaire can be found in Appendix B. The questionnaire was decided to be written in Dutch and it was translated along with the help of my supervisors. The reason for this were some hesitations on using English by a Dutch organization and because the likelihoods for more precise, well understood and friendly responses would increase.

5.3 Conclusions

First, it can be said that answers have been given to the research question 'What assumptions can be formulated after combining these evaluations?', which are formulated in the first paragraphs and then the answer to 'What comes out of this combination?' is the creation of an occupant comfort survey and the need for a case study to apply this survey.

Finding of this chapter is that a case study is needed in order to explore the interaction of the users with the building systems, the above-mentioned occupant's satisfaction and test the hypotheses. After creating in this chapter a survey that summarizes these factors, it can be concluded that this occupant comfort/satisfaction survey can work as a mean in order to evaluate a sustainable building and its users. This survey can and will be implemented on a selected case study. The choice of the case study of the town hall, its analysis and results are explained and described in the next chapter.

6 Case Study: The Town Hall of Leiderdorp

6.1 Description

6.1.1 General Data and Background

6.1.1.1 Introduction

As indicated in the introduction of this research report, the triggering facts for conducting this research were the steady stream in the Netherlands of constructing new sustainable town halls, the possible event of a performance gap and to what extent their users are satisfied. Therefore, it could not be any other case study rather than a new sustainable town hall in the Netherlands, which has the aim and intention to maintain its sustainability. The choice was the new sustainable town hall of Leiderdorp. In this case study, as a first step, the performance of the town hall will be investigated in order to conclude if there is a performance gap or not. As explained in the previous chapter, another need for a case study was to apply the survey and evaluate users. Therefore, the second step is the implementation of the survey on this case study, analyze it and make conclusions that could be useful and maybe possible to be generalized. The survey that was formulated in the previous chapter will be used along with some adjusted or additional questions to the needs of the specific town hall, derived from the interviews that will be analyzed later.

In this chapter, the case study will be introduced. First, the town hall will be described according to the design that won the competition. Furthermore, the sustainable systems and elements that the building has are indicated. The next step is to observe and describe the town hall from the current point of view during its occupancy phase and compare it. The later concerns the design, operation, maintenance and other characteristics, which concern its sustainable building performance among all.

Town Hall of Leiderdorp

Client: Municipality of Leiderdorp
Architect: VVKH Architects (Joost de Haan)
Contractor: Dura Vermeer
Constructor: IMd Rotterdam
Sustainable experts: BenR Adviseurs
Construction period: August 2010 – November 2011
Budget: 11 Million Euros
Gross Floor Area: 4.512 m^2
Address: Willem-Alexanderlaan 1, Leiderdorp, The Netherlands

The employees of the municipality of Leiderdorp moved in to the new town hall the last fall after being in a conventional (not sustainable) building, not far away from the new one, which is depicted in the next figures.

Figure 6.1: The town hall of Leiderdorp (exterior façade)

Figure 6.2: The main hall inside the town hall (left) and the reception (right)

Figure 6.3: The main hall (left) and the restaurant (right)

Figure 6.4: One of the project rooms (left) and the big conference room (right) on the ground floor

Moreover, the next section starts with explaining all the sustainable features in the town hall and its systems. All the below information was distracted from the official design book that was handed in for the competition and finally won.

6.1.1.2 Structural and Architectural Building Elements

Through the column free spans, an optimum flexibility is created. Different office concepts are possible. The facades are constructed with wooden frames and colored glass panels (with warm colors to absorb heating).

One advantageous system installed in the building is the Concrete Core Activation (CCA). Through prefabricated under floor tubes inside the concrete floors, the basic heating and cooling is supplied from the ceiling on each floor.

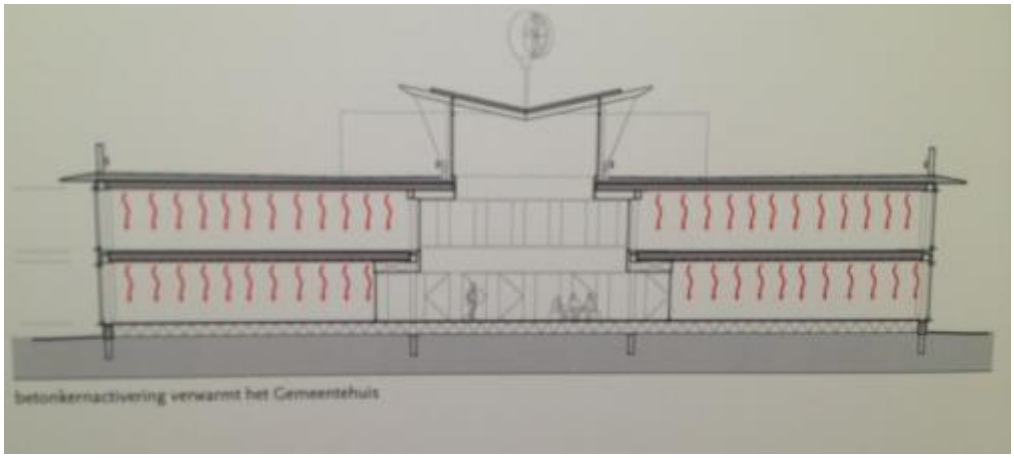

Figure 6.5: CCA in the town hall according to the design

Furthermore, it is an efficient open construction, where only occasionally one column or a bearing wall is constructed. This kind of structure makes it possible in the future without major interventions to rearrange the building and its functions. The structure consists of steel columns with steel girders along with the supporting structure. It has also many prefabricated prestressed elements that create long spans. For the roof, a hollow core slab was used and with the idea of the roof having a double function, the quantity of used

concrete was reduced. The big advantage of the structure is that all its elements can be disassembled and can be used in the future even for other purposes.

6.1.1.3 Acoustics

Acoustic panels are located as free hanging units, named absorbent islands. These acoustic panels try to contribute to the acoustics along with the existing of Concrete Core Activation (CCA) inside the building. Modern buildings that have extensive areas of glass, open plan areas accommodating a large number staff and a lot of heat-producing equipment require effective cooling systems. One solution for lowering temperatures is to cool the slab, allowing the room to be chilled by the cold ceiling – concrete core activation, CCA. One advantage of this solution is that the slab can store the cold that is available during the night, and another is that the cooling takes place without any air movement, which can otherwise cause draughts and discomfort. Problems arise when this system has to be combined with good acoustics. The traditional solution – an overall, class A acoustic ceiling - does not work, as the cooling effect from the concrete ceiling is screened off. Alternatively, free-hanging units can be used, which improve the acoustics as well as allowing the cooling effect to pass through.

The use of free-hanging units provides flexibility and a multitude of acoustical solutions to acoustical design. Free-hanging units can be an efficient way to add absorption to a room. In premises where, for various reasons, an overall ceiling cannot be used, e.g. where temperature is regulated via concrete slabs or where there are large areas of glass, absorbent islands offer an efficient way of creating a good acoustic environment. Absorbent islands can be designed as horizontally suspended units or for use as baffles. Nevertheless, acoustically a complete wall-to-wall ceiling is generally a better solution than free-hanging units. This is especially emphasized at low frequencies (CCA, 2013).

The variability of the void depth from the soffit and the minimal contact area of the mounting points mean that the ceiling element is an ideal means of improving acoustics in concrete core activated or thermal mass buildings (Sto Ltd, 2010).

Figure 6.6: Modular Ceiling canopy (Sto Ltd, 2010)

6.1.1.4 Lighting

According to the design, the lighting system will consist of a daylight control system and some conventional electric lighting systems on the floors. The lighting cannot be controlled manually by the employees but only from a specific section in the reception. The goal of using such systems is achieving visual comfort, thermal environment and user acceptance and satisfaction. Research indicates that daylight can improve user satisfaction/performance. These characteristics can make such buildings more valuable. Daylight also enables daylight harvesting, an innovative control strategy that can generate 35-60% energy savings. A daylight harvesting system decreases electric light contribution as the daylight contribution increases. Daylight harvesting, also called daylight control or automatic daylight dimming or switching, uses a ceiling-, wall- or fixture-mounted light sensor to measure the amount of illumination at the task surface in the space or at the daylight aperture. Then, it signals a switch or dimming ballast to adjust light output from the

electric lighting system to maintain the desired level of illumination. An effective daylight harvesting control system saves energy while being virtually unnoticed by occupants (DiLouie, 2007).

6.1.1.5 Ventilation Systems

The ventilation system of the town hall is a hybrid balanced mechanical system that works with ventilated fresh air. The atrium functions as a return plenum, where free heat in the atrium is captured and used, in order to reduce the consumption of electricity. The return fans pull the air from the atrium until the heat yields. More scientifically, return fans pull air from the return duct system and discharge it into the rooftop unit's return air plenum. The advantage of this system in the winter is that the atrium on a sunny day cares for extra warming of the air return. Moreover, if the heat from the return air is not the desired one, return fans switch off.

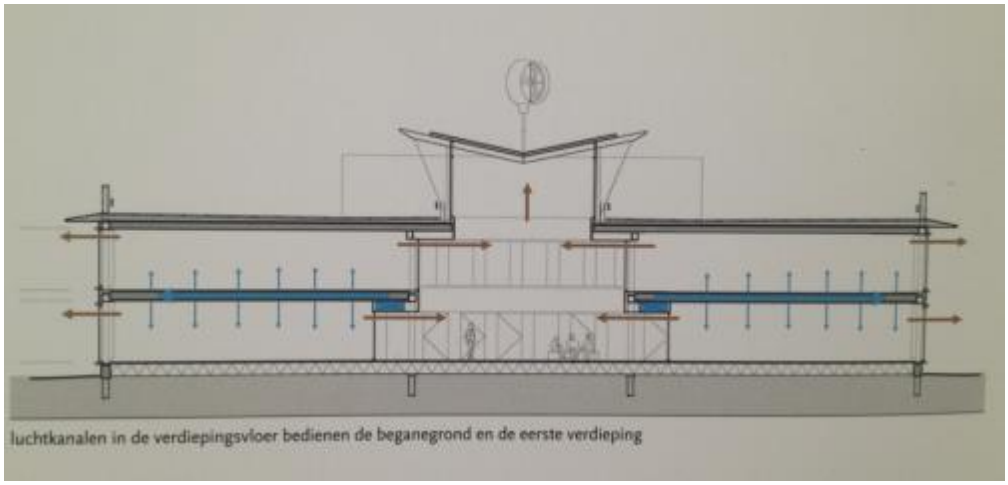

Figure 6.7: The ventilation system in the town hall according to the design

A hybrid ventilation system, which mainly relies on outside air for cooling in summer and transitional season, and a hydraulic radiant floor heating system for heating in winter are to be installed in this building for advance energy performance and indoor air quality. A forced air mechanical ventilation system builds upon the layout of natural ventilation system, with outside air inlet placed in the plenum (Dong, 2010).

6.1.1.6 Heating System

The heating system that is installed in the town hall is a heat cold storage system (WKO-Warm Koud Opslag). This system has a mono source, heat and cold source in the aquifer inside the soil. With the compression technique, the constant floor temperature becomes cold or warm. This source can be also called an electric heat pump. This is a regeneration source for a good warm cold balance in the floor. In addition, gas is omitted, making no local emission of CO_2.

Figure 6.8: The WKO system in the town hall

The system maintains the temperature at the constant level of 21°C. The operation of the WKO is controlled by the responsible employees with a control system (software program: BMS) that is located on the ground floor next to a room next to the WKO. From there, the level of temperature can be controlled and changes if necessary can be made. This control system is monitoring also the other systems of the town hall, as the ventilation.

Figure 6.9: Control Maintenance and Operation System (Monitoring the WKO)

Figure 6.10: Control Maintenance and Operation System (Monitoring the Ventialtion)

The temperature, although, can be controlled individually by employees through thermostats (with 24°C being the upper limit).

Figure 6.11: Thermostat in the town hall (installed on many spots inside the building)

6.1.1.7 Parking

Visitors can park their car or bicycle near the town hall and employees can park their car on the roof of the building using the upward ramp to the roof or the lift. With this parking solution, the available space has multiple uses and cars are hidden from public view. To stimulate the use of bicycles among employees, indoor bicycle storage is created on the ground floor.

6.1.2 The sustainability of the town hall – Design Phase

6.1.2.1 Sustainable Elements and Systems

The basic systems of the town hall (heating, ventilation, acoustics, and aesthetics) were described. Every system contributes with its own way to the sustainability of the town hall. In this section, every aspect of these systems will be explained in more detail.

Construction and Materials: From the structural point of view, the building is prefabricated with more use of steel elements and less concrete. As mentioned above, all these elements can be disassembled and removed, as the façade panels. This kind of structure with column free spans creates flexibility and multiple office concepts. The use of steelworks provides its key attributes, which are adaptability, structural efficiency and flexibility. Each of these attributes carries significant sustainability advantages (Barret, 2007). Having fewer columns provides a major benefit to building owners and users, as it is easy to subdivide space or alter it in any way that changing circumstances demand. Buildings will frequently require modifications to meet changing needs during their lifetimes – the flexibility delivered by choosing steel framing solution means that building lifetimes can be considerably extended (Barret, 2007).

The majority of the materials used for the construction of the town hall are reusable and recyclable. Inside this context, the Cradle to Cradle concept was used. In 2002, William McDonough and Dr. Michael Braungart published ‘’Cradle to Cradle: Remaking the Way We Make Things’’ that maps their new design paradigm, offering practical steps on how to innovate within today's economic environment. In the cradle to cradle model, all materials used in industrial or commercial processes—such as metals, fibers, dyes—fall into one of two categories: "technical" or "biological" nutrients and have no negative effects on the natural environment. In this manner, these materials can be reused instead of being "downcycled" into lesser products, ultimately becoming waste (McDonough, 2006).

Water Management: According to the design, 35% of the water usage will be saved and in addition, the rainwater can be filtered and used for other purposes.

Health Management: With the reduced use of concrete for the construction of the town hall, one health side effect of concrete, radon is avoided. Radon gas can enter from the ground through cracks in concrete floors and walls, through gaps between floor and slab, and around drains and pipes, and small pores of hollow-block walls. The possible effects will depend on exposure level. The main danger from high radon exposure is an increased risk of lung cancer, although this is not common because radon as a noble gas is rapidly exhaled after being breathed in (WHO, 2002). Radon can enter the indoor air where it and its decay products accumulate in poorly ventilated areas (Occupational Health and Safety, 2012). However, the good ventilation system and the filtering of the outside air in the town hall decrease this danger furthermore.

Energy and CO_2 emissions: The concept that was applied on the town hall for the limitation of energy consumption is Trias Energetica. This is a simple and logical concept that was developed as a strategy by TU Delft and helps to achieve energy savings, reduce the dependence on fossil fuels, and save the environment. The three elements of Trias Energetica are: reduce the demand for energy by avoiding waste and implementing energy-saving measures, use sustainable sources of energy like wind, sun, water and the ground and use fossil fuel energy as efficiently as possible and only if sustainable sources of energy are unavailable (Trias Energetica, 2013).

Moreover, the use of a heating system as the WKO that is described above, contributes to the constraining of energy use and to the energy from renewable resources, as the heat pump in the ground. According to the design, the existence of a solar collector and two windmills that consume 4600 kWh/year increase the sustainability of the building. Furthermore, the installation of a lighting system that will work with daylight and a control system with presence detection are two more aspects that reduce energy consumption.

It is obvious that a system to monitor all of the above mentioned sustainable aspects and systems will be necessary and this is the reason why in the design it is indicated that the installation of a Building Management System (BMS) with possibility for energy monitoring at the level of sub systems is required.

6.1.2.2 Building's Energy Performance

After the execution of the design, the energy performance of the building was measured and the results were:

- 50% better than current Building Regulations
- 40% better than requirements of 2009
- CO_2 emissions reach a reduction of 47%
- Solar water heating and the existence of two windmills

At this point, it would be wise to introduce GPR tool that was used in this case. GPR-Gebouw is a tool, introduced and described in the third chapter, which assesses the performance of the building according to some criteria. These criteria are Energy (9.0), Materials (8.5), Waste (9.0), Water (8.9) and Health (8.7). The scores in the brackets represent how the town hall scored according to GPR.

The municipality of Leiderdorp uses the Regional DuBoPlus Directive 2008 as a sustainable building-guide. The desired quality and sustainability of this project is guaranteed in the contract to Dura Vermeer (the contractor of the project), based on their offer, as best tender procedure. The minimum score that applies to municipal buildings is a score of 8.0 for each theme on a scale of 1-10. In the offer of Dura Vermeer, the result of the calculation is conducted with GPR version 3.2. Meanwhile, GPR version 4.0 was used. Dura Vermeer has recalculated the design in version 4.0. The goals were better energy than required by law, preventing leaching of construction materials as heavy metals and applying wood with FSC (Forest Stewardship Council) certification. From the following calculation, the result showed that the agreed goals were met, for health and future value as well. This is reflected in the Sustainability Label with three and a half stars, which is shown in the next figure.

Figure 6.12: Sustainability Label (May, 2010)

Furthermore, according to the policy of the municipality, Leiderdorp has established a common policy along with other municipalities in the region, the Regional Sustainable Urban Policy Framework (Regionaal Beleidskader Duurzame Stedenbouw). The next table indicates how and to what extent the design was according to this framework.

Thema	Design	Policy Framework
Intensive use of space	Yes (parking on the roof)	Yes
Separation of rainwater	Yes	Yes
Reduction of CO_2 emissions	47%	≥40%
Sustainable energy production	32%	≥20%
EPC reduction*	50%	20%
Removable/Reusable**	Yes (IFD principles)	Yes
Closed ground/soil balance***	Yes (no semi ground garage)	Yes

Table 6-1: Design and framework

*EPC=Energy Performance Coefficient
**IFD=Industrial, Flexible and Demountable Building Principles
***All ground within the area is reused and no additional soil was supplied

6.1.2.3 Operation Maintenance Management

According to the design, the aspects that have to be taken into account for the operation of the municipality are the use of energy, water and CO_2 emissions. More specifically it is stated that energy performance is improved by 50% (while according to the regulations it could be 38%) and water is saved by 35%. In the context of operation, the concept of Corporate Social Responsibility (CSR) is introduced, which is also closely related to CO_2 emissions. The

reduction of CO_2 emissions would be an extra cost to the operation of the municipality but according to the CSR pattern, it was transformed into a financial incentive.

Many definitions have been given to CSR by many organizations, although the most precise definitions are made by the European Union and by ISO.

-ISO 26000 'CSR is the responsibility of an organization for the impacts of its decisions and activities on society and the environment through transparent and ethical behavior and is an evolution in the approach towards sustainable development' (ISO, 2010).

-European Union 'CSR is the responsibility of enterprises for their impacts on society. Enterprises should have in place a process to integrate social, environmental, ethical human rights and consumer concerns into their business operations and core strategy in close collaboration with their stakeholders' (European Commission, 2011).

Long-term targets are usually set in the context of CSR and in this case, one of these targets is the improving of energy performance, with reduction of CO_2 emissions in particular.

One important statement in the design was the outsourcing of the heating system (WKO system). The contractor of the project, Dura Vermeer, created a new organization along with Unica, the so-called UDV Energie and promised the best possible maintenance of the WKO. This organization would be responsible for the operation, maintenance and management of the WKO. This system, as explained before, can achieve high performances, while a combined efficiency for heating and cooling is 510% feasible, but only with a proper operation and maintenance. The outsourcing of the WKO had the advantage of the limitation of the risks for the municipality. The contract was set for 15 years, while the municipality should pay monthly the UDV for their services and should receive annually in advance reports that indicate the performance of the system.

6.1.3 Results from the workshop and interviews regarding current sustainable building performance

The analysis of the design performance was the first step to gain an insight in the sustainable systems and features of the building. In order to get some additional information, get to know some of the employees and get more familiar with the building, a workshop was organized from the side of TU Delft at the beginning of this project (4th of December). Many employees from different departments took part and after discussion, they were divided in groups and they were asked to walk through the building and complete a simple SWOT Analysis. The creation of a summarized SWOT Analysis that covers the sub SWOTs and remarks from the employees can be seen in the next table.

SWOT analysis – Sustainability of the town hall of Leiderdorp		
Internal	**Strengths** • The Nieuwe Werken, new tablets • Lighting (exclusive during the night) • Energy purchase • Central office supplies, less paper consumption • Digital subscriptions • Political image • Glass: disposable	**Weaknesses** • Paper consumption • Plastic cups disappear in trash • No sustainable policy (eg new phones are now being replaced by mobile phones) • Lighting / LED not • The big conference room is usually empty • No canopy(roof) above the

	• Computer turns off at 22:00 • LED screens at the big conference room • Manually instead electrically adjustable desks • Double-sided printing / copying • Lockers	entrance: wet and dirty corridor (more cleaning) • Electric locks and doors: consume more energy than mechanical • Light control • No waste policy • Large screens 400 watts • Paper reservations meeting rooms (daily print per room) • Halogen lighting in elevator • Copier is default color set • Nespresso cups are not returned
External	**Opportunities** • Investing in policies / services (eg cleaning)	**Threats** • Bad transport • Concrete core activation vs acoustics (ceiling vs cleaning) • Large atrium height vs. o cleaning / maintenance o heating costs

Table 6-2: SWOT Analysis from the first Workshop

The next step of this research was to acquire information for the performance of the building during the current occupancy phase. Some difficulties arose regarding the amount of information that the municipality had already, which can be attributed to organizational aspects inside the town hall (municipality). It proved that due to the outsourcing of systems as heating and acoustics, information could not be available at that point. It was asked from the municipality if the responsible people could retrieve some important information regarding operation and maintenance of the systems from the respective companies. However, this seemed to acquire more time than expected and due to the restricted time limit of this research, it was decided to go further with interviews with the most appropriate people from the municipality in order to acquire some information and be able to proceed with investigating the current performance and comparing it to the design performance.

An interview is the right method to gather information about attitudes, opinions, feelings, thoughts or knowledge. Interviewing has its advantages and disadvantages. The disadvantages are that gathered data are not always reliable, since people sometimes are not aware of the motives of their behavior. However, oral interviews have the advantages that are suitable for open and difficult questions. The researcher can have a good control on the filling-in and he/she can push the respondent for answers that are more specific and a relatively low number of non-responses.

The interviews were conducted with the responsible people that would know more about the operation and maintenance of the building, as the project manager, facility manager, technical building manager and one responsible for ICT. Finally, the retrieved information proved to be useful and is presented in the next paragraphs. Most of it represents how the building performs now and in addition, how users of the building comprehend the current situation. The most important results are categorized below:

Moving into a new different building

One aspect that was emphasized by interviewees was how the change from a conventional to a sustainable building with new technologies, affected the users. The previous building was reported to be small with no sustainable features (for instance heating could be adjusted individually), with separate closed office workplaces for each employee and no open spaces. On the other hand, the design of the new building is sustainable, innovative and with many open space offices, which make it transparent and more user friendly.

The aspect of Nieuwe Werken

This year, which is the second year of the town hall's operation, it was decided from the municipality to follow the policy of Nieuwe Werken, which promotes working from home, flexible working, clean desk policy and other concepts that are explained at the beginning. New phones and tablets were provided to all employees. However, users seem to be reluctant about this policy and it was expressed that it would be wiser and more effective from the side of the municipality to conduct first a survey in order to find out to what extent users agree to this policy. Maybe, then users could be more prepared and positive thinking towards it.

Another consequence of this concept is the overconsumption in energy from heating and ventilation. The town hall is open from 6.00 – 22.00. The heating and ventilation are working for all these hours, plus Saturday and this was decided due to the concept of the ''Nieuwe Werken'' that everyone can come and go, or come at late hours or during the weekend. But it was realized by the municipality that it is not efficient and the municipality wants to change it and make these systems operate from 6.00 – 19.00, because normally most employees work from 8.00 – 18.00.

The heating system – WKO

Regarding heating, it can be concluded that there is strong contradiction. On the one hand, it is explained by the responsible people that the WKO operates as it was supposed to. The temperature was set from the beginning to 21 degrees and based on monitoring, it never goes under 20 or 21 degrees. However, users are complaining about feeling cold and not be able to adjust the temperature by themselves. They can only increase the thermostats up to 23 degrees but this does not seem sufficient in the open spaces and this is why they demand for more silent rooms where heat is kept and maintained.

Acoustics

Acoustic panels (absorbent islands) were installed as stated in the design. Many complaints were about acoustics in the open spaces because of many employees working together. The need for privacy (not to be heard) exists and is not fulfilled, at least for now, by the current acoustics. Maybe more panels on the corridors or other solutions as foam rubber on the walls and ceilings could be a solution.

Lighting

According to the design, the lighting of the system should contain high frequency lighting, LED's and a sensor lighting control system. There are sensors that work with presence detectors but they were supposed to work also by detecting daylight. When the sun is shining and the sensors detect 150 lux the light was supposed to go out. However, this is not fixed yet.

One additional problem with the current performance regarding natural lighting is the way the sun approaches the building. It was stated that one side of the building (most probably

the southern western side) receives more sun during the summer and sunny days during the winter and it gets two or three degrees warmer than the other sides of the building. In order to tackle this problem, the municipality decided to install shading panels on the windows to absorb 50% of the heat and light. The panels were installed from the internal side of the windows but they were not effective. The next idea according to the municipality was to put shadings on the external side of the windows, which usually is the most preferred option from the beginning of the design, but they are not sure if this solution is cost efficient enough.

Ventilation

The system of ventilation is operating as supposed to. Only a change in the wind flow has been made. There is air coming from the outside into the building and when the temperature is very low, it will come as heat and then it will be refreshed. Because the velocity of the ingoing stream was big and hard, it was lowered.

Energy and Construction details

The design specified that for lower energy consumption windmills and photovoltaic would be installed. Photovoltaic was never installed, windmills failed to operate from the first day and only one sun collector exists now in the town hall. The next step, according to the municipality, is to remove the windmills and replace them with new PV cells that will consume the same amount of energy.

Moreover, a change under the concept of lower energy consumption has been made. At the start, some computers systems on maintenance were not set to turn off at a specific time and if someone forgot to turn off the terminal, normally it would stay on until the next day because no one could shut it down. The change was the installation of timers and now with the timer these systems automatically shut down at 00.00 in the night.

The construction regarding structural details and the use of materials was totally respected to the design. Indeed, the system of Concrete Core Activation exists, construction elements can be disassembled, materials can be recycled and were used in all structural aspects as insulation. Even the furniture is made/chosen from/with recycled materials.

Waste management

The initial plan regarding waste management was the separation of waste and recycling. Small trash bins and one big for organic waste were installed on a regular basis through the building. This concept did not seem to work, users did not follow the waste separation, and previous trash bins were replaced by normal trash bins (without waste separation). In addition, it is reported that there is a quite big consumption of paper (even with the cups from the coffee machines), which should be reduced.

Parking

The sustainable use of the parking roof is on the one hand as designed and expected. On the other hand, some parameters have not been predicted. One parameter is the limited amount of space. Employees of the municipality are told to park only on the roof, but due to the lack of space, they park also in the parking places around the town hall, which are intended for visitors. So, the result is that sometimes visitors cannot find a parking spot. Another parameter is the caused problems by bad weather conditions as ice and snow. The ramp that leads to the parking roof is during winter sometimes inaccessible and dangerous.

6.1.4 The sustainability of the town hall – Occupancy/Use Phase

After the conducted interviews, which are presented before and in detail in Appendix C, and walkthroughs in the building, it can be confirmed that many of the above-mentioned sustainable characteristics do not exist or do not operate according to the expected performance. This is a powerful aspect for the verification of an existing performance gap. On the other hand, many other features and concepts in the town hall function normally. All these features will be explained one at a time. Even if the technical information for the systems, energy consumption and current building performance during the occupancy phase was not available, it was tried to complete this section with all the information gathered so far. First, the below overview table indicates all the sustainable elements that the building has and which is their functionality now and which one was supposed to be.

Sustainable elements/systems	Functionality: As intended	Functionality: As is
Construction details		
Concrete Core Activation		
Reused and recycled building materials		
Architecture		
Innovative design with open spaces		
Heating System		
Operation of the WKO		
Ventilation (with the atrium as a return plenum)	 (with one small change on the velocity of the ingoing stream air)	
Acoustics		
Free hanging units (absorbent islands)		
Acoustic panels on the walls		
Water Management		
Lighting		
LED's		
Sensor lighting control system		 (only sensors for presence detectors work – no sensors detecting daylight)
Energy		
Windmills		
PV cells		
Parking		

Table 6-3: Sustainable elements/systems and their functionality

Each of the above sustainable elements will be analyzed below and the problems that were most probably the cause of this change in functionality will be tried to be investigated. A remark for the above table is the explanation of the used images. The tick/check symbol and the x/cross symbol have an obvious meaning. However, when a little human form

accompanies them on the right, this means that users play an important role at it. It means that technically the system may perform as based on the design but users may have a different opinion (stronger or lighter which is presented by x + human and tick + human respectively).

6.1.4.1 Heating system – WKO

A creation of an architectural design with an open space and a wing floor is advantageous for collaborative working climate and creating a friendly behavior but sometimes it can cause difficulties in the thermal comfort of such a huge open space.

Persons interviewed, experienced some problems and inconvenience with the heating. They reported that during the winter it was too cold. One side of the building, due to the sun, was warmer but in general the building was cold and sometimes employees had to wear more clothes to adjust to the conditions. From a technical perspective, according to the responsible people for monitoring and maintenance of the WKO, it works as it is supposed to. It maintains a constant temperature at 21 degrees and this can be adjusted manually through the thermostats in the office up to 23 degrees. The problem is that this combined with the open space of the office layout makes it impossible to create satisfying conditions of warm and cold in the office.

However, the normal operation of the WKO, which implies that everything goes according to the design and plan, is suspicious. It was found through the interviews, which is also common sense that the above-mentioned problem depends on users' perceptions on warm and cold. Some mentioned that it can be attributed to the fact that users do not have control over the heating, as they used to in their previous building. These perceptions and the satisfaction level will be investigated and analyzed through the survey later in this research. The conclusion is that somehow the working climate has to be better, either with improving in a way the WKO or with more satisfaction measures for the users.

6.1.4.2 Ventilation

In general, the ventilation seems to operate perfectly. There are some complaints from cold air coming from the ventilation on the floor but there is no other about the air quality, which is the most important. Along with the information from the responsible managers, it can be stated that ventilation is one of the strong and advantageous systems in the building.

6.1.4.3 Acoustics

Another problem, mentioned by all the interviewees, is acoustics. The office layout as an open space and the fact that employees share their offices (usually 8 per time) create some problems in the acoustics of the building. Acoustic panels are installed and work as described above (in the design), but there are none of them on the corridors.

In the building, the problem is that when employees talk, it goes to the windows, to the wall and to the workplaces. Therefore, there is a need always to close the doors of the silence rooms, or to go and take a phone outside. Noise levels are too high when eight people or more are sitting in one space and they are talking to each other, or on the phone.

The municipality tried to take initiatives and contacted the architect, who proposed for installing panels under the tables, and the acoustic factory (acousticfabriek), who are busy on finding a sustainable solution to get the acoustics down to normal level.

6.1.4.4 Lighting

The lighting system was supposed to entail a daylight control system. However, there seem to be some flaws in this system.

The part of the lighting system, which is the daylight control, does not work. It is believed that it was never available from the beginning. The maintenance team wants to see if it is possible to have a sort of a sensor outside, so when the daylight gets brighter, the lights go down. Some lights, like the big ones in the atrium are always closed. All the other can be controlled manually from a system. Every space has a presence detection sensor, so when employees are not in the office or not moving, the light goes out. Although it is reported that sometimes, it can get dark and there is a need to move a lot to get the light on again.

Another problem concerning lighting is how the sun approaches the building. From the one side, it was too sunny and too hot during the summer.

6.1.5 Parking

Even if it is admitted by everyone that parking on the roof is a nice idea, everyday it is full and the employees start parking their cars outside of the town hall, where are only 20 parking places for visitors and then visitors have nowhere to park. Moreover, complaints are made about difficult access to it and dangerous conditions as slippery and freezing on the roof during winter. Another thing that was not taken into account in the design is that this parking seems sustainable due to the 'green roof' style but it may cause problems, as the heat created by the car's machines is uncertain.

6.1.6 Performance gap and applying the occupant comfort survey

Despite the difficulties in acquiring technical information, the available information was sufficient to get the research into the next level and conclude about the performance gap. As indicated in the first chapters, a performance gap is present when the current building performance differs from the design performance, when there is still a significant gap between predicted and actual energy consumption and where there is a missing link between technical and user perspectives. The analysis of each system and feature concerning the sustainable building performance of the town hall contributed to the fact that design intents were aiming at high sustainable levels and performances and to the final statement that there are reasons to suspect a possible performance gap in the town hall. Even if the 'numbers' of actual and precise current energy consumption are missing, other facts reveal a gap between performances and also between expectations. However, it should be added that the statement of the existence of a performance gap cannot be valid in total because of the missing numbers and information but can be supported with the other facts. These reasons and facts are mainly that the 'symbolic benchmarks/items' of the sustainability of the building, as the windmills, the lighting system (with daylight) and the toilets, which are part of the main building systems, do not function. This influences the general sustainable picture of the current performance and enhances the first impression, which judging from the interviews and the first workshop, was that there are some problems with the sustainability of the building and the overall satisfaction with the building. These problems are outlined mainly in the awkward acoustics, in the challenging lighting system and in the suspiciously dissatisfying heating system.

Furthermore, the above-mentioned satisfaction will be researched with applying the survey that was described and formed in the previous chapter and analyzing it, as it will be covered in the next section. The analysis will give an insight into how users correspond to this green building, how this green building and its above mentioned performance affects them, judging from their satisfaction levels, and from testing the already formulated hypotheses.

At this point, it has to be noticed that even if the performance gap is considered only as technical and measurable, user satisfaction plays a role in this phenomenon. When technical perspectives do not match with user perspectives towards design or realization performance, user satisfaction is a factor that can evaluate the performance and can help to alleviate the possible existence of a gap. In the case of Leiderdorp, a possible gap has been already identified and the next step is the analysis of the survey in order to evaluate users and conclude about their level of satisfaction.

6.2 Analysis

In the previous section and chapter, the case study of Leiderdorp and the survey were described. The building is analyzed according to the operation of its systems (heating, ventilation, acoustics, lighting etc.) and its sustainable performance overall. The case study, as indicated in the introduction of this research is a mean to

- Evaluate the current building performance in order to check if it complies with the design performance and the sustainable ambitions of the town hall
- Investigate the relation between users' satisfaction and sustainable building performance
- Test the formulated assumptions (with the help of the survey)

For the first goal, the first step has already been made in the previous chapter. The current building performance and the design performance have been compared and the respective 'performance gap' is analyzed in the last section. As stated before, not so much of current technical data about performance was available and the interviews were a helpful source of feedback for that. In addition, interviews were a huge help in gaining a first insight into the second goal of investigating the users' satisfaction – building performance relation. After getting the first impression from interviews, having investigated the general relation between users, buildings and sustainability and formulated the questionnaires in the previous chapter, the next step was the implementation of the survey and the analysis of the responses.

6.2.1 Results from the survey

6.2.1.1 Gathering of data

The questions of the survey have been presented in Chapter 5. The questionnaire was created with the program of Student & Enquete (http://www.studentenenquete.nl/). This program is free for students after request. Moreover, it uses the LimeSurvey software tool (http://www.limesurvey.org/), which is a leading open source tool for online surveys.

The survey was sent to all employees of the town hall of Leiderdorp, meaning to **172 employees**. It was sent to the 144 of them by email via a link that was created automatically by the program and the rest 28 employees filled in the hard copy of the questionnaire because they did not acquire an email account. The response of employees was regularly checked and the result was **99 responses**. This means that it had a response of **57.6%** and that more than the half of the employees were willing to express their opinions and feelings about their building. Furthermore, it should be also noted that from the 99 responses, 88 were complete and 11 incomplete (the surveys were not submitted as complete nor all questions were answered).

At this point, two things have to be noted for the validity of the analysis. First, even if the 11 survey responses were not completed records they were taken into account in the results and statistics because more answers, even not to all questions, can cover a wider range of opinions and perspectives. The sample size (n) is noted per question in Appendix D. Second, the sample size is not so large (almost half of the actual sample size of the employees), Hypotheses have been made in general about users of the town hall and not only a part from them. However, as an approximation, this sample is used as a representative size of the users of the town hall. This explains when sometimes the word 'users' instead of 'respondents' is used.

The results of the questions were inserted in the software tool SPSS for statistical analysis. The important aspects that have to be researched through the questions are the frequencies of almost all the questions, the correlations that have some questions with each other and some statistical tests with the already formulated hypotheses. Each question represents a variable and it is important to define first the type and the scale of the variables and then proceed. Almost all of the variables are measured in an ordinal scale as being answered in a 5 point Likert scale and there are some other nominal variables as for example gender and age. Descriptive statistics is the type of statistics that will be used.

Often there is no clear picture of the situation and therefore methods are needed that help search for patterns and structures in the data. Despite the fact that in this case, assumptions for the results could be made beforehand, it is important that these methods are able to reveal unexpected aspects in the data. Methods for descriptive analysis can be divided into two groups. In the first place, there are methods that study the distribution of a variable. They aim at mapping the distribution of the present values of a variable. In this way, an image is obtained showing, which values occur and which of them occur often, but also which values are rare and perhaps which values deviate seriously from the rest. Other methods study the relation between variables (Heijnen, 2011).

In the next paragraphs, the main results from SPSS and from the program of Student & Enquete will be presented. The detailed analysis with all frequencies and statistical tests and correlations is presented in Appendix D.

6.2.1.2 Statistical Analysis

As it was indicated previously, each question represents a variable to be analyzed and furthermore a related topic in question. Therefore, it deems appropriate to present first some basic results that create the profile of users.

More than half of the respondents are male (59.6%) and according to age, most of them belong to the categories between 41 to 50 and 51 to 60 years old. Many factors can define and influence the relationship between users and building performance, the satisfaction level and occupant comfort of users. These factors are described below and the correlations that occur. The building is evaluated during occupancy from its users. With the help of the results of this analysis, satisfaction will be measured and the most important factors will be identified that influence this satisfaction. Also, the results will constitute answers for the respective research questions.

6.2.1.3 Assumptions

Each statistical analysis is based on made assumptions theoretically informed on the data. The sample of this analysis is quite small (N=99) and after conducted tests, it is proven that the data does not follow the normal distribution and as result in most cases the assumptions

of parametric tests are violated. These assumptions are: a normal distribution and homogeneity of variance, which here is not valid, the data should be at least interval, which in this case does not apply either because most of the data are ordinal and some nominal and the only valid assumption is the independence of the sample (Field, 2009). Therefore, as it will be seen, in most cases non-parametric tests are used, which do not require any specific form for the distribution of the population. In addition in order to be pragmatic, the results of some parametric tests used, can be said that they are a little bit exaggerating.

Moreover, because the format of the data in some questions is complicated and some questions include more than one variable, actions have been made to group the data. In some questions, this is done with just transforming the data with the suitable computation (when only the average of variables is sufficient) or with the execution of a factor analysis (when variables are grouped within a scope). After conducting a reliability analysis (Appendix D) to find out if the data is consistent and if there is, a possibility to form factors based on the initial hypotheses, the results are:

- Environmental awareness: the data of the sub questions of environmental awareness could not be grouped in categories from the beginning as their consistency is not strong (Cronbach's Alpha α=0.574 and it should be approximately over 0.7). Therefore, a factor analysis is the next step, where the program of SPSS will form its own form the categories. The following factors are created: Sustainable everyday habits (Component 1), Willingness to invest on green/sustainable home owing devices (Component 2), Waste management and energy consumption (Component 3).
- Control over the building: The initial hypothesis, while forming the questionnaire, was that control can be divided in groups of control over the systems (heating-temperature, lighting, daylight access and ventilation) and control over windows and doors. The consistency is strong (α=0.868, α=0.683) and two new computed variables are created, Control over systems and Control over windows and doors.
- Occupant comfort: Even if the consistency of the data under this question is strong (α=0.8), it is more useful to investigate the correlations of each variable separately rather than grouping the variables in factors, because each sub question may consist an answer to different issues and hypotheses.
- Additional satisfaction factors: Again the consistency of the data is strong (α=0.725) and through the initial assumptions of dividing the questions, the variables of Factor of knowledge and information, Factor of sustainability, Factor of Nieuwe Werken and Factor of overall satisfaction are computed.

6.2.1.4 First impressions and results from Frequencies Analysis

Some very important first impressions can be made through analyzing the frequencies of the variables. On the other hand, it would be pointless to analyze the statistics for each variable (question) therefore the most necessary will be described below.

Environmental Awareness/Green users

As it is indicated in Chapter 5, many hypotheses have been formulated through extensive literature about the interaction between users and buildings. One strong statement is that users of green buildings are more prepared to overlook and forgive less-than-ideal conditions than their 'brown' (non-green) counterparts suggesting there is a possible link between occupant satisfaction and environmental attitudes (Deuble & De Dear, 2012). A variety of actions can determine if a user is green or not. A question about the way employees travel to the town hall is a first attempt of gaining insight into the profile of the

user. Moreover, further actions that can characterize a green user have been summarized in questions in the first section (*Q8 and Q6*) of the questionnaire and they can be divided into three categories:

- Sustainable everyday habits (turning off the lights when leaving a room, decreasing the heating when leaving the house, closing the tap while tooth brushing, waste separation at work)
- Willingness to invest on green/sustainable home owing devices (owing at home devices with solar energy, owing at home water saving taps/faucets, owing at home energy efficient lighting)
- Waste management and Energy consumption (use of rechargeable batteries, be aware of energy saving/consumption while purchasing devices, waste separation at home)

The first category includes the actions of trying to be green and an environmental friendly user. However, even if behavior is essential, by being green it is also crucial to get deep into it and move to the second category and third category. It is wise to look at the frequencies of the respondents and draw some initial conclusions.

The results from the variable of means of transportation (*results from Q6*) show that the same amount of users travel with their own car (37.4%) and with the bicycle (37.4%). The use of car can be justified by the location of the town hall (*results from Q7*) and the fact that most of the respondents live in a distance more than 7.5 kilometers from the building (13.1% between 7.5 and 10 kilometers and 34.3% in more than 10 kilometers). Public transportation is not so frequently chosen and a combination of transport means, which could indicate the use of bicycle and public transportation, is also not frequently chosen. This can indicate that approximately 40% of the respondents could be recognized as 'green' based on the first category, by choosing the bicycle and public transport as modes of transportation. These could emerge in suggestions like themes as car sharing or could lead to explorations of opportunities to improve public transport.

Some first observations can be done on the detailed frequencies (Appendix D) and choices of the users. It is found that the aspect that gained in total the most positive response is the sustainable habits (*results from Q8*) regarding the heating system (45.5% of the users fully agreed and 32.3% agreed) and then the lighting system (42.4% fully agreed and 29.3% agreed). These two aspects are categorized as everyday habits. From this point of view, the majority of the users (users=respondents) do the basic environmental friendly stuff at home and have sustainable everyday habits. However, the aspects of the second category, which represents the willingness to invest on owing sustainable devices and programs at home, gained neutral, weak positive responses or even negative responses. Almost 72% of users disagree on owing any devices working with solar energy.

Furthermore, users showed a weak interest in acquiring sustainable installations at their homes and rechargeable batteries. A surprising also fact is the one regarding waste separation. Recycling is an aspect that can influence the decision of characterizing a user 'green' or not according to the first category. Users agreed on positive considerations towards waste separation both at home and at work, with a little bit over 60%. It is surprising, because it was found during walkthroughs and interviews that even there was a recycling option in the beginning, now there is no possibility in the town hall of waste separation. Therefore, this could indicate that these users are recycling at home and with their way of answering the same question about their working environment, they express the desire of being offered the opportunity for recycling also at work.

To sum up, it can be said that **most of the respondents present a profile that tends to be 'green' and they could be characterized as 'light green' users**. They are following 'green user's' basic habits but they seem hesitant to invest in other sustainable activities.

Control over the building

First, it is investigated to what extent users are satisfied with the amount of control they have and the systems with the higher and lower satisfaction levels will be ranked. One obvious conclusion from the percentages (Appendix D) and the tendency of expressing dissatisfaction in almost all questions is that **users are not satisfied with the control they have** (*results from Q12*). The weakest aspect is ventilation with 50.5% dissatisfaction. This can be combined also with the complaints from the interviews for dry eyes and annoying throats and clearly with their lack of ability to open or close a window, when 62.6% of the users expressed their dissatisfaction. Even if it is a hypothesis, it is possible that their negative feelings about opening windows could have influenced their opinion about the whole ventilation system. The next in order most dissatisfying aspect is the control of temperature with 46.5% (dissatisfied and very dissatisfied). Users seem to not care and be more neutral when answering on the aspects of artificial lighting, exterior doors and interior doors. These variables have been summed up into two variables as indicated above, Control over systems and Control over windows and doors.

Working activities and favorable rooms

If the percentage of often is also added to very often in the activity of working on the computer, then it can be said that approximately 67% of the employees work on the computer (*results from Q10*). This finding can lead to focus on this activity and to possible preventive and corrective actions. For example, working on the computer can create problems as red and dry eyes, physical pain and discomforts from glare on the screens. These problems should be prevented with good ventilation, anatomical furniture, satisfying visual comfort and lighting settings.

According to the analysis in SPSS (Appendix D), respondents seem to appreciate and rank more positively (*results from Q11*), spaces like project rooms (59.6% good on the ground floor and 46.5 good on the first floor), meeting rooms and silent rooms (closed places) than open space places (32.3% good). The areas of toilets (28.3%) and bicycle storage (30.3%) were the only areas, which had worth noticed percentages in scoring bad and very bad. Some of the above facts are supported with additional comments of the users at the end of the questionnaire and from the interviews, where toilets, bicycle inconvenience and open space acoustics were mentioned as the most problematic.

Occupant Comfort inside the Working Environment

One of the important sections in the questionnaire is the research on the working environment based on occupancy comfort, because based on these answers the operations systems of the building(heating, ventilation, acoustics etc.) will be researched and judged. Questions were divided based on systems and features inside the building: heating, ventilation, lighting, acoustics, office layout – open space design, aesthetics, parking, maintenance and cleaning and services (*results from Q13*).

In general, the responses were inside the ranges of neutral and only few responses had obvious preferences on agree or disagree side. Regarding the heating system, respondents stated with their preferences that they face some comfortable problems with the

temperature. Many respondents agreed on feeling cold and disagreed on feeling warm, therefore it can be said that low temperatures could be an issue. Ventilation received almost neutral answers with a small tendency to disagreement with fresh air and sufficient humidity. Moreover, the innovative design of open spaces and acoustics are two aspects mutually combined. Respondents seem to feel dissatisfied with some acoustics aspects, as sound privacy (61.6%) and this may explain their disagreement with being able to concentrate in an open space (45.5%) and their need to find a silent room, regardless if they find silent rooms attractive or not. However, two aspects of open spaces gained positive reactions. One was the satisfaction with the ability to approach and find other colleagues easily and quickly and the other was the flexibility that such designs offer with the possibilities to change personal workspaces. Lighting received neutral responses with a tendency to agreement, which indicates the satisfaction of users with visual comfort and access to daylight. In addition, respondents do not seem enthusiastic with their personal amount of space in the building and storage space in the office, although half of them stated satisfied. Furthermore, aspects as maintenance and cleaning, aesthetics and safety gained neutral responses with a tendency to satisfaction. The service bike seems not to be needed as most of the respondents stated that they do not agree that they use it and in addition, most of them are using the roof as parking, as it is agreed and find the space sufficient.

A final observation from the above percentages is the ranking of the systems and features of the building (according to frequencies) that create dissatisfaction and satisfaction to the users in order to prioritize future actions. The next table shows these aspects in an order from the most dissatisfying to the most satisfying under occupant comfort.

Occupant comfort	Adjusted Percentages
Acoustics Comfort and Open spaces layouts	44.2%
Ventilation Comfort	34.4%
Heating Comfort	26.8%
Aesthetics Comfort	22.2%
Lighting Comfort	16.2%
Other Services Comfort (safety, parking, handicapped accessibility)	15.9%
Maintenance and Cleaning Comfort	12.1%
Personal workspace Comfort	11.52%

Table 6-4: Occupant Comfort Ranking

To investigate and judge how the systems operate, the average of questions that correspond to each system and express dissatisfaction is computed and is indicated in the above table. Among with the above remarks and this table, one conclusion is that acoustics concern an issue for further actions. This fact is enhanced by the results from the interviews. Then ventilation (many complaints about dry eyes as its can be seen later from the open answers) and the sense of feeling cold have to be addressed. On the other hand, it is important to notice the positive aspects. Respondents feel satisfied about their personal space, which can prove crucial to their working performance, with maintenance and cleaning, other service provisions and the system of lighting.

Forgiveness Factor

The definition and effect of the forgiveness factor is given in previous chapters and the attempt now is to measure it with the data from the survey. According to Deuble and de Dear and their research on green buildings with green occupants, the forgiveness factor, as it is stated also at the beginning of this thesis, is ‘an attempt at quantifying how occupants

extend their comfort zone by overlooking inadequacies of their working environment'. In their research (Deuble & De Dear, 2012), their finding was the below equation:

$$Forgiveness\ factor = {Comfort\ overall} \Big/ \left(\frac{AirW+AirS+TempW+TempS+Light+Noise}{6}\right)$$

Equation 1: Forgiveness factor by Deuble and de Dear

This index is derived by dividing 'comfort overall' scores by the average of the indoor environmental quality (IEQ) variables. In their research, the variables are overall temperature in summer (TempS) and winter (TempW), overall ventilation/air in summer (AirS) and winter (AirW), overall noise (Noise) and overall lighting (Light) and are rated along 7-point Likert scales ranging from 1 (unsatisfactory) to 7 (satisfactory). In this research, variables are rated along a 5-point Likert scale ranging from 1 (strongly disagree/dissatisfied) to 5 (strongly agree/satisfied) and the above equation will be approximated according to the need of my data.

- 'Overall Comfort' -> 'Overall satisfaction with the building'
- 'AirW, AirS, TempW, TempS' -> 'Air and Temp': In the occupant comfort survey of this research it was not considered necessary to research user satisfaction based on differences between seasons (winter and summer) because a general view for the ventilation and the heating was a first priority.

So the equation is transformed and the new equation, which will be used is:

$$Forgiveness\ factor = {Overall\ satisfaction} \Big/ \left(\frac{Air+Temp+Light+Noise}{4}\right)$$

Equation 2: Revised Forgiveness factor

For each of the above variables the most important aspects will be taken into account in the computation (Air: fresh air, Temp: feeling cold, Light: visual comfort and Noise: sound privacy). For each variable, the average/mean is computed (Appendix D) and the forgiveness factor is:

$$\text{Forgiveness factor} = {3.49} \Big/ \left(\frac{2.74+3.35+3.28+2.81}{4}\right) = 1.15$$

Forgiveness factor typically ranges from 0.8 to 1.2, with scores greater than 1 taken to indicate greater tolerance to the building's indoor environment (Deuble & De Dear, 2012). Therefore, **the above result indicates that the respondents are forgiving and tolerant regarding their working environment and their occupant comfort**. This could mean that because of their moving in into the new building they are more forgiving with aspects that created discomfort and that in general occupants seem to be willing (maybe with some feedback and necessary changes) to overcome any obstacles and try to be satisfied with the building.

Additional Satisfaction Factors

First it should be stated that an overall satisfaction (*results from Q14*) in the agree side with almost half of the users (48.5%) should be further analyzed if it is a satisfying result or not by taking into account more aspects.

A quite big amount of the respondents is familiar with the building (61.6%), although a larger percent could be more satisfying as it is very important for a user to be familiar with the building, because this would also increase the forgiveness factor. Most responses were neutral, especially regarding the knowledge of the users on how systems operate and on their receiving information about the building. Half of the employees know where to report a deficiency or a complaint in the building, but not all of them seem to be satisfied with the handling of these remarks and complaints afterwards.

It is surprising also that only 27.3% of the user were on the 'agree' side regarding the sustainability of the building (answer to the question if they agree that it is a sustainable building) and **more surprising is the fact that almost half of them were neutral if it is a sustainable building or not**. This fact, along with some other previous factors, may reveal the lack of knowledge and information users have.

Again neutral were users regarding the Nieuwe Werken (42%) and a small percent of respondents (20%) on the dissatisfaction side, which may reveal that this concept is not yet fully integrated in the main policy of the town hall and that more efforts have to be done, as for instance conducting a survey exclusively for this. For the catering of the restaurant and its equipment, respondents were neutral with a tendency to agree. Based on the interviews and comments in the last open question, negative remarks were made on the restaurant regarding cleaning and its location and maybe this shows their dissatisfaction with the services provided. Last, but not least, maybe one of the most important questions in the questionnaire was the overall satisfaction. Worth noticed percentages were in 'agree' and in 'neutral' (40.4% and 28.3% respectively).

What users dislike

The answers of respondents can be found in detail in Appendix D. Even if almost half of the respondents made a comment (47 out of 99), useful conclusions can be drawn from their remarks. It can be said that most of the comments had a negative sense, they can be characterized as complaints, only two were total positive ('It is a very nice building!') and some of the remarks were suggestions (towards the organization). The most frequently used issues in comments on the building are:

- **'feeling too cold/warm':** remarks were on feeling too cold in the winter and too hot in the summer. Furthermore, many complained about their inability to open a window, which can relate to both heating and ventilation. ''The temperature in the building is too cold and this has not yet been solved!'', ''Always cold feet'' are some remarkable quotes.
- **'too stuffy air/dry eyes':** many reported dry eyes and throat at the end of the day and an increased humidity, ''As the day proceeds, my eyes get dry and red''.
- **'lighting/daylight/glare from computer screen':** during the summer (because of limited shading, there is poor visibility on the screen and there is also glare from the screen. Some of them indicated the need for less light in general. ''Lights are kept on even when they are not needed'', ''The sun reflects on the computer screen and there is nothing to do for the glare'' are some representative quotes.
- **'parking':** all remarks reported for parking were on the same thing: about the narrow slope and how dangerous parking is during winter (freezing and problems with snow and ice). ''The steep slope to the parking deck is scary'', ''I am disappointed that the ramp to the parking deck is not heated at freezing temperatures''.
- **'cleaning and maintenance':** the majority of the complaints were about hygiene in general. Dirty toilets and restaurant tables were mentioned as serious problems and

after a quick analysis to correlate these complaints to gender, it was found that men were too dissatisfied with the toilets (Appendix D). ''The outdoor space of the building should be better maintained. Sweep every Monday morning. Put some flowers outside!'', ''Very bad toilets / urinals can often not be used and smell''.

- **'too noisy, open spaces layout':** after the hygiene, complaints on acoustics was the second most usually mentioned. The need for more silent rooms and the disturbing taking place of public events in the main hall were frequently reported. '' The quiet rooms are mostly all occupied'', ''Anyone walking by can have a view on computer screens'', ''The building is very noisy and therefore, there is difficulty in concentrating'' were remarkable phrases.
- **'about the survey itself':** many of the respondents remarked that there should be a choice on questions as 'Not applicable' or 'Not answering' and that questions could be skipped. However, the aim of this research was to push respondents to answer all questions as in reality they concern their building and try to gather as many answers as possible (for better validity in the research sample)

Moreover, some observations that were formed by respondents as suggestions are precise and should be mentioned. These suggestions cover several issues as aesthetics (more flowers outside and more pillows on the couches in the entrance) and parking (implementation of a heated ramp for ice problems during winter). Regarding sustainable issues, suggestions have been made for installing daylight sensors, energy saving equipment and for efforts to promote sustainability in general. The above comments are summarized in the next tables with the most important percentages of user satisfaction on certain features.

About what are users satisfied

	Satisfied	Not Satisfied
Entrance/atrium	63%	6%
Pantry's	72%	14%
Parking roof	47%	9%
Conference rooms	66%	4%
Restaurant	58%	9%
Visual comfort	41%	16%
Enough space in workplace	63%	7%
Survey	40%	11%

Table 6-5: About what users are satisfied

About what users are not satisfied

	Satisfied	Not Satisfied
Toilets	38%	28%
Bicycle storage	33%	30%
Control over temperature	22%	46%
Temperature (i.e. too cold)	17%	36%
Fresh air	21%	37%
Humidity	15%	31%
Sound privacy	7%	61%
Ability to concentrate in open spaces	10%	45%

Table 6-6: About what users are not satisfied

6.2.1.5 Correlations and Influential Factors

The first conclusions have been drawn from the frequencies of the answered questions and the analysis of the variables. The next step is to correlate the most important variables to each other and conclude to facts that also answer the research questions and aims of this thesis.

Factors that influence the environmental awareness

As indicated above, most of the respondents present a profile that tends to be 'green' and they could be characterized as 'light green' users. They are following 'green user's' basic habits but they seem reluctant or unwilling in investing in other sustainable activities. Moreover, it is important to find out which factors influence the environmental awareness of the respondents and users in general. The first considerations of independent variables that may affect the dependence of environmental awareness are gender (Q1), age (Q2), level of education (Q3) and choice of means of transportation (Q6). These input factors are tested with the procedure of Multiple Regression. The test is conducted three times because environmental awareness is divided into three categories: Sustainable everyday habits, Willingness to invest on green/sustainable home owing devices and Waste management and Energy consumption. The detailed results can be found in Appendix D. The important results are that for the first and the last category, the regression indicates a warning message, which means that none of the input factors has a significant affection on the categories. On the other hand, it is found that the factors of age ($p=0.003$) and education ($p=0.01$) affect the category of willingness to invest further on sustainability. The regression indicates with the help of b-values the relationship between the outcome and its predictor factor and to what degree the predictor factor affects the outcome. The result is that from age and education, the most significant is the factor of age and with a b-value of 0.255. This means that as age increases by one unit, willingness to invest further on sustainability increases by 0.255 units.

In other words, these tests say that the outcomes, the 'first steps' of sustainability, which are common sustainable habits and waste management/energy consumption, are not shaped from factors as age, gender, education and way of travelling. However, age, education and most probably income have a positive relationship with the outcome of willingness to invest further on sustainability and in home owing sustainable devices in particular.

The relationship between green users and satisfaction aspects

The last question in the survey investigates how other satisfaction aspects affect users. As indicated above, these aspects have been summarized in the factor of knowledge and information, factor of sustainability, factor of Nieuwe Werken and factor of overall satisfaction. With a bivariate correlation (Appendix D), the most significant correlations are researched. The hypothesis is that there is a relationship between being a green user and these factors (with the null hypothesis: there is no such relationship).

Each of the factors that form the environmental awareness is tested to see to what extent it correlates with the above factors. The significant relationships (where the null hypothesis can be rejected) are:

- Users with sustainable everyday habits (Q8) tend to be significantly ($p=0.013<0.05$) more familiar with the building, have more knowledge on the systems in the building and be more satisfied with the amount of information they receive and some services of the town hall (Q14). With a positive relationship and a Pearson correlation coefficient of

0.272, which equals to a medium effect size of 27.2%, **the more green users are the more satisfied they become** with the above aspects.

- Users with the willingness to recycle, separate waste and pay attention on energy consumption while purchasing tend to be significantly ($p=0.031<0.05$) more familiar with the building, have more knowledge on the systems in the building and be more satisfied with the amount of information they receive and some services of the town hall. With a positive relationship with a Pearson correlation coefficient of 0.238, which equals to an effect size of 23.8%, the more green users are the more satisfied they become with the above aspects.

In the beginning, some hypotheses were made about green users and that they could be more satisfied with the building, more forgiving with failure of systems, the amount of information they acquire and the control over the building. Therefore, the formulated hypothesis in Chapter 5 (H1: Users are more satisfied if they are 'green' users and H3: Users seem to forgive and be more tolerant if they are familiar with the building and know how it works and operates) can be approved and the next step is the correlation with control.

Control over the building

It is stated that green users may be more tolerant with the amount of control they acquire. The forgiveness factor has been already computed and it is found that the respondents/users are quite forgiving. In order to find which of the users are indeed the most forgiving, it is necessary to investigate the relationship between control over the building (Q12) and environmental awareness (Q8). The control will be researched in terms of two factors as indicated under the assumptions: control over the systems and control over windows and doors.

The first and foremost relationship that has to be researched, is the one with environmental awareness in order to test the hypothesis that green users are more tolerant and satisfied with the control they have. By testing the factors of environmental awareness towards the control over the systems and the control over operations as windows and doors, the significant results were found only with the control over the systems:

- Users with the willingness to invest further on sustainability (green users) have a significant relationship ($p=0.011$) with the control over the systems in the building with a b-value of 0.265, which means that as environmental awareness increases by one unit, satisfaction with the control over the systems increases by 0.265 units.

This result confirms the initial hypothesis, formulated in the previous Chapter (H2: Users are more satisfied if they have or think that they have control over the systems of the building and the building in general) that **the more green a user, the more satisfied and tolerant is he/she with the control over the systems in the building**.

Another test that could be performed, is to investigate which other factors can affect the control over the systems. As an input the factors of education, sustainability and knowledge and information are given. The results of this regression are:

- The factor of sustainability has a significant relationship ($p=0.000$) with the control over the systems with a b-value of 0.826. This means that as users' beliefs in sustainability (most of the times these are beliefs from green users) increases by one unit, the satisfaction with the control increases by 0.826 units.

- The factor of education has a significant relationship (p=0.001) with the control over the systems with a b-value of -0.172 and a significant relationship (p=0.000) with a b-value of -0.195. This means that as education levels increase by one unit, the satisfaction with the control over systems and operations as windows and door opening, decreases by 0.172 and 0.195 units respectively, which could be explained as the more educated someone is the more demanding on controlling the systems he/she could be.
- The factor of knowledge and information has a significant relationship (p=0.006) with the control over the systems with a b-value of 0.451. This means that as users' familiarity with the building, knowledge on the operation of the systems and satisfaction with services increase by one unit, the satisfaction with the control increases by 0.451 units.

As a last correlation about control, it could be researched if users with having or believing of having more control are in overall more satisfied. The result of this test is indeed that this relationship is significant (p=0.000) with a b-value of 0.381. This means that as satisfaction with the control over the systems in the building increases by one unit, the overall user's satisfaction increases by 0.381 units.

Type of workspaces and satisfaction

One additional significant correlation that worth to be noticed is how respondents appreciate their type of workspace (Q10) and more specifically if they are satisfied with the open spaces in the building or not (Q14). From Crosstabs correlation two important observations can be made. First, users of open spaces on the ground floor and on the first floor seem to agree more on the overall satisfaction with the building (see Appendix D). This could be explained with the fact that users are satisfied with the advantages that open spaces can offer. These advantages could include the creation of a more cozy and intimate environment and the easiness to find a coworker. However, as explained before, open spaces could have some disadvantages that relate to acoustics. It can be seen from the analysis (Appendix D) that users of open spaces on the ground floor and on the first floor are more dissatisfied with the acoustics and the sound privacy, compared to users of other spaces. These correlations should be taken into account and a way should be found to exploit them in order to improve users' satisfaction and the building performance furthermore.

Perspectives towards sustainability and satisfaction

One last important correlation is between how users responded to the question if they think that the building is sustainable and the overall satisfaction (Q14). According to the detail Bivariate correlation with Spearman's rho being significant (p=0.005), which is described in Appendix D, the correlation is significant (p=0.005<0.05) ant the value of Spearman (0.304) indicates a mediocre positive relationship. The more they think and agree that the building is sustainable, the more satisfied they are. This is pictured also with crosstabs in Appendix D.

6.3 Conclusions

This chapter was about describing and analyzing the case study and the results of the survey that was applied on the case study by testing the most important hypotheses formulated in the previous chapter. First, it should be said that the research questions of 'How can these assumptions be tested?' and 'Which are the results after the testing? are answered here.

The answer to the first question is through the survey. However, in order to apply such a survey on a case study, the whole case study has to be researched both from technical and user perspectives. Therefore, after the description of the town hall, the analysis of the

design and current performance, the conclusions were first the possible existence of a performance gap and the need of implementing the survey. The analysis of the design and current performance and their comparison gave an insight into how the sustainable performance may affect users' perceptions regarding technical aspects, which is further investigated through the survey. The answer of the second question is the results from the statistical analysis of the survey, which were also the testing of the formulated assumptions in Chapter 5. The main hypotheses and their results are presented below:

- H1. ''*Users are more satisfied if they are 'green' users*'': Respondents' profile tends to be 'green'. Users are characterized as 'light green' users with 'green user's' basic habits (i.e. turning off the lights/lowering the heat) but they do not invest in other sustainable activities (i.e. photovoltaic/solar energy at home, waste management). In addition, the more green users are, the more satisfied they are, the more familiar they are with the sustainable building and the more satisfied with the operation of the systems and the amount of information they receive.
- H2.''*Users are more satisfied if they have or think that they have control over the systems of the building and the building in general*'': Users are not satisfied with the control they have (i.e. control over the systems as temperature, ventilation, opening of windows). As satisfaction with the control over the systems in the building increases, the overall user's satisfaction increases as well
- H3. *''Users seem to forgive and be more tolerant if they are familiar with the building and know how it works and operates (forgiveness factor)''*: Users seem to be quite forgiving with their working environment and willing to overcome difficulties with the appropriate response and actions. This is also indicated by the high value of the calculated forgiveness factor.

To sum up, the findings of this chapter are first that there is a possible performance gap in the town hall, regarding also the missing link between technical perspectives and user perspectives/satisfaction. Second, after the testing of hypotheses through a survey three influential factors for user satisfaction stand out; how 'green' users are (their environmental awareness), the control they have over the sustainable building systems and the available knowledge and information they have on the systems and the building. The correlations show that the more these factors increase, the more satisfied users are. It could be said that these distinct factors determine user satisfaction. User satisfaction can affect the perspectives of users towards the building performance and this may affect a possible performance gap. In addition, these factors indicate vice versa also how the sustainable building performance (the operation of the sustainable building systems, 'green' features inside the organization) may influence the user satisfaction.

The findings from the town hall in total provide evidence that there are some factors, which can work as stepping stones and mechanisms for maintaining the sustainability of a building inside an organization. This evidence comes from a real case study and can be used in order to formulate some actions and suggested solutions. The reflection of the evidence and the suggested solutions is discussed in the last chapter of reflection.

7 Conclusions and Recommendations

7.1 Introduction

Before analyzing the main conclusions from this research, it is important to understand and explain how the structure of this thesis was and how it evolved during the research. The diagram below shows exactly the starting point of this research, how the research distinguishes design and realization performance, technical and user perspectives, which are the contributions of the literature reviews and the case study and how all of the above helped in forming the conclusions.

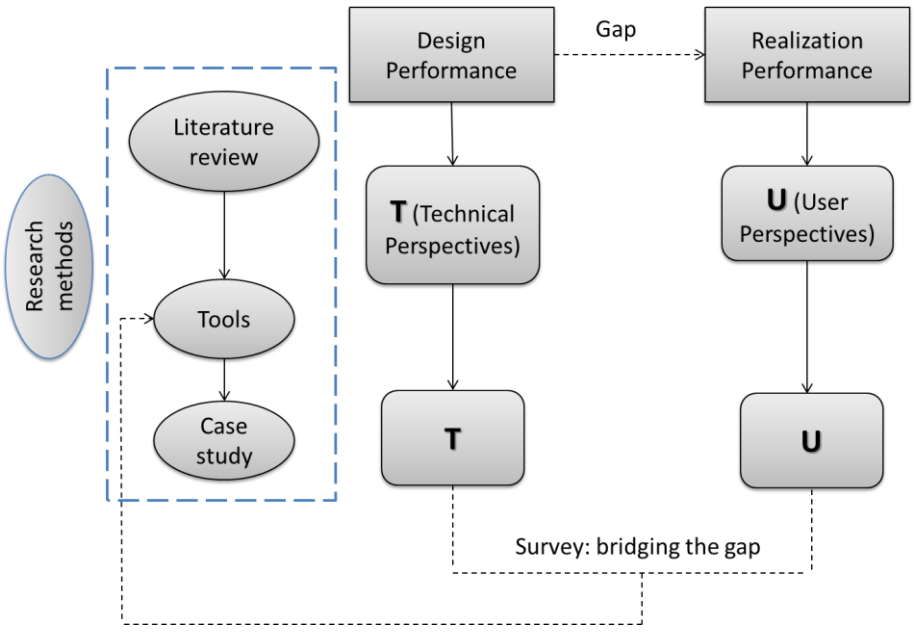

Figure 7.1: Research structure towards conclusions

In order to explain this diagram some points have to be introduced. The object of the evaluation is solving the problem of the phenomenon of the performance gap, the gap between design and realization performance and technical and user perspectives. The main research question was the determination of the relationship between the sustainable building performance and user satisfaction ('What is the relationship between sustainable building performance and user satisfaction?'). It can be said that this research started with literature reviews on monitoring and evaluating the sustainable building performance. The first review was based on existing assessment tools that include criteria and indicators and aim at achieving high sustainable performance levels. The second review was based on evaluation concepts that assess building performance by including the aspect of judgment and the human factor of the user. The third review was based on evaluating the interaction of users and sustainable buildings and performances. These reviews, combined, lead to the

formulations of hypotheses, which were the identification of factors that may influence user satisfaction and the creation of a survey that would include these hypotheses and would help in evaluating and researching user satisfaction. These hypotheses were tested with the help of the case study and the result was the identification of three basic influential factors, which are the environmental awareness (how green users are), the control users can acquire on systems and the knowledge and information users have about the building. It can be said in addition that all three factors have a positive relationship with user satisfaction, which means that the more these factors increase the more satisfied users are. In other words, and according to the diagram, the survey worked as an answer in helping bridging the gap and also at the same time as a way to complete the missing ''user'' features of the tools as it will be described in the suggested solutions.

7.2 Conclusions

After introducing the basic concept and structure of the research, the main conclusions should be mentioned:

- Assessment tools, which evaluate the sustainable building performance lack of criteria involving users and their satisfaction and comfort and focus more on the phases of design and in general before the occupancy phase. Assessment tools measure building performance from a sustainability point of view, pay more attention on technical perspectives and standards and aim to raise the sustainable ambitions of the client (more according to technical perspectives), but lack of including criteria regarding users' involvement and satisfaction (user perspectives)

- The physical and technical performance of buildings is directly linked to the building qualities perceived by occupants. It is of high importance to conduct evaluation processes and keep improving based on the results, in order to maximize building life cycles and at the same time keep users satisfied.

- Evaluation frameworks indicate that the factor of the user and occupant plays a very crucial role in the whole evaluation process. Sustainable building performance is not limited to energy conservation, life cycle costing, and the functionality of buildings. It also focuses on users' perspectives of buildings.

- There is a clear two-way correlation between user satisfaction and good performance of the building and there are factors that influence the interaction and perspectives of users towards sustainable building systems and their satisfaction and comfort. The findings from the case study of the town hall and the applying survey in total provide evidence that based on the formulated assumptions there are factors, which influence user satisfaction. These factors are the environmental awareness of the users, the control they have over the sustainable building systems and the available knowledge and information they have on the systems and the building.

The above-mentioned factors can work as stepping stones and mechanisms for maintaining the sustainability of a building inside an organization. User satisfaction affects and forms the perspectives of users towards the building performance and this may affect a possible performance gap, a missing link between technical and user perspectives inside a building. In addition, these factors indicate also how the sustainable building performance (the operation of the sustainable building systems, 'green' features inside the organization) may

influence vice versa the user satisfaction. The mentioned conclusions indicate the interrelationship between sustainable building performance and user satisfaction that can be shaped by the mentioned factors, which function as stepping stones of maintaining sustainability.

7.3 Suggested solutions

According to the conclusions of this research, some recommendations can be made. These recommendations can be specifically driven from the results of the case study but can also be generalized. Based on the results of the case study, it can be said that it is important for the town hall:

- To make sure that in any case the symbolic items, as the windmills, the lighting system with daylight or the toilets and acoustics work perfectly (either by replacing or fixing them)
- To make sure to implement solutions that respond to the employees' needs for controlling the environment
- To make sure to promote the good points inside the town hall so that users will not focus only on discomfort features as seen in the survey
- To make sure to enhance the green behavior of the employers either with events as ''Green Monday'' or ''Green employer of the month'' or by providing them with more information

One proposed action list for the town hall is listed in Appendix E, which is based on some ideas that have been used already in similar cases. These recommendations can be generalized for sustainable buildings and organizations. It should be noticed that the whole research and the general conclusions have a strong focus on the need and use of evaluation processes. The use of the case study showed how an evaluation could be conducted in reality. The evaluation of the sustainable building performance of the town hall and the evaluation of its users' satisfaction through the survey were included and researched. The remark that should be kept in mind is how building evaluation can help and how it should be integrated into life cycle processes.

The need of evaluation was indicated through the research. It was justified with the possibility of a performance gap and with the unknown extent of user satisfaction. It was indicated in addition at the end, with the two main conclusions: that assessment tools lack of involving criteria for user involvement and satisfaction and that there are factors (three were found out through the case study), which can shape the relationship between performance and user satisfaction. Therefore, a suggested solution for the initial problem statement of the gap between design and realization performance, technical and user perspectives can be the creation of a model that will try to alleviate this gap and keep users satisfied. This can be achieved with integrating building and user evaluation inside the model.

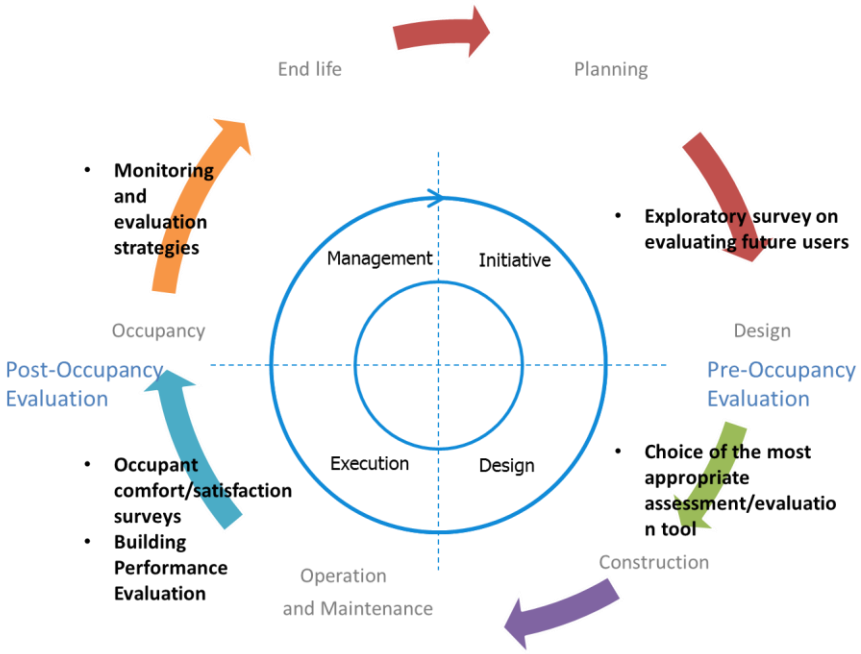

Figure 7.2: Model of evaluation inside life cycle processes

The start can be made already from the first phases, which are the initiative and the design. It is discovered through this research that surveys and users play a huge role during the life cycle of a building. The involvement of the user, even from the early phases of a project, could be proven as fundamental. Although the influence from the user starts to increase intensively after the building is being used and operated. The below diagram indicates a 'possible' situation with the user's influence on the building during the phases. The adjective 'possible' is used because in many situations the user's influence could be zero during the design while in other cases, users' opinions are taken into account with explorative surveys.

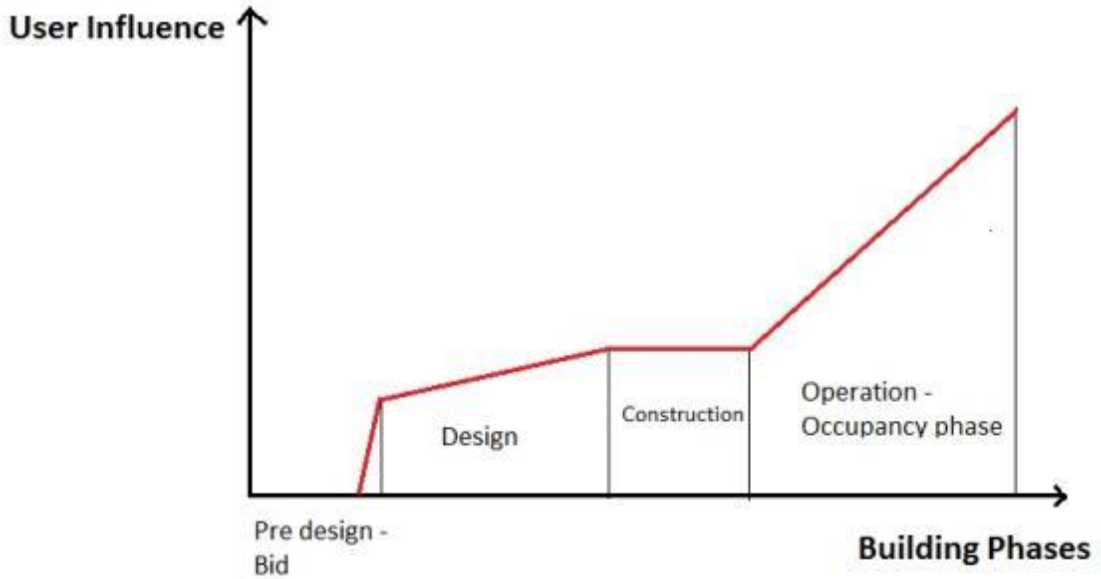

Figure 7.3: Possible diagram of the user influence on each building phase

Before continuing with an ambitious sustainable design, it could be wise to research and evaluate how the future users of the building react to the specific idea and what they think, expect, need and prefer. With the feedback of such a survey, the possibilities of creating a design performance that will match the realization performance could increase. The reason

is that attention will be paid equally on technical and user perspectives. In addition, it would be important to formulate specific goals inside the concept of BPE and create suitable sustainable performance criteria and indicators, as indicated in the theory of Chapter 3.

Moreover, the most appropriate assessment tool has to be chosen from the start, from the design phase. Assessment tools that monitor and measure sustainable building performance have been researched and the conclusion is that criteria regarding user involvement and satisfaction are missing. Therefore, a suggestion is to choose a tool that will include such criteria and most important, occupant surveys as the one created and applied in this thesis. These criteria should focus not only on the design phase but also on the occupancy phase. Assessment tools should entail criteria for both pre-occupancy evaluation and post-occupancy evaluation. It is common for a building to be designed and constructed according to sustainable ambitions and standards and at the end to achieve a high performance that will be confirmed by an assessment tool. However, this does not guarantee its high performance and state during the occupancy phase and if users are satisfied. Due to this fact, criteria that could offer this guarantee have to be added or deeper analyzed inside the tools from the early phases. After describing in the second chapter the most important criteria of such tools, some recommendations can be made in the next section, about what could be a good outline for an evaluation tool. Furthermore, during the phases of execution/construction and management, evaluation could be represented with occupant comfort surveys, building performance evaluations as described in the third chapter, monitoring and measurement strategies, which most of them will be indicated in the criteria that could be the most valuable inside assessment and evaluation tools.

7.3.1 Outline for important criteria inside an evaluation tool

The focus of this research is on the performance of the building in the energy and social field. Therefore, it can be said that the categories of tools as Energy Performance, Social Quality and Function and Management and Monitoring are of great importance. The researched assessment tools have plenty of criteria that refer to the design and to technical perspectives but miss references to the occupancy phase and to user perspectives. In this section, some valuable criteria for this aim, that it is important for tools to include them, are outlined and briefly described.

References to Energy Performance

1. Energy Efficiency Best Management Practices – Optimize Energy Performance

There is a big need in developing documentation on the practices that should be used to achieve energy efficiency and the desired energy performance during occupancy. For this prerequisite, the energy consumption and use breakdown should be monitored, measured and documented. The criterion includes energy audits and the most important is the aspect of developing a report with a graph of annual energy consumption. Up to date monitoring software systems should be used to measure and monitor the building performance. If it is found that the building is relatively sustainably inefficient, operational changes may be needed or even some capital investments for improvements.

The first thing to do is try to identify through the energy audits the areas that are troublesome and the areas that contain the best opportunities for improving efficiency. With the mentioned documentation and the results from the energy audits, strategies have to be created. These strategies will help the organization and the responsible teams (facility managers or technical/management teams) identify opportunities to reduce energy

consumption, which could be cost effective. Examples are changing heating and cooling set points by one or two degrees and reminding occupants to turn off lights and office equipment when not in use (LEEDuser, 2009). This could promote and enhance, furthermore, the sustainable behavior of users.

2. Existing Building Commissioning – Investigation and Analysis, Implementation and Ongoing Commissioning

The previous criterion introduced the significance of conducting energy audits and taking advantage of their results to maintain and improve the energy performance. A next step could be to make a commission for collecting the performance data and check in detail how the building is performing. This commission could be a management or technical committee, if there are some experts in the house. Otherwise, a third party could be hired to do the work. However, outsourcing too many activities may not be so wise, because in the end the organization could end up with not knowing its own building features.

Moreover, an important aspect of implementing a commissioning is to provide staff training. This training can be divided into training programs for occupants and for facility managers, management teams and other groups responsible for the maintenance of the building. Users could be informed through workshops, online courses and newsletters about building's green features and how systems operate. Meetings could be arranged by management staff on a monthly base to give tips to users and to get feedback from the day-to-day use of the building. Another training program could be done with arrangement with the suppliers/contractors of the building systems. They could train some staff, with the help of demonstrations, on how exactly systems work (technical knowledge) and how to react to emergencies.

3. Performance Measurement – Building Automation System (BAS)

Many of the existing assessment tools indicate the necessity of a BAS system in the building. BAS is the same as BMS (Building Management System) used in buildings. These systems are computer-based control systems installed in buildings that control and monitor the building's mechanical and electrical equipment such as heating, ventilation, lighting, power systems, fire systems, and security systems.

References to Social Quality

1. Occupant's Health and Comfort

As it was explained inside the theoretical framework of the literature study and in the case study, occupant's comfort plays a crucial role in assessing the performance of the building. Therefore, it has to be included in the criteria. How comfortably an occupant feels is also closely related to his/her health. Comfort depends on many aspects within a building, as how heating, ventilation, lighting and acoustics perform. Each organization should acquire modern monitoring systems that measure and keep in balance substances that are dangerous for occupants' health (such as volatile organic compounds (VOCs) and formaldehyde, and lead and asbestos in older buildings) and maintaining a satisfying indoor air quality.

2. Occupant Comfort Survey (Thermal, Acoustic, Visual and Indoor Environmental Quality Survey)

Through survey responses, along with energy audits mentioned earlier, troublesome areas can be identified and solutions can be found. Usually, organizations willing to perform an occupant comfort survey create a questionnaire that is incomplete and does not cover all possible occupant comfort categories. These categories could be thermal, visual and acoustic comfort and indoor environmental quality, which focuses mainly on indoor air quality. According to LEED, a thermal comfort survey should be conducted six months after occupancy, should be anonymous and if the result is that more than 20 per cent of the users is dissatisfied then a corrective action plan is mandatory (LEEDuser, 2009). Furthermore, visual comfort is essential because it includes aspects as access to daylight, which could be very influential on occupant's comfort. Users appreciate a working environment full of daylight, because it makes them feel more friendly and cozy. All the above aspects have been proven as essential also through the results from the conducted occupant comfort survey in the town hall.

3. User control possibilities

As formulated with the initial hypotheses and proven through the survey in the case study, the amount of control users have on the building is a factor that influence the user satisfaction and vice versa. In new designs and innovative office spaces, systems usually operate without having an option for the individual user to control them manually. This could lead to low satisfaction levels and increasing energy consumption. LEED indicates the example of the controllability of lighting. ''Adding lighting controls is a great strategy for reducing energy consumption and improving occupant comfort and productivity. They allow occupants to adjust lighting levels to their specific needs, rather than relying on a broadly over-lit space'' (LEEDuser, 2009).

4. Service Quality

A significant criterion is the provision of excellent service quality to the users. Service quality can be found in many sections and spaces within an office building, from the working spaces until the restaurant/cafeteria. A simple example could be the owing of service bikes and their provision to anyone who needs it. One additional example that could increase dramatically service quality and user satisfaction at the same time is the creation of a help desk facility. This could become the quickest and easiest solution for the users when dealing with some problems or when wanting some information. Of course the responsible persons of the help desk should acquire all the 'easy to find' information and for something outside of their scope they should know to whom they could send the user for further information.

5. Functionality

Apart from having excellent service quality and desired levels of occupant comfort, the functionality of the building should be high as well. By functionality, it is meant the amount of flexibility there is in the building. The office layout must be desirable and easy to use by the employees. This requires space efficiency and suitability for conversion. Users should feel comfortable in their own space and in all the spaces where they might work due to policies as the flexible working ('Nieuwe Werken'). It is not only important to feel satisfied with the personal workplace but with the overall space in general. If a problem occurs, as increased noise levels, then if the building is functional, a change (creation for artificial silent

rooms) could be easy. However, it should be kept in mind that this does not mean that a user should take the initiative and convert the office layout without consulting someone responsible because such a change could cause problems in the systems of the building.

6. Education, knowledge and environmental awareness

Apart from the occupant's surveys that should be conducted as described earlier, actions should be done in order to promote 'green' behavior and enhance the sense of awareness and responsibility. This is proven as a significant influential factor and therefore, policies and strategies have to be created. Implementing a strong waste policy or organizing seminars with a green intent could help users feel more environmental friendly. Moreover, as it will be described later, the existence of a manual and the availability of information that could enhance the knowledge of occupants regarding the systems and services of the building, is of great importance.

References to Management and Monitoring

1. Inspections and Commissioning

A management team, which usually consists of facility managers and persons with technical knowledge, should be in charge of audits and make sure that everything goes according to plan.

2. Thermal Comfort Monitoring

One specific criterion that applies on the occupant's comfort is the thermal comfort monitoring. This criterion addresses the conditions that building occupants experience, not the measured conditions inside the heating, ventilation systems. This criterion has a more management nature and this is why it is not included in the first category of energy performance.

3. Maintenance and Green Policy

Except for audits and commissioning, other factors play a role in the maintenance of the building. This is determined by the green policy each organization follows. Usually under such policies, the most important issues of sustainability are cleaning and waste management. Green cleaning policy and green cleaning program are two relevant factors.

Along with the appropriate green cleaning equipment, this program should be implemented and observed. Moreover, in order to promote ideas such as recycling and waste separation, easy practices should be applied. Users tend to overcome the fact of recycling when there are no clear indications that they should so (as proven in the case of the town hall). For instance, trashcans should somehow make it obvious for the user where to throw each waste.

Figure 7.4: Recycling trash signs with four different colors (123RF, 2013)

The above figure indicates an example of how these bins could be. Of course, they will be smaller for office use. An indication for their use should be labeled on them. For instance, BLUE = PAPER, YELLOW = CANS, RED = GLASS and GREEN = PLASTIC. With the use of colors and with the label on the garbage bins, the user will not overthink and the goal of recycling will be achieved.

4. The 'Energy Guide Manual'

BREEAM NL suggests the use of a user manual that should be given to all general users and to facility managers. However, not all information and guidelines are addressed to the users. Some material is only for managers to take care of activities that users may not even understand. Therefore, it was decided to name the whole document as 'The Guide' and it will have two parts, the 'Operation and Maintenance Manual' and 'Building User Manual'.

First, it will be indicated what the 'Building User Manual' shall definitely include. A report should be included, written in simple and everyday language so that any user can understand it, with building services information, information on how things work and what does not work. A second report should be on energy information. New technologies and the control of them should be explained to the user and some visual proof (simple graphs) about the energy consumption and the performance of the building should be provided. Other reports should contain information on transport possibilities, as explained earlier and a description on the waste policy of the organization. In simple words, it should be explained to the users how they can use the garbage bins in order to recycle and promote sustainability.

Furthermore, it will be indicated what the 'Operation and Maintenance Manual' shall definitely include. A report should be included, written in language with technical terms, with building services information, information on how things work and what does not work in detail and with underlying strategies. The second report is about energy. Information on all new technologies, on how to control them in detail, on energy consumption from every system in the building and on precise analyses of the performance should be first described. Moreover, information on monitoring strategies, metering and maintenance should be also included. Another report should contain the waste policy of the organization, referring not only to guidelines on how to recycle but also on other things concerning waste management. Reports should exist with the information and contact details of all suppliers, contractors and installers, so that managers could find out anytime information on systems that they do not own and in general they should be able to communicate fast with the suppliers so that they can adjust the systems in a case of urgency.

It is explained in the above section, how a good outline for the criteria of an evaluation tool could look like and what important monitoring strategies and evaluation surveys could be applied. This evaluation tool should follow the life cycle of the building and the model that is indicated in Figure 7.2. This outline, along with assessment tools and evaluation processes could solve the problem of the performance gap and the missing link between technical and user perspectives.

8 Reflection and further research

After concluding this research study, it is crucial to reflect on the process, the research methodology, the limitations that appeared and what is gained on personal level. Reflecting can lead into suggestions for future research on this field, which will be indicated at the end.

To be critical on the use of the case study, it has to be indicated that not so much technical information was available for the current sustainable performance of the town hall. The most possible reasons are the limited time of the research (when we asked for specific information until I finished the report) and the use of Dutch in the most official documents with information. However, through interviews and walkthroughs in the building and talking to responsible people of the operation of building systems, the needed information to identify a performance gap or not, was gathered. On the other hand, more information on technical perspectives could be of great help and possibly would have increased the validity of the result.

Moreover, another limitation was the use of only one case study for the conduction of the survey. It has to be noticed that even if the results are derived from one case study only and cannot be generalized for instance for all sustainable town halls in the Netherlands, they can work as evidence for conclusions and help in the formulation of recommendations how to bridge the gap (*between technical and user perspectives and design and realization performance*).

In addition, the role of the survey was two-fold. It functioned as research method to explore factors that influence user satisfaction and the interaction between users and building systems, but also as a part of the solution to the main conclusion that assessment tools lack of criteria regarding users' involvement. This survey can be used as a blueprint for other occupant comfort surveys in other sustainable buildings with the necessary alterations or additions (as for example adding a question for work productivity and connect it to the performance or a question for the user expectations from the design).

The personal findings from this research is that I gained insight into the way sustainable town halls and office buildings can be constructed in the Netherlands, how municipalities deal with green policies and sustainability and how users react to that. Even if the creation of a survey was my first attempt, I learned how a questionnaire should be formed in order to be user friendly and easy to be answered and how users of an organization can be reached more easily. I also noticed that sometimes people could be suspicious when it comes for expressing opinions for their own organization and you need to deal with this. However, the most important thing that I learned is how important is the role of the user inside a sustainable building, with all the possible ways that can interact with it and influence its performance and how beneficial and effective it might be when the user is involved even from the beginning. Finally yet importantly, I think that this research boosted my environmental awareness and my green behavior towards sustainable buildings.

Recommendations for further research

This research intends to address the research questions discussed in the first chapter, but also creates space for further discussion and ideas for future research. First, the most suitable suggestion for future research is the use of more case studies in order to have more evidence and be able to generalize the three factors that popped out form the case study of Leiderdorp. More town halls in the Netherlands, or even abroad, can be researched and then the result will have an increased validity and credibility. It can be interesting enough to include case studies with sustainable buildings that perform as promised and find out which factors stand out then and affect user satisfaction.

Furthermore, as indicated in previous chapters, there are many kinds of surveys that could be conducted in order to investigate the interaction between users and building performance. The aspect researched in this thesis was to find out to what extent users are satisfied and furthermore, the interaction regarding how the sustainable building performance influences user satisfaction. Another aspect that could be also investigated is the factor of productivity. It would be useful to be able for future research to determine which is the relationship between employees work productivity and sustainable building performance.

Moreover, additional aspects that could be involved in further research are of economical nature. It could be researched how the factor of cost could influence initial decision-making and the sustainable performance of a building from the beginning. It could be said that some designs are awarded based on the most cost effective option and this could influence the sustainable building performance afterwards. In addition, the research of the most appropriate use of contract would be useful. Contracts should entail a green intent but at the same time should have provisions for the monitoring of the performance during the occupancy phase.

In general, this research provides an opportunity of creating an evaluation tool that will entail standards regarding both technical and user perspectives. The survey showed how important is to be part of such a tool and evaluate the users of a building. In this way, with such an evaluation process and assessment tool, the sustainable building performance will be monitored and evaluated and users will be kept satisfied.

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Appendixes

Appendix A

- **A1: Literature review on qualitative assessment tools**

- LEED (U.S.A.)

Organization and roots of the tool

In 2000, the U.S. Green Building Council (USGBC) established the LEED green building rating system as a way to define and measure green buildings. LEED is an internationally recognized green building certification system, providing third-party verification that measures how well a building performs across the factors that matter most: Impact on the land, Energy savings, Water efficiency, CO2 emissions reduction, improved indoor environmental quality, stewardship of resources. At the beginning, it was developed through a consensus process that included non-profit organizations, government agencies, architects, engineers, developers, builders, product manufacturers and other industry leaders. In the process, LEED has grown from one rating system that could be applicable only on new construction to a combiantion of rating systems that could be used in the whole lifecycle of buildings (U.S. Green Building Council, 2011).

Participation and Certification

LEED provides the interested parties that are usually building owners, a concise and precise framework for the whole life cycle, for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions. LEED certification is obtained after submitting an application documenting compliance with the requirements of the rating system as well as paying registration and certification fees. Certification is granted by the Green Building Certification Institute (GBCI). The application review and certification process is handled in LEED Online. After deciding that LEED is suitable for a project, the next step is to register the existing project. Then, once the rating system has been determined and the appropriate registration fee has been paid, the project will be immediately accessible in LEED Online. The fees are indicated in the next table (GBCI, 2013).

	Project Gross Floor Area in Sq Ft (excluding all parking areas)			
	Less than 50,000	50,000-500,000	More than 500,000	Expedited Review
Registration				
USGBC members	$900			N/A
Non-members	$1,200			
Recertification Registration: contact customer service to request a promo code				
USGBC members	Free			N/A
Non-members	Free			
Initial Review	Flat rate	Per Sq Ft	Flat rate	
USGBC members	$1,500	$0.03/sf	$15,000	$10,000 surcharge
Non-members	$2,000	$0.04/sf	$20,000	
Recertification Review	Flat rate	Per Sq Ft	Flat rate	
USGBC members	$1,500	$0.03/sf	$15,000	$10,000 surcharge
Non-members	$2,000	$0.04/sf	$20,000	
Appeals				
Complex credits	$800/credit			$500/credit surcharge
All other credits	$500/credit			
LEED Interpretations				
USGBC members	$180/credit			N/A
Non-members	$380/credit			
Project CIRs	$220/credit			N/A

Figure 5: Costs for LEED participation

Requirements for participation in this tool and use this tool on a project is by being personally involved. Personal involvement means that any party can be able anytime to demonstrate how an individual or a project team has contributed to the project through active participation.

Decision-making

The U.S. Green Building Council is responsible for any decisions made and for the content of LEED. Through their board of directors and their experts, who are called LEED Ap's, the content and all the activities concerning LEED and LEED for Existing Buildings, which is the subject category in this research, are defined.

Type of groups-users, possibilities of training and provided information

There are many parties and users that could be interested in applying LEED and indeed the group of users that implement LEED on their projects are: professionals, including architects, real estate developers, facility managers, project managers, engineers, interior designers, landscape architects, construction managers, lenders and government officials and authorities. They all use LEED with the goal of achieving excellent levels of performance, by transforming the built environment to sustainability. LEED is widely used by the government section, which includes state and local governments across the country. They adopt LEED for public-owned and public-funded buildings.

Furthermore, according to the training of individuals that are not quite familiar with the application and function of LEED, there are many possibilities. First of all, the description and guidelines being online are very informative, simple and anyone can have access to it without further credentials. Second, the teams behind LEED organize also workshops for better guidance by face to face, new online courses which are free and webinars are also being planned (U.S. Green Building Council, 2011). The intention of training is not providing an extensive green expertise but a modest level of training to all staff involved in the project and not only to members of design teams or parties and persons directly involved in it but also to occupants and other parties who participate indirectly. It is a low-cost way to enhance commitment to green to developers and the public. In this way, it can be ensured that all will recognize key green development strategies in new project applications (U.S. Green Building Council, 2011).

Education of the staff/employees can start with letters to all occupants providing information on the institution's sustainability goals and policies, an explanation of LEED and information about the building's green features. Electronic newsletters and monthly tips are also useful. Agencies or departments should hold meetings to help staff stay informed and to implore feedback about the building's day-to-day use. Installing signage is another way to educate occupants about the different green features and it can be installed in public areas of buildings to educate visitors as well (U.S. Green Building Council, 2011).

LEED and regulations

LEED, as it is mentioned earlier, has five categories: sustainable sites, water efficiency, energy & atmosphere, materials & resources and indoor environmental quality. All these rating systems and categories have to be in accordance with local and national regulations. Although, in some fields, LEED is trying to be more ambitious and overcome any barriers or restrictions that regulations may create. One example is the extension LEED-ND (Neighborhood Development) in the section of sustainable sites that tries to encourage all projects to meet high standards by obeying only the minimum standards of regulations (U.S. Green Building Council, 2012).

Moreover, some examples of regulations and local codes and their relation to sustainable development are the prohibiting of building narrower streets and locating parking behind or beside buildings (U.S. Green Building Council, 2012).

Involvement and participation of government authorities

USGBC is responsible for the development of LEED. USGBC is sometimes confused for a government agency or entity, but it is not and this results in the fact that government is not involved in the development of LEED. USGBC is a private, membership based non-profit organization that promotes sustainability in how buildings are designed, built, and operated. USGBC is a community of member companies and organizations of all sizes, in every sector of the industry (U.S. Green Building Council, 2012). The role of these members can be advisory (from experienced technical companies) and commentary and reviewing (from stakeholders and other interested parties.

One of the first adopters of LEED was the U.S. General Services Administration (GSA), which manages much of the federal government's real estate portfolio. The federal government is the nation's largest real estate owner and lessee and started implementing a LEED policy immediately towards sustainability. One role model example is Seattle, which was the first city to enact a LEED mandate for municipal buildings, requiring Silver certification in 2001 (Hart, 2009).

So, USGBC is committed to support federal, state and local governments in their pursuit and development of green building programs and initiatives. This is proven by the wide use of LEED that is found in 442 localities (384 cities/towns and 58 counties and across 45 states), in 34 state governments and in 14 federal agencies or departments (Hart, 2009).

Use and application of LEED

In general, as stated also above regarding government authorities, LEED is widely used and a large amount of projects is certified with it, as the next table indicates. It is even more obvious regarding the top 10 U.S. States.

Top 10 States based on Registrations & Certifi-cations

	Certified?		
State	No	Yes	Grand Total
CA	4,119	1,807	5,926
TX	1,998	760	2,758
NY	2,062	597	2,659
FL	1,922	551	2,473
PA	1,222	489	1,711
IL	1,028	583	1,611
VA	1,165	427	1,592
MD	1,116	333	1,449
GA	1,051	371	1,422
WA	804	517	1,321
Grand Tot..	16,487	6,435	22,922

Figure 6: Registrations and Certifications fees

According to the category of LEED for existing buildings that is more relevant for this research, the use is also extensive. LEED for Existing Buildings: Operations and Maintenance or LEED-EBOM, began in 2008. LEED-EBOM certifications had an upward trend ever since. Currently, there are about 640 million square feet certified under the existing building standard and 625 million certified as green new construction (Guevarra, 2011).

Minimum project requirements and prerequisites

To register and take part in the category of LEED EB, the building must be occupied for at least 12 months with 75% occupancy rate or greater per industry standards for building type. Moreover, it has to meet all regulatory requirements for hazardous material management (PCB/Asbestos/Mercury in lamps) and waste water discharge. A minimum three-month performance period required for all credits is pursued (Sidebottom, 2009).

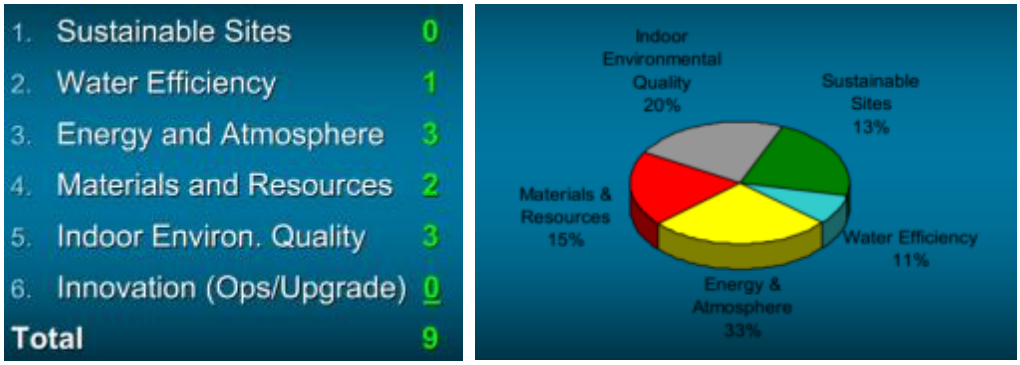


Figure 7: Minimum project requirements and criteria

The persons responsible for requiring the performance data and check in general if the project complies, is the Existing Building Commissioning. LEED Committees are responsible for the development, implementation of, and revisions to LEED rating systems and their implementation on the buildings. The Administrative-Management Committee (AMC) assists the LEED Steering Committee in monitoring procedures and the results are held by the later. Improvements, suggestions and possible strategies can be proposed along with the help of the LEED Technical Committee (U.S. Green Building Council, 2013).

- GPR (The Netherlands)

Owing and management of GPR

'GPR gebouw' is a web tool designed by principals, councils, architects and consultants. The tool enables the performance of a building to be measured and its sustainability to be determined by scanning the design data. The package was developed by the City of Tilburg and was launched by W/E Consultants. GPR expresses the sustainability performance of buildings in terms of scores. W/E consultants are a consultancy agency. They advise, communicate and carry out research in the field of sustainability with a focus on energy, building physics and environmental quality. W/E consultants developed the GPR software in order to advice organizations, companies and individuals on a sustainable way of building. W/E consultants provide project and implementation advice tailored to professional construction parties (GPR Gebouw, 2012).

Participation in the assessment process

GPR Building is designed for municipalities, property owners, architects, housing associations, project developers and consultants. Moreover, a large number of universities in the Netherlands use GPR Building in their curriculum. It is licensed to over 400 organizations across the Netherlands, accounting for over 5000 users. English and German translations are available for a selection of the software (GPR Gebouw, 2012).

Decision - making

GPR Gebouw has been developed, as mentioned, by W/E consultants in close cooperation with the municipality of Tilburg. W/E consultants in close cooperation with the municipalities of Tilburg and Groningen have developed GPR Urban Planning. GPR Maintenance has been developed by W/E consultants and Delft University of Technology. Although decisions that have to be made for the tool itself, the process and other changes, are made by W/E consultants.

Use of GPR, costs and training

GPR Gebouw is designed for the parties that were indicated (municipalities, architects, developers, housing associations, property owners, and consultants). Moreover, a large number of training programs in the Netherlands work with GPR software. Any party can use GPR, as long as this party has acquired the respective license. There are no ex ante requirements or prerequisites. Although training is required to use this tool, its simplicity and the comfortable way to use it on a web-based format make it easier. Many consultancy companies (i.e. Cleanfield) offer a training program on GPR Gebouw. According to costs, the next figure indicates how costs are attributed:

Organisatielicentie	Kosten	Incl. introductiecursus voor
1 Gebouw	€ 275,-	/
All-in 10	€ 1.100,-/jaar € 250,- instapkosten	1 deelnemer
All-in 20	€ 1.650,-/jaar € 250,- instapkosten	1 deelnemer
All-in 50	€ 2.750,-/jaar € 500,- instapkosten	6 deelnemers, in-company mogelijk
Onbeperkt	€ 3.300,-/jaar € 500,- instapkosten	6 deelnemers, in-company mogelijk

Architectenbureaus en zzp'ers ontvangen 50% korting op jaarlijkse abonnementskosten van GPR Gebouw. Indien van toepassing graag vermelden in licentieaanvraag.

Figure 8: GPR costs

GPR and regulation

For buildings, the Dutch National Building Act 2006 is used as a benchmark: when a building is rated with 6 on every indicator, it means that it meets the requirements of the Building Act. Thus, architects can also use the GPR software to prove the compliance with the building regulations on specific indicators. GPR Building has been recognized as a national standard by the Dutch public authorities for sustainable procurement and for tax relief schemes (the so called Vamil and MIA scheme for businesses). The Energy performance is based on the Dutch National standards for new and existing buildings and it complies with the European Building Directive. The latest versions of GPR (GPR Gebouw 4.2) are entirely in in accordance with the Building Act 2012 (GPR Gebouw, 2012).

Government involvement

As it is indicated in the above paragraphs, government in the form of municipal authorities has helped in developing two of the forms of GPR. The municipality of Tilburg has helped in GPR Gebouw and in GPR Urban Planning along with the municipality of Groningen.

Wide use of GPR

GPR has been used widely in the Netherlands and this can also be proven by the number of licenses that are given. Total number of licensees is 409, which is attributed in architects (63), corporations (17), municipalities, regions, environmental services and government (186), educational institutions (13), developers, real estate, maintenance and management (59) and consultants (71) (GPR Gebouw, 2012).

Monitoring according to GPR

A monitoring procedure is required during the use of GPR, starting from the initial phase of the lifecycle of a building. It would be of best interest to take the example of a possible municipality that will make use of this tool. First, the municipality and market parties make together agreements about ambitions and then the municipality translates the ambitions into performance requirements. The sustainable building tool GPR then starts and the municipality enters the performance requirements into the software. The architect enters the design data into the GPR tool. From the start and during the whole design process: (intermediate) results can be monitored and compared to the requirements. During the design, there is a dialogue between the municipality and the architect. If the design does not meet the requirements, then they look for possible improvements together. The municipality keeps in touch to monitor the (intermediate) results and it can adjust requirements if those appear to be unrealistic. Eventually the project is submitted to the municipality for approval (GPR Gebouw, 2012).

Time scale of monitoring and recommendations on results

The time horizon is not specified but the results are usually delivered to the architect or consultant that is responsible for the project. GPR (at least for the design) does not have from its own any recommendations and the architect takes over this role. Nevertheless, the version of GPR for existing buildings should entail recommendations for existing buildings from analyzing possible scenarios.

• DGNB System (Germany)

Organization of DGNB

The German Sustainable Building Council (DGNB - Deutsche Gesellschaft für Nachhaltiges Bauen) was founded in Stuttgart in 2007. In an effort to promote sustainable building, the

non-profit organization has developed the DGNB Certificate, a certification system to assess buildings and urban districts that demonstrate a high level of environmental and economic efficiency, conserve resources and offer users optimized comfort. The DGNB has more than 1,100 members from all branches of the German construction and real estate industries. Moreover, DGNB has numerous partners around the world and this enables and ensures international adaptation and application of the system (DGNB System, 2013).

Participation and requirements

Any natural adult, corporation, institution, research center, company, or legal personality involved in construction can become an ordinary DGNB member. Membership applies to the entire organization. By the term natural persons, it is meant freelancers and those who do not pursue a commercial or professional interest. If membership is not exclusively personal, the membership fee shall be determined based on the future member's employer/firm. Therefore, only members of DGNB can use it in their projects (DGNB, 2010).

Decision - making

Inside the DGNB, which decides first for the content of the DGNB System, there is also a DGNB Academy. This academy includes DGNB registered professionals, consultants and auditors. All the three contribute to the process of developing new versions or extensions of the current system by using their expertise knowledge.

Use of DGNB, costs involved and training

First, for the above-mentioned membership, there are fees. For instance, a consulting agency with up to 5 employees has to pay 500 Euros as an annual fee and a University has to pay 2000 Euros as an annual fee. Furthermore, the costs for the certification process are indicated in the next figure:

	DGNB Mitglieder			Nicht-Mitglieder der DGNB		
Projektgröße (BGF in m²)	< 4.000	4.000 bis 80.000	> 80.000	< 4.000	4.000 bis 80.000	> 80.000
Vorzertifikat (Projekt in Planung / Ausführung)	2.000 €	2.000 € + 0,13 €/m²	11.880 €	4.000 €	4.000 € + 0,13 €/m²	13.880 €
Zertifikat (Fertiggestellte Projekte)	3.000 €	3.000 € + 0,33 €/m²	28.080 €	6.000 €	6.000 € + 0,33 €/m²	31.080 €

Figure 9: DGNB costs

Involvement of the government

As it is stated in the introduction, the German Sustainable Building Council was founded in 2007 by 16 initiators from various subject areas within the construction and real estate sectors. The aim was to promote sustainable and economically efficient building even more strongly in future. German government initiated the idea for making such a council in 2007 and ever since is trying always to promote and support DGNB with any possible mean (DGNB, 2012).

Wide use of DGNB

By the beginning of 2008, 121 organizations had already joined the DGNB. Today the association has more than 1,100 members throughout the entire world. The vision for 2050 is a sustainably built and livable future. There are more than 500 experts, who support DGNB on a volunteer basis. These experts are architects, investors, project developers, scientists, builders and other specialists from the construction and real estate sectors. Moreover, on an international base, DGNB has certificates in Luxembourg, Austria and Switzerland and soon in Bulgaria, Hungary, Russia and China will follow (DGNB, 2012).

- Open House (European Union)

Organization

In order to achieve the OPEN HOUSE objectives, a multidisciplinary strong consortium has been created. This consortium is able to stimulate any kind of stakeholders from the entire supply and value chain. It will provide complementary scientific and technical knowledge for performing the research tasks, and skills for the dissemination and exploitation of the results. It is composed by 20 organizations covering 11 countries. It has been configured with a contribution of large companies with strong research capabilities, research organizations, end users and policy makers (Open House, 2013).

Participation and government involvement

OPEN HOUSE is a tool that was designed from the beginning with an aim to come closer to users around the world that want to embrace sustainability. Therefore, its open and transparent character specifies that this is a tool for everyone. It is striving to represent an open and transparent procedure for the public. The results are regularly public consultations through the OPEN HOUSE Platform, training activities for stakeholders, assuring in that way methodology's proper implementation and its continuity. Moreover, this process and its character contribute to the automatically suitability of the tool for all European countries. It has a user-friendly methodology, supported by an interactive web tool (OPEN HOUSE Platform) that will facilitate the communication and interaction between the building stakeholders. Anyone can have access to documents, criteria, systems and guidelines after request. Moreover, judging from personal experience, there is always a quick response with log in details. Users can be individuals, architects, engineers, consultants, companies and they can share their ideas and opinions on the tool in a forum created on the website. The given comments and suggestions are taken into account by the team behind OPEN HOUSE. Moreover, government authorities are not involved in the creation of the criteria and requirements of the tool. Main identified gaps and barriers regarding methodologies for the sustainability assessment of buildings, are the facts that there is no common understanding on the concept of sustainable building in Europe and no common European sustainability standards are finalized yet. Still unresolved issues regarding accessibility, weighting, variables such as building type, target user and climate are on the agenda. There is also lack of the necessary transparency and open engagement during the process of defining the methodology and not enough efficient software platforms to create awareness and use. Most of the methodologies are proprietary models (Payramale, 2013).

Categories and criteria

Environmental Quality	
1.1	Global Warming Potential (GWP)
1.2	Ozone Depletion Potential (ODP)
1.3	Acidification Potential (AP)
1.4	EutrophicationPotential (EP)
1.5	Photochemical Ozone Creation Potential (POCP)
1.6	Risks from materials
1.7	Biodiversity and Depletion of Habitats
1.8	Light Pollution
1.9	Non-Renewable Primary Energy Demands (PEnr)
1.10	Total Primary Energy Demands and Percentage of Renewable Primary Energy
1.11	Water and Waste Water
1.12	Land use
1.13	Waste
1.14	Energy efficiency of building equipment (lifts, escalators and moving walkways)

Social / Functional Quality

2.1 Barrier-free Accessibility
2.2 Personal Safety and Security of Users
2.3 Thermal Comfort
2.4 Indoor Air Quality
2.5 Water Quality
2.6 Acoustic Comfort
2.7 Visual Comfort
2.8 Operation Comfort
2.9 Service Quality
2.10 Electro Magnetic Pollution
2.11 Public Accessibility
2.12 Noise from Building and Site
2.13 Quality of the Design and Urban Development of the building and Site
2.14 Area Efficiency
2.15 Conversion Feasibility
2.16 Bicycle Comfort
2.17 Responsible Material Sourcing
2.18 Local Material

Economic Quality

3.1 Building-related Life Cycle Costs (LCC)
3.2 Value Stability

Technical Characteristics

4.1 Fire Protection
4.2 Durability of the structure and Robustness
4.3 Cleaning and maintenance
4.4 Resistance against hail, storm high water and earthquake
4.5 Noise Protection
4.6 Quality of the building shell
4.7 Ease of Deconstruction, Recycling, and Dismantling

The Location

6.1 Risks at the Site
6.2 Circumstances at the Site
6.3 Options for Transportation
6.4 Image and Condition of the Location and Neighbourhood
6.5 Vicinity to amenities
6.6 Adjacent Media, Infrastructure, Development

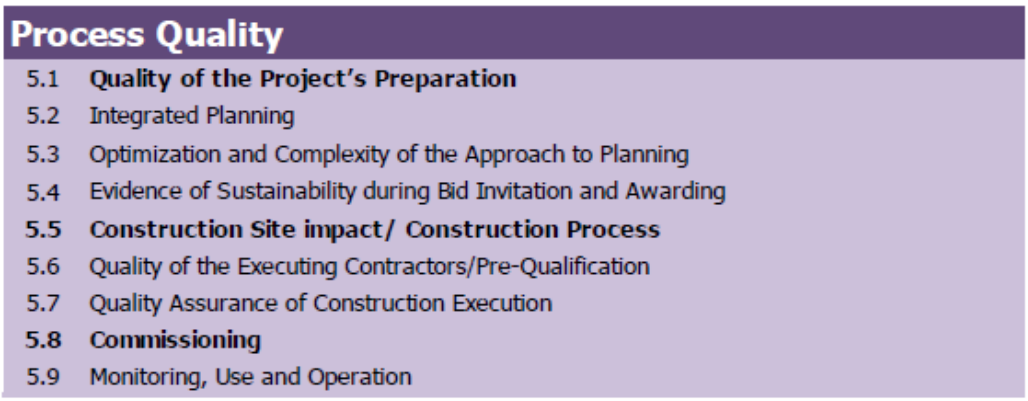


Figure 10: Categories of OPEN HOUSE

- BREEAM NL (The Netherlands)

Aims and objectives

BREEAM was the first assessment tool that was established and consequently its aims and objectives were result of a greater idea for environmental performance. Firstly, the impacts that buildings were causing to the environment have to be eliminated, a label or certification or something that could guarantee the environmental performance of a building is required and to stimulate demand for sustainable buildings. Furthermore, main objectives are to ensure that best environmental practices are applied on buildings, to challenge the market and many sections of various industries to be more innovative and in general to to raise the awareness of owners, occupants, designers and operators of the benefits of buildings with a reduced impact on the environment.

Categories, Weighting and Scoring

A BREEAM standard covers issues in categories of sustainability as Management, Health and Well Being, Energy, Transportation, Water, Materials, Waste, Land Use and Ecology and Pollution. Each category consists of a number of issues and criteria. Each criterion contributes to accomplish the main aims and objectives by defining a target performance and assessment criteria that must be met to confirm the target has been achieved.

Each category has a certain weight that has to be taken into account for the overall scoring. The weights follow from research-based consensus among different groups including government, suppliers, manufacturers and research institutions. This research was conducted at first by BRE to determine the relative importance and contribution and then the weight of each category. The Netherlands has not yet performed own research / stakeholder analysis and that is why the same weighting as BREEAM International is currently maintained. Therefore, these can be called weights after agreement rather than scientific weightings. The weighting percentages may change over time given societal developments.

Category	Weighting
Management	12%
Health & Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12.5%
Waste	7.5%
Land Use & Ecology	10%
Pollution	10%

Figure 11: Categories and weighting

As mentioned in the introduction, the scoring of BREEAM NL is based on the following scale:

BREEAM-NL Rating	Score
PASS	≥ 30%
GOOD	≥ 45%
VERY GOOD	≥ 55%
EXCELLENT	≥ 70%
OUTSTANDING '	≥ 85%

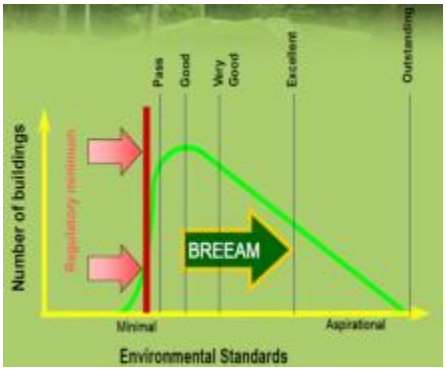


Figure 12: Scale of measuring and scoring

Application

BREEAM NL is an assessment tool that can be executed for projects as new build, large-scale renovation of existing buildings, new extensions to an existing building. Thus, existing buildings do not fall under this scheme, there is a separate method (BREEAM Existing Building) being developed. This method is not yet fully developed and released in the Netherlands but it is in the UK as BREEAM In Use and this is what is going to be described later, taken as a hypothesis that the Dutch version will be similar enough, judging also from the main BREEAM part. Moreover, the building types that are assessed are housings, offices, retail / retail premises, schools and industrial Buildings.

BREEAM and Key Performance Indicators (KPIs)

The method assessing a buildings environmental performance is based on the use of KPIs. Key Performance Indicators are probably the most common benchmarking experience that construction companies and other organizations will have encountered. A Key Performance Indicator (KPI) is the measure of a process that is critical to the success of an organization. A quite big number of performance measures exist that define the success of a project or organization. In relation to BREEAM, these indicators can be called Environmental

Performance Indicators. They are designed to look at the environmental "footprint" of a building, in terms of energy use, water use, impact on the local environment and transport issues. As BREEAM is an environmental assessment method and quality standard used to assess and review the environmental performance of buildings, it uses the above mentioned indicators (Swan and Kyng, 2004).

Organizing and beginning of BREEAM NL

The Dutch Green Building Council (DGBC) is an independent organization that has developed a sustainability label for new Dutch buildings. DGBC is a foundation that certificates issued to clients that the degree of sustainability of their building or area have them assessed according to predetermined criteria. The DGBC is supported by a large number of organizations who all have ambition and the sustainability objectives of the DGBC subscribe. These are active participants in the development and continuous improvement involved.

Decision making

A large number of people were involved in translating BREEAM to the Dutch situation. First, there is the Advisory Group. They give advice to the Board DGBC when it comes to substantive decisions. This is similar to a National Board of Experts. All credits and parts of the label by the Advisory Group reviewed and approved by the board.

Fees and training

There is training programs that are organized by DGBC and are divided into courses in the different sections of BREEAM NL (as General, New, Existing) and depending on the level of training someone would want (basic, expert, expert with certification etc.). However, these trainings could be costly. For instance a basic training for a member costs € 562.50 and for a non-member € 750 (DGBC, 2013). Moreover, the fees to acquire the method and implement it in a project are shown in the next figure:

Costs for certification

	Partaker	Non-Participant
BREEAM -NL New Certification including registration fee	See "Offset"	See "Offset"
BREEAM -NL New Bespoke excluding costs for bespoke development process.	€ 3,281.25	€ 4.375, -
Re-submit assessment report from the fourth report, submit a	€ 375, -	€ 500, -
	Partaker	**Non-Participant**
BREEAM -NL In-Use Certification	€ 1,406.25	€ 1.875, -
BREEAM -NL In-Use Re-submit assessment report from the fourth report, submit a	€ 375, -	€ 500, -
	Partaker	**Non-Participant**
BREEAM -NL Area Development Certification including registration fee	€ 5.625, -	€ 7.500, -
BREEAM -NL Area Development Re-submit assessment report from the fourth report, submit a	€ 375, -	€ 500, -

Figure 13: BREEAM costs for certification

BREEAM NL In Use

According to the English framework of BREEAM, an extension was created to evaluate existing buildings that is called BREEAM In-Use. At first place, it was created to help building managers reduce the running costs and improve the environmental performance of existing buildings. It consists of a standard, easy-to-use assessment methodology and an independent certification process that provides a clear and credible route map to improving sustainability. Its aim was to pass the idea that environmental impact lies in better management and improvement of the existing building stock and to encourage better building management and targeted investment in existing building stock (Breeam, 2013).

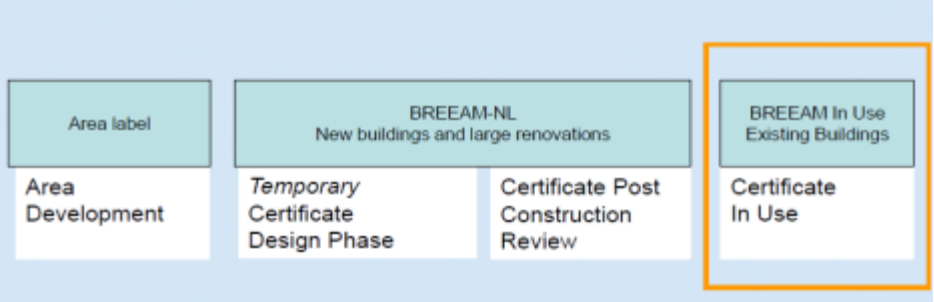


Figure 14: The extension of In Use for BREEAM NL (DGBC – BREEAM, 2010)

A2: Standards of Open House

Environmental Quality

LCA Indicators

Date: ***current date of edition***
Project Name: ***name of the current project***

1. Indicator Information

The current assessment form is valid for all indicators basing on a Life Cycle Assessment (LCA):

- Indicator 1.1 Global Warming Potential
- Indicator 1.2 Ozone Depletion Potential
- Indicator 1.3 Acidification potential
- Indicator 1.4 Eutrophication Potential
- Indicator 1.5 Photochemical Ozone Creation Potential
- Indicator 1.9 Non-Renewable Primary Energy Demand
- Indicator 1.10 Total Primary Energy Demand and Percentage of Renewable Energy

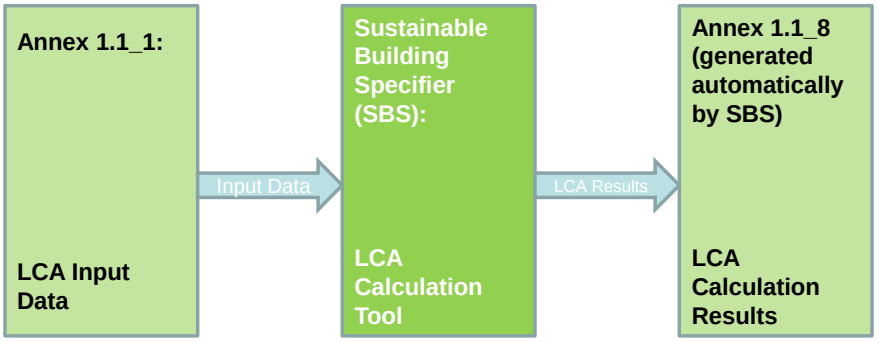
For all the Indicators named, one common set of input data is required, which has to be inserted into the LCA calculation tool (Sustainable Building Specifier, SBS). Inside the SBS, the

LCA results are calculated.
Benchmarks for the LCA indicators are to be developed based on the case study LCA results. So at the time of the assessment workshop, no rating for the LCA indicators is possible. As soon as respective benchmarks have been developed, the assessors will be informed and the case study buildings can be rated.
The same data requirements apply for the "Basic and quick" and for the "Complete" assessment, but for the "Complete" assessment, data has to be documented and verified whereas the "Basic and quick" assessment can be performed based on qualified estimations (cp. 3. Annexes). In addition, assessment teams dealing with a "complete" assessment are asked to provide further information for a future expansion of system boundaries (cp. Annex 1.1_7).

2. Evaluation

For the evaluation of the LCA indicators, the following steps are required (preferably before the Assessment Workshop):

- Completion of LCA Questionnaire (Annex 1.1_1) by the Building owners / planners / assessor
- LCA modelling: Input of data from questionnaire into SBS by assessor according to SBS User Manual.
- LCA calculation in SBS by assessor (SBS generates Annex 1.1_8: LCA Calculation results)
- Complete Assessment: Compilation of documentation by building owners / planners



Social / Functional Quality

Indicator 2.3 Thermal Comfort

Date: ***current date of edition***
Project Name: ***name of the current project***

1. Indicator Information

The indicator **2.3 Thermal Comfort** is evaluated with **4** sub-indicators:
2.3.1 Operative temperature
2.3.2 Radiant temperature asymmetry and floor temperature
2.3.3 Draught, air velocity
2.3.4 Humidity in indoor air

2. Evaluation

Sub-indicator 2.3.1 Operative temperature

Please specify the evaluation method chosen:

1.Thermal building simulations ☐

2.Measurements according to EN ISO 7726 ☐

3.Heating load calculations according to EN 12831 ☐

Winter requirements

If **1 or 2,** with which category defined in EN 15251/EN ISO 7730 is the building compliant?

Category **I** **II** **III** **None**

If **3,** with which minimum room temperature defined in EN 12831 is the building compliant?

Minimum room temperature **21°C** **20°C** **< 20°C**

Is there compliance with the national standards?

Yes ☐ **No** ☐

Summer requirements

With which category defined in EN 15251/EN ISO 7730 is the building compliant?

Category **I** **II** **III** **None**

Is there compliance with the national standards to avoid summerly overheat?

Yes ☐ **No** ☐

Explanation and evidence can be found in **annex 2.3.1_1**

Sub-indicator 2.3.2 Radiant temperature asymmetry and floor temperature

With which category defined in EN ISO 7730 is the building compliant?

Category **I** **II** **III** **None**

Explanation and evidence can be found in **annex 2.3.2_1**

Sub-indicator 2.3.3 Draught, air velocity

Does the building include a HVAC (Heating, Ventilating and Air Conditioning) system?

Yes ☐ **No** ☐

With which category defined in EN ISO 7730 is the building compliant?

Category **I** **II** **III** **None**

Explanation and evidence can be found in **annex 2.3.3_1**

Sub-indicator 2.3.4 Humidity in indoor air

What is the value of the absolute humidity?

Absolute humidity [ ] g of water per kg of dry air

Explanation and evidence can be found in **annex 2.3.4_1**

Sub-indicator 2.3.1 Operative temperature

Depending on the method chosen:
1. Thermal building simulations that show compliance with the categories of EN 15251/EN ISO 7730
2. Measurements according to EN ISO 7726 that show compliance with the categories of EN 15251
3. Heating load calculations according to EN 12831 (for buildings with a window area of less than 40 %)

- Annex 2.3.1_1: Name_of_the_Annex_1_1

Sub-indicator 2.3.2 Radiant temperature asymmetry and floor temperature

Winter and Summer design temperatures of building components
Assessment of the maximum and minimum surface temperatures of building components with a large surface area:

- Ceiling
- Glazed facade/wall surfaces, if glazed surfaces comprise more than 40 % of the interior façade or wall surface area,
- Floor

- Annex 2.3.2_1: Name_of_the_Annex_2_1

Sub-indicator 2.3.3 Draught, air velocity

Technical specifications of the air-outlets
Evidence of the compliance with EN ISO 7730
- Annex 2.3.3_1: Name_of_the_Annex_3_1

Sub-indicator 2.3.4 Humidity in indoor air

Description of HVAC system
- Annex 2.3.4_1: Name_of_the_Annex_4_1

Social / Functional Quality

Indicator 2.4 Indoor Air Quality

Date: ***current date of edition***
Project Name: ***name of the current project***

1. Indicator Information

The indicator **2.4 Indoor Air Quality** is evaluated with **4** sub-indicators:
2.4.1 Indoor air contamination with the most relevant indoor air pollutants (formaldehyde, naphtalene, toluene, xylene, styrene).
2.4.2 Contamination levels of non-specific allergenic, pathogenic or toxic fungal spores
2.4.3 Occupancy-based ventilation rates
2.4.4 CO2 concentration above outdoor level

2. Evaluation

Sub-indicator 2.4.1 Indoor air contamination with the most relevant indoor air pollutants (formaldehyde, naphthalene, toluene, xylene, styrene).

What is the concentration of formaldehyde in indoor air?

Formaldehyde ☐ μg/m³

What is the concentration of naphthalene in indoor air?

Naphthalene ☐ μg/m³

What is the concentration of toluene in indoor air?

Toluene ☐ μg/m³

What is the concentration of xylene in indoor air?

Xylene ☐ μg/m³

What is the concentration of styrene in indoor air?

Styrene ☐ μg/m³

Evidence of the contamination level can be found in **Annex 2.4.1_1 and 2.4.1_3.**

Sub-indicator 2.4.2 Contamination levels of non-specific allergenic, pathogenic or toxic fungal spores

Are the indoor mould level or spore counts no more than 50% of the outdoor level during winte

Yes ☐ **No** ☐

If **yes**, evidence of the contamination level can be found in **Annex 2.4.2_1 and 2.4.2_2.**
If **no**: 0 points

What is the level of spore counts in indoor air?

Spore counts ☐ / m^3

Evidence of the contamination level can be found in **Annex 2.4.2_1 and 2.4.2_2.**

Sub-indicator 2.4.3 Occupancy-based ventilation rates

With which category defined in EN 15251 is the building compliant?

Category **I** **II** **III** **None**

Is the building compliant with national regulations?

Yes ☐ **No** ☐

Evidence of the calculations can be found in **Annex 2.4.3_1**

Process Quality

Indicator 5.9 Monitoring, Use and Operation

Date: ***current date of edition***
Project Name: ***name of the current project***

1. Indicator Information

The indicator **5.9 Monitoring, Use and Operation** is evaluated with **2** sub-indicators:
5.9.1 Efficient monitoring and surveying
5.9.2 Optimized operation and use

2. Evaluation

Sub-indicator 5.9.1 Efficient monitoring and surveying

Please check the box when the following requirements
- **definition of performance metrics**
- **effective measurement system**
- **data acquisition and archiving**
- **data visualization and reporting**

were fulfilled for the following categories:

Energy: final energy consumption

Water: water consumption

Materials & Waste: waste production

Health & Well-being: occupant satisfaction

Pollution: refrigerant leakage

Land use and ecology: biodiversity

Management: condition survey

Explanation and evidence can be found in annex **5.9.1_1 - 2.**

Sub indicator 5.9.2 Optimized operation and use

Project documentation

Please specify which of the following statement applies to your project:

A building pass documentation is compiled with detailed information about the project.

Simplified project documentation is compiled

No project documentation is compiled.

Explanation and evidence can be found in annex **5.9.2_1.**

Instructions for servicing, inspection, operation, and care

Please specify which of the following statement applies to your project:

Detailed instructions for maintenance, inspection, operation, and care are compiled and a maintenance and repairs plan was drawn up;
these instructions are specified for individual target groups (facility manager, building services engineer, users, cleaning firms, etc.).

Usual instructions for maintenance, inspection, operation, and care are documented and made available to service providers

No instructions for use, maintenance, and care are compiled.

Explanation and evidence can be found in annex **5.9.2_2.**

Adaptation of plans and calculations for the finished building

Please specify which of the following statement applies to your project:

Plans for the building are updated and prepared for use by facility managers; like the evidence documentation and calculations, the plans correspond to the finished building.
In particular, the national energy performance certificate was adjusted to reflect reality.

The plans mostly correspond to the finished building.

The plans do not correspond to the finished building. ☐

Explanation and evidence can be found in annex **5.9.2_3.**

User manual

Please specify which of the following statement applies to your project:

A detailed user manual is compiled, including recommendations for facility managers and information for users how to use the building to minimize ecological footprint and gain comfort during operation.

A manual is compiled for facility managers/operators.

No manual for facility managers nor users is compiled.

Explanation and evidence can be found in annex **5.9.2_4.**

Process Quality

Indicator 5.3 Optimization and Complexity of the Approach to Planning

Date: ***current date of edition***
Project Name: ***name of the current project***

1. Indicator Information

The indicator **5.3 Optimization and Complexity of the Approach to Planning** is evaluated
with **10** sub-indicators:
5.3.1 Safety and Health plan
5.3.2 Energy concept
5.3.3 Water concept
5.3.4 Optimization of daylight and artificial lighting
5.3.5 Waste concept
5.3.6 Measurement concept
5.3.7 Concept for conversion, dismantling and recycling
5.3.8 Concept for ease of cleaning and maintenance
5.3.9 Independent third party review of planning documents
5.3.10 Execution of variant comparisons

2. Evaluation

Sub-indicator 5.3.1 Safety and Health plan

Was a Safety and Health plan implemented?

Yes ☐ **No** ☐

If yes, evidence of the implementation of a safety and health plan can be found in **Annex 5.3.1_1**

Sub-indicator 5.3.2 Energy concept

Was an energy concept covering the whole life cycle implemented?

Yes, with detailed reviews of alternative energy supply systems and the use of renewable energy, while at the same time taking economic feasibility into consideration	
Yes	
No	

If yes, explanation of the energy concept and evidence of its implementation can be found in
Annex 5.3.2_1

Sub-indicator 5.3.3 Water concept

Was a water concept covering the whole life cycle implemented?

Yes, considering: - Reduction of freshwater consumption and rain water seepage - Increased use of rain water and grey water	
Yes, considering reduction of freshwater consumption and rain water seepage	
Yes, considering reduction of freshwater consumption	
No	

If yes, explanation of the water concept and evidence of its implementation can be found in
Annex 5.3.3_1

Sub-indicator 5.3.4 Optimization of daylight and artificial lighting

Realisation of a simulation of daylight:

Yes **No**

Realisation of a calculation for artificial light:

Yes **No**

If yes, explanation of the lighting concept and evidence of its optimization can be found in
Annex 5.3.4_1

Sub-indicator 5.3.5 Waste concept

Was a waste concept implemented in the planning phase with a local waste processor?

Yes, and implementation of the results into the further planning

Yes

No

If yes, explanation of the waste concept and evidence of its implementation of the waste concept can be found in **Annex 5.3.5_1**

Sub-indicator 5.3.6 Measurement concept

Creation and implementation of a measurement and monitoring concept that records **nearly all technical systems** relevant for operation and consumption for **over two years** after the building is put into operation.
Realisation of improvements based on the results of the measurements during the two years.
Implementation of a long term concept for monitoring

Creation and implementation of a measurement and monitoring concept that records the **energy** and **water** consumption for **over two years** after the building is put into operation.
Realisation of improvements based on the results of the measurements during the two years.
Implementation of a long term concept for monitoring.

No measurement concept was implemented

If a measurement concept was implemented evidence can be found in **Annex 5.3.6_1**

Sub-indicator 5.3.7 Concept for conversion, dismantling and recycling

Were the following options taken into consideration in planning:
Converting and dismantling the building:

Yes, and documented **Yes** **No**

Recycling components and construction products:

Yes, and documented **Yes** **No**

Was a detailed concept given, including:
- a concept for changes in types of use, including the consequences for construction and technical components
- a concept for recycling and dismantling

Yes ☐ **No** ☐

If a concept for conversion, dismantling and recycling was implemented explanation and evidence can be found in **Annex 5.3.7_1**

Sub-indicator 5.3.8 Concept for ease of cleaning and maintenance

Was a concept for ease of cleaning and maintenance created?

Yes ☐ **No** ☐

If yes, was this concept detailed and implemented in practice to improve the construction of the building?

Yes ☐ **No** ☐

If a concept for ease of cleaning and maintenance was created, explanation and evidence can be found in **Annex 5.3.8_1**

Sub-indicator 5.3.9 Independent third party review of planning documents

Was there a review of planning documents conducted by **one** of the following person:
1. Independent third parties OR external auditors
2. Internal review by an expert, such as « design review »
3. The two heads principle : a second staff member from within or outside the processing team is involved

Yes ☐ **No** ☐

Does the implementation of independent third party review of planning documents correspond to the legal requirement?

Yes ☐ **No** ☐

If yes, explanation and evidence of the independent third party review can be found in **Annex 5.3.9_1**

Sub-indicator 5.3.10 Execution of variant comparisons

Were variant comparisons about basic or special services in building planning executed during the preliminary planning phase?

Yes ☐ **No** ☐

If yes, was the evaluation of different alternatives done with methods taking into consideration ecologic, social/functional, economic and technical aspects (like : Life Cycle Assessment, or Life Cycle Costs)?

Yes ☐ No ☐

If yes, explanation and evidence of execution of variant comparisons can be found in **Annex 5.3.10_1**

Appendix B

The questionnaire

Gebruikers enquête -Gemeentehuis Leiderdorp

Wij willen graag weten hoe u, als gebruiker van het gebouw, het nieuwe duurzame gemeentehuis ervaart. Het invullen van de enquête duurt ongeveer 10 minuten. De enquête is anoniem. Uw antwoorden helpen om het gemeentehuis ook in de toekomst duurzaam en gebruiksvriendelijk te houden. TU Delft voert deze enquête uit in opdracht van de gemeente Leiderdorp. Voor meer informatie kunt u contact opnemen met Jurjen Teuben, j.teuben@leiderdorp.nl of Ellen van Bueren, e.m.vanbueren@tudelft.nl

Hartelijk dank voor uw medewerking!
Er zijn 15 vragen in deze vragenlijst

☐ Gebruikersprofiel

1 [Q1] Uw Profiel *

Kies a.u.b. een van de volgende mogelijkheden:
☐ Vrouw
☐ Man

2 [Q2] Leeftijd *

Kies a.u.b. een van de volgende mogelijkheden:
☐ <20
☐ 21 tot 30
☐ 31 to 40
☐ 41 to 50
☐ 51 tot 60
☐ >60

3 [Q3] Uw hoogst genoten opleiding: *

Kies a.u.b. een van de volgende mogelijkheden:

☐ Basisonderwijs
☐ Lager beroepsonderwijs
☐ Voorbereidend middelbaar beroepsonderwijs (VMBO)
☐ Middelbaar voortgezet onderwijs (Mavo, MULO)
☐ Middelbaar beroepsonderwijs (MBO)
☐ Hoger voortgezet onderwijs (Havo, VWO)
☐ Hoger beroepsonderwijs (HBO)
☐ Wetenschappelijk onderwijs

 Zeg ik liever niet

4 [Q4] Hoeveel jaar werkt u al bij de gemeente Leiderdorp? *

Kies a.u.b. een van de volgende mogelijkheden:
 < 1.5 jaar
 1.5 tot 5 jaar
 > 5 jaar

5 [Q5] Hoeveel tijd brengt u door in het gemeentehuis? Gemiddeld aantal dagen per week: *

Kies a.u.b. een van de volgende mogelijkheden:
 1 dag of minder
 2 dagen
 3 dagen
 4 dagen
 5 dagen

6 [Q6] Hoe reist doorgaans u naar het gemeentehuis? *

Kies a.u.b. een van de volgende mogelijkheden:
 Openbaar vervoer
 Auto, eigen vervoer
 Auto, meerijden
 Scooter/brommer
 Fiets
 Te voet
 Een combinatie

7 [Q7] Wat is de afstand van uw woning tot het gemeentehuis? *

Kies a.u.b. een van de volgende mogelijkheden:
 Minder dan 1 km
 1 - 2 km
 2 - 5 km
 5 - 7.5 km
 7.5 - 10 km
 > 10 km

8 [Q8]Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken? *

Kies het toepasselijk antwoord voor elk onderdeel:
(helemaal mee oneens mee oneens neutraal mee eens helemaal mee eens)

Thuis draai ik altijd de lichten uit als ik een kamer uit ga

Thuis zet ik de verwarming laag als ik het huis verlaat

Ik draai de kraan dicht tijdens het tandenpoetsen

Thuis heb ik apparaten op zonne-energie (dwz fotovoltaïsche cellen, zonnecollectoren)

Thuis heb ik zoveel mogelijk water besparende kranen geïnstalleerd

Thuis heb ik zoveel mogelijk energiezuinige verlichting (LED) geïnstalleerd

Ik gebruik zo veel mogelijk oplaadbare batterijen

Bij de aanschaf van apparaten let ik op de energiezuinigheid

Thuis scheid ik mijn afval zoveel mogelijk

Op het werk scheid ik mijn afval zoveel mogelijk

9 [Q9] In welk gedeelte van het gebouw voert u uw werkzaamheden voornamelijk uit? *

Kies a.u.b. een van de volgende mogelijkheden:

- Ruimte A: begane grond balie
- Ruimte B: begane grond open kantoorruimte zijde hoofdingang
- Ruimte C: begane grond open kantoorruimte zijde milieustraat
- Ruimte D: begane grond open kantoorruimte zijde loods
- Ruimte E: begane grond spreekkamers
- Ruimte F: bedrijfsrestaurant
- Ruimte G: 1e verdieping stilteruimte of eigen kantoorruimte
- Ruimte H: 1e verdieping open kantoorruimte zijde hoofdingang
- Ruimte I: 1e verdieping open kantoorruimte zijde milieustraat
- Ruimte J: 1e verdieping open kantoorruimte zijde loods
- Ruimte K: 1e verdieping open kantoorruimte zijde Simonsmitsweg
- Ruimte L: Buiten (groen, grijs, milieustraat)
- Ruimte M: Loodsen
- Ruimte N: Alle ruimtes

10 [Q10] Welke activiteiten voert u uit tijdens uw aanwezigheid in het gemeentehuis? *

Kies het toepasselijk antwoord voor elk onderdeel:

(1-Zeer weinig 2-Weinig 3-Gemiddeld 4-Vaak 5-Zeer vaak)

Op de computer werken

Telefoneren

Vergaderen

Informeel overleg met collega’s

Gesprekken voeren met burgers (in persoon)

Stukken/dossiers lezen

11 [Q11] Hoe ervaart u elk van de volgende ruimten? *

Kies het toepasselijk antwoord voor elk onderdeel:

	(Heel slecht	Slecht	Goed/niet slecht	Goed	Heel goed)
Ruimte A: bedrijfrestaurant					
Ruimte B: gemeenschappelijke ruimten op de eerste verdieping (lounge overleg en aanlandplekken)					
Ruimte C: gemeenschappelijke ruimten op de begane grond (overleg en aanlandplekken)					
Ruimte D: entree/atrium					
Ruimte E: de pantry's					
Ruimte G: Vergadercentrum begane grond (raadzaal tot en met leeskamer nummer 1 tot en met 6)					
Ruimte H: Vergaderruimtes 1e verdieping (7 en 8)					
Ruimte I: Spreekkamers					
Ruimte J: Toiletten					
Ruimte K: Kleedruimten					
Ruimte L: Douches					
Ruimte M: Fietsenberging					
Ruimte N: Parkeerdek					

Werkomgeving

12 [Q12] Hoe tevreden bent u met de controle die u heeft op het gebouw? *

	(Heel erg ontevreden	Een beetje ontevreden	Niet tevreden, niet ontevreden	Een beetje tevreden	Heel erg tevreden)
Ik kan de temperatuur voldoende beheersen					
Ik kan de kunstmatig					

e
verlichting
voldoende
beheersen
Ik kan de
daglicht
toetreding
voldoende
beheersen
Ik kan de
ventilatie
voldoende
beheersen
Ik kan de
ramen
openen/slu
iten
Ik kan de
buitendeur
en
openen/slu
iten
Ik kan de
binnendeu
ren
openen/slu
iten

13 [Q13] In hoeverre bent u het eens met de volgende uitspraken? *

	(helemaal mee oneens	**mee oneens**	**neutraal**	**mee eens**	**helemaal mee eens)**
Ik vind het te koud					
Ik vind het te warm					
Ik vind de lucht voldoende fris (geen bedompte lucht, geen geurtjes)					
Ik vind de luchtvochtigheid voldoende					
Geluid privacy op uw werkplek (Ik kan een gesprek voeren zonder dat mijn buren meel vice versa)					
Ik heb geen last van achtergrond geluid (Ventilatiesysteem, Verlichting, Apparatuur, va					
Ik kan geconcentreerd werken in een open kantoorruimte zonder dat ik last heb van het collega’s					
Ik werk in een stilteruimte als ik geconcentreerd moet kunnen werken					

Ik werk in een stilteruimte omdat ik dat prettiger vind dan een open kantoorwerkplek

Visueel comfort van de verlichting (Ik ondervind geen last als gevolg van schittering, helde reflecties, contrast)

Ik ben tevreden met de daglichttoetreding in het gebouw
Mijn werkplek is ruim genoeg
Ik heb genoeg persoonlijke bergruimte
Ik vind het fijn dat ik snel even een collega in persoon kan raadplegen
Er zijn voldoende ruimten om bezoekers te ontvangen
Ik heb voldoende visuele privacy (Ik voel mij niet bekeken)
Mijn werkplek (stoel, bureau, e.d.) is makkelijk aan te passen aan mijn eigen behoeften
Ik maak vaak gebruik van de dienstfiets
Ik vind dat het gebouw goed wordt onderhouden
Ik vind dat het gebouw goed wordt schoon gehouden
Ik vind het gebouw mooi
Ik voel mij veilig in dit gebouw
Ik voel mij veilig buiten het gebouw
Er is voldoende parkeerruimte
Ik parkeer zoals afgesproken altijd
Het gebouw is goed toegankelijk voor mensen met een beperking

Algemene opmerkingen

14 [Q14] Alles bij elkaar genomen: *

	(helemaal mee oneens	**mee oneens**	**neutraal**	**mee eens**	**helemaal mee eens)**
Ik ben bekend met het gebouw					
Ik ben mij bewust van de aanwezigheid van systemen in het gebouw (bijv. WKO, betonkernactivering, ventilatie, verlichting, enz.)					
Ik heb voldoende informatie ontvangen over de duurzaamheid van het gebouw en hoe het werkt					
Ik weet waar en hoe ik een gebrek aan het gebouw kan melden					
Ik ben tevreden met de afhandeling van meldingen/klachten ten aanzien van het gebouw					
Ik vind dit een een duurzaam gebouw					
Ik ben tevreden et de wijze waarop het gebouw mij ondersteunt in het Nieuwe Werken					
Ik vind de catering in het bedrijfsrestaurant voldoende duurzaam					
Ik vind de voorzieningen voor warme dranken voldoende duurzaam					
Ik ben tevreden met het gebouw in het algemeen					

15 [Q15] Eventuele aanvullende opmerkingen of aanbevelingen over uw persoonlijke werkruimte of gebouw het algemeen? *

Vul uw antwoord hier in:

Bedankt voor uw deelname aan deze vragenlijst.

Appendix Cd

Interviews – Leiderdorp (20.03.2013)

Interview 1 – T. Hoonhout

I am busy with the building. Jaan Robert did most of the technical things. We did everything about the chairs, tables, fridges, and catering, cleaning, plants. About the technical staff, I know a little bit about. We are a new building, in a new situation and we are working with Servicepunt 71 (http://www.servicepunt71.nl/). We have four municipalities Leiden, Leiderdorp, Oegstgeest and Zoeterwoude that work together and have one service center. The number 71 comes from the number of the network. Everything that has to do with facilities/technical services/facility management, we take it from there. **I am the person between the Gemeente Leiderdorp and the Servicepunt 71.** When there is a problem, I jump into it. This is half of my job (facility manager), the other half is health and safety coordinator (arbocoördinator), which is to take care mostly of the wellbeing of the people in the building. I check their chairs, tables and even the people working outside of the building, I check their work environment.

In the beginning of the building, it was nothing to think about. All the elements were out of the architect's head and everything was sustainable, from the ceilings to walls.

- What do you think of the building? Do you like it? Can you shortly tell me some pros (strengths) and cons (weaknesses) of the building?

In the past, we had an old building. It was of stone and it was dark and brown, it was not that nice and it had all different rooms, for 2 or 4 persons. **In this new building, it is open, transparent and everyone can work everywhere.** It is mostly divided by groups. Management seat over there, policy over there etc. But it is nice, because you can see everyone and you can seat anywhere, it is a clean desk.

-This is more or less under the concept of the ''Nieuwe werken''?

Yes. **This year we started with working out of your house**. You can log in from wherever you are and you can use all the technical instruments that you use also at work. I am the one although that have to be here, but there are a lot of colleagues who work from home and they are allowed to work one day or two half days from home. **This is why we have new phones and tablets (provided by the municipality).**

-Apart from the working climate and the open space that fit for you and as you told me, you like them very much, can you tell me a little bit more on the systems of the building? How is the situation with heating, lighting, acoustics?

Well, **it is different from the old building. Here we have different sides form the location.** When the sun is up, that side is hot and the sun will shine and it's going to be

hot for your workplace. **So we put some foil (folie) at at the windows to reduce it.** If it is effective, I don't know, we have to see it when the sun is coming this year. Because last year we put it on the windows from the inside so the reduction of the light, 50%, would come in. **We had some problems with the WKO. Sometimes it was very cold here**, during the winter. The system says that it is **21 degrees continuous** but some colleagues were here with winter jackets and it was cold. Sometimes, because of the sun, one side of the building was 2 or 3 degrees more hot but in general it was cold.

-And can you control this temperature by your own?

No. You can adjust it a little bit for certain place, you can put it up to 23 degrees. You can see everywhere in the building how hot it is. **In the BMS (Building Management System, GBS - Gebouw Beheer Systeem), you can see the temperatures** and where is hot and cold.

-But even if they increase it to 23 degrees, does it make any difference with such a big and open space?

No. And another thing is that someone is cold and in his jackets and the other one is with T shirts and you have to create a balance and it is difficult. Sometimes there is also cold air coming from the ventilation on the floor. **The WKO has to be better**. For solutions, there are the **silent rooms**, that are small spaces and there you can close the door and increase the temperature. There are 13 on this floor for all the employees.

-How many employees work here?

There are 120 workspaces and we have 160 employees, but we have more heads in the house because some are part time. By taking all the employees into account, even the part time its maybe round 200.

-So can you tell me more about the systems of lighting and acoustics, elements/systems that make this building sustainable?

There is problem with the acoustics of the building.

-Yes, I am a little familiar with that because when I interviewed Mr. Joost de Haan, he told me that you contacted him for the acoustics and that he would find a solution.

I went to another town hall with the new building that had a similar problem and **they used foam rubber (schuimrubber)**, which it seems like art and they put it like blocks on the walls and in the ceilings and that worked. Here in the house, **the problem is that when we talk, it goes to the windows, to the wall and to the workplaces.** So we have always to close the doors of the silence rooms, or to go and take a phone outside. And when you are **together with 8 people in one space and they are talking to each other, or on the phone there is a lot of noise.** We have already contacted the acoustic factory (acousticfabriek) and they are busy on finding a sustainable solution to get the acoustics down to normal level, but **what we have to change in the building, is so expensive and so where to begin**? This is a problem and we are not happy yet and this is the reason why we are not doing business with them and we are searching for other solutions. In the building, we have in some spaces panels on the ceilings for better acoustics, but there are none of them on the corridors.

The lighting system that is supposed to work with daylight, **doesn't work or is not available yet.** The people from the maintenance want to see if it is possible to have a sort of a sensor on the outside, so when the daylight is brighter, the lights go down.

-But can you control the lighting manually?

No. Some lights, like these big ones in the atrium are always closed. **All the other are in a system at the reception and you can control them manually only from there. Every room has a sensor**, so when we are not here or not moving, the light goes out. But sometimes, it is dark and you have to move a lot to get the light on again. **And sometimes lighting makes it really hot** and this is why we are trying to fix the system with the daylight.

-You were involved in the project, from the beginning, so I believe that you knew most of the information, but how did the other employees receive this information?

We had weekly or two weekly newsletters that were made by the persons in the group (architect, contractor, gemeente) responsible for the building of the town hall. The information was ranging from explaining the WKO and other systems step by step till which type of coffee machines will be used. **When we moved in, we had a little book, where we could find anything** (lockers, rooms, coffee) and an envelope with our name and our locker. We had also 3 or 4 moments inside the building, when we all gathered somewhere and we had some soup and bread and walk around.

-So did they know how the WKO works or that the lighting could be switched off only by the reception?

No, they don't know that, but they now that they can increase the temperature. This is written in the text in the little book. But also during the first half year of the first year, we had some newsletters on the internet, little text on what new happened. We tried to inform the people as we could.

-Does this sustainability of the building affect you anyhow? In your habits?

I can mention **the fact of the trashcans**. In the start, we had two small and one large for organic waste (like your apple) but it didn't work and we were putting all in one can. This is something that wasn't thought through good enough. Because if you do it like IKEA, and put three different bags together in one can with obvious signs for plastic and other, it could work. Only the batteries and sometimes the paper is separated.

-I wanted to ask you if you are familiar with the tool of GPR that was used during the design for the municipality.

No I have no idea.

-It measured the performance of the building……explanation…..A measurement should be conducted again because some systems don't work and the performance has to be measured.

I know that there are some problems and systems that could be bad for the energy performance, as the lighting in the restaurant, which is day and night always on.

-If you could be "supervisor-for-a-day" at your current (or higher) position, what changes would you make?

I think I would so something about **acoustics** and this is the main problem of the building. Perhaps something also about the **hot and cold situation** (WKO).

-Do you think that the employees here are satisfied?

In general yes. But if you ask different persons you get different answers and everyone will suggest for different changes. Some complaints are done about the roof. **Parking on the roof is a nice idea but everyday its full and the employees start parking their cars outside of the gemeente, where are only 20 parking places for visitors** and then visitors have nowhere to park.

-Explanation of the worldwide used tools, the criteria, the research, the evaluation tool.

Well, **we have something in sort of an evaluation tool, the Employee Satisfaction (MTO** – Medewerkerstevredenheidsonderzoek). We did it once last year and we had to log in and answer questions about the building and its management. But it was more related to the staff than on the building. You had questions more like ''Do you like your management team?''. The result was an MTO report and afterwards every group had to talk with its manager about the problems and the results presented on the MTO. But we didn't have anything for the building and it would be nice to have one.

Something else that **doesn't work, are the windmills**. They worked for the first month but then they were broken and they didn't produce so much electricity. The supplier went bankrupt, so now they are **going to be removed** because there is no software or company

to repair them. And **we will get sun collectors.**

Interview 2 and 3 – R. Karregat and J. Janssen

We do the same, we take care of the buildings, the installations, mostly on maintenance.

- What do you think of the building? Do you like it? Can you shortly tell me some pros (strengths) and cons (weaknesses) of the building?

The building is very **nice and open** and you can find your colleagues very quickly. It is a **new building with new technologies**. Most of the people here like the building. Some may not and **the problem is that they do not have control of the heating**. In the old building, they were seating in closed rooms and they could adjust the temperature whenever they wanted. We think that the problem is that you have different types of people. The one is sitting and is feeling cold and the other is feeling just nice.

-So the problem is identified mostly on the personal habits and preferences of each one. But does the WKO work as it is supposed to regarding the technical part?

We monitor the operation of the WKO from the room downstairs. The temperature is settled to be **continuous at 21 degrees** and **people can change it using the thermostats from 21 to 23 degrees**. And even if some feel cold, this is only personal because through graphics we can see that the temperature never goes under 20 or 21 degrees.

-Furthermore, I heard that there are also some problems with the lighting system.

In the beginning, we were thinking what to do with the sun and we put **folies on the windows, before it gets too hot, in order to absorb 50%** of the heat and light. It did not work. The **next idea was to put screens on the outside of the windows, but then we thought that people wouldn't like it** even if it seems the only solution.

The **windmills** don't work, they will be **removed and PV cells will come** in their place with the same energy production of 47 kWh/year. Now there is only one sun collector.

-You are the specialists here, so you knew all the information beforehand, but how informed were the people about the building before moving in here?

Yes and no. **For a normal person it is very difficult to get in his/her mind all this information.** When the moving in is from an old building to a new one with all these new systems, even if there is information on the Internet provided to them with how everything works, **a person cannot process all this information.** For us it is very common to understand them, but not for all the others.

-Even the newsletters beforehand did not work?

No because **if it is not ''core business'' for the people they do not care so much to understand it.**

-Some surveys showed that when the users of the buildings understand how their building work and how they can control it, they are more forgiving.

Well, it depends. In the old building that there were radiators, anyone could go near the small box increase the temperature and he could feel that he got warmer immediately.

- Are there any changes done during the usage phase (until now)?

There has been **a change in the ventilation system** about the wind flow. There is air coming from the outside into the building and when the temperature is very low, it will come as heat and then it will be refreshed. Because **the velocity of the stream going in was big and hard, it was lowered.** The lighting system doesn't work and we are trying to fix it for the past year. Normally, when the last one left the building and the alarm system went on, then the lighting system went off and the same thing happens in the morning. There are sensors that work with presence detectors but they were supposed to work also by detecting daylight, when the sun is shining and the sensors detect 150 lux the light was supposed to go out. This is the responsibility of the installer.

-In general, what do you think that it makes this building sustainable?

Hard question. What made it sustainable was the **use of sustainable and reused materials, high frequency lighting and not conventional lighting, no gas in the building, the WKO (we are pumping water from the ground), the insulation, even the furniture are made from recycle materials**.

- Does this sustainability of the building affect you anyhow? In your habits, maybe with recycling?

This is different for everyone. Recycling here did not work. The separation of the dishes in the restaurant did not work and we throw away everything in one bag only. But it depends on how someone thinks. I think that if **the direction (upper management layers) gives the right examples**, then something could actually work in this field. We would go with them. **There is no stimulation of the staff by them**. **They could give everyone a cup with his name**. We drink everyday more than 5 coffees and every time we have to throw the old cup away and a new cup comes out of the coffee machine. **People can learn and when the direction pushes** that also, then it could be done.

-Are you familiar with GPR?

No, We do not know at all what it is.

-Explanations…..

We saw some diagrams with some scores but we did not know what it was.

The truth is that we use a lot of energy. With the WKO, for example, it is now electric and when the water comes from underground it is 11 degrees and we have to make it for the winter to 40 degrees. We have systems to control and monitor the systems (BMS).

Another change that we want to make is to change the operations according to opening hours. The gemeente is open from **6.00 – 22.00. The heating and ventilation are working for all these hours, plus Saturday**. This was thought due to the concept of the ''Nieuwe Werken'' that everyone can come and go, or come late hours or during the weekend. **But it is not efficient and we want to change it and make these systems work from 6.00 – 19.00**, because normally we work from 8.00 – 18.00.

-Explanation on the tools and criteria

People have always their own perspectives and opinions. If someone feels cold and wants to continue to feel cold, this would not change even with someone told him/her that it is hot and not cold at all. In the next appointment with Van Dorp installaties, they could come to select data and then through a program, **the lines and the curves of heating and other systems could be formed and this could be visual for everyone in order to see it as a proof and believe it.** It is not enough for someone to see it on a thermostat.

Interview 4 – R. Kuijt

My role in the organization is all different kind of ICT projects, for example the Servicepunt project, a new intranet environment to share documents. Currently we are trying to create a new document management system.

- What do you think of the building? Do you like it? Can you shortly tell me some pros (strengths) and cons (weaknesses) of the building?

One good thing is that the building is new. Bad things are the **parking spots up on the roof**. **During the winter** with snow and ice, you cannot go there because it is **too slippery** and it is **too noisy because everyone sits together with many people**. It is a good thing that the design was done in such a way and under the flexible working and the **building is transparent** and you can see everyone just with standing up from your chair. It is very good design and a very practical and beautiful building. Nevertheless it is **too noisy and maybe too crowded in one spot**.

- Do you know how the building work (control temperature/ ventilation)?

Well, **not exactly.** I heard some things while we were here with you during the first workshop and someone told me about WKO, but I am working here only since April of last year.

-Have experienced some problems with the heating?

Indeed, there are **days that the building is too cold**. But **I understand that we did not have a very warm summer and the heating system has to be in use for 2 or 3 years to gain full capacity.** It was really cold sometimes, you had to bring extra clothes to work.

*-This building is **sustainable**. In which elements/systems do you recognize this sustainability?*

We had the **windmills** on top but they do not work. I think we also have **special glassing** to keep the heat inside and lighting that someone can turn on individually and only in some areas (but I do not know if this is sustainable).

-When you came in this building, were you informed about it and its systems? (newsletters)

I was the new guy and in a way I was informed, but when you come to work for the government**, they give you a big book with all the information but I hadn't read it. It was too much information. Maybe it was better that someone from the facility management could come to me and inform me in person**.

-Does this sustainability of the building affect you anyhow? In your habits, maybe with recycling?

No, I do not think so because I am already used to such habits. I am already recycling at my home and try to be sustainable at home. **It did not affect my personal behavior on sustainability, but it reminded me somehow to be sustainable** (to recycle when I see the signs of different trash cans, to turn off the lights, to save water). But this environment could be an eye opener for someone that it is good for the environment.

-In ICT, have you worked on maintenance systems?

There are some computers systems on maintenance, there are also some timers that work until 12 in the night. **When someone forgets to turn off the terminal, normally it would stay on until the next day because no one could shut it down but now with the timer it automatically shuts down at 12 in the night.**

- If you could be "supervisor-for-a-day" at your current (or higher) position, what changes would you make?

The first thing that I would change, are the **toilets.** In the men 's room, they do not use water to flush the urinals, but chemicals I think and it is disgusting. I would **switch off more lights in the atrium**. Maybe I would **put some solar panels** on the top. I would **remove all the telephones from the desks**, because everyone has a cell phone now. From the last month in the concept of the ''Nieuwe Werken'' the gemeente provided us with phones and tablets.

- Do you think that the employees here are satisfied?

I think that with the changes that have been made through all the years some of them maybe were too rush for some employees. **If you work at a desk for 15 years, and then you have to move to another spot and have under flexible working a clean desk policy etc., some people (usually older) think that their personal freedom is violated** (pictures of your children on your desk, radio, cozy space). This aspect affected many people here. At first, I heard that there was a rule that you could not drink coffee at your desk and you had to go to the pantry, but then this rule was vanished because everyone was going to the pantry all the time. So I think that **first before apply all the rules, you have to see if the rules will work and maybe do it in more phases.** You could go and ask around what people think.

-In the context of ICT, is it possible to create a system as a feedback loop for employees to share their opinions, problems, suggestions etc.?

It would be possible and we have done something similar before. **We made a form with Google docs by asking the people if they want the tablets or not and if they had any remarks**. It was easy and it could be approached from every location. I think that this **feedback should not be about equipment or facilities (something physical) but about people's opinions, where does this non-enthusiasm come from. Maybe something like a satisfaction research** could be useful. Moreover, this is a very small organization and some technical problems could be reported directly to the responsible persons.

-Explanation of the research and the criteria and the evaluation tool

So I think a system like this could help, like: **we have these issues coming from the building, we have noticed them and we came with these solutions and communicate it through the organization so that people can feel urged**. Furthermore, **flexible working has to be fixed for every position in the organization**. It is different for the employees that serve coffee (they do not have to flex), different for the employees responsible for the archives (they have to flex but in a way that they can keep paper in a drawer and have all the required staff), and different for me.

Appendix D

Statistical Analysis

Reliability Analysis

Reliability Statistics

Cronbach's Alpha	N of Items
,574	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis heb ik apparaten op zonne-energie (dwz fotovoltaïsche cellen, zonnecollectoren)]	5,99	3,446	,346	,529
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis heb ik zoveel mogelijk water besparende kranen geïnstalleerd]	5,14	3,100	,399	,449
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis heb ik zoveel mogelijk energiezuinige verlichting (LED) geïnstalleerd]	4,85	3,564	,410	,439

Reliability Statistics

Cronbach's Alpha	N of Items
,868	4

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
tempcontr	7,9885	10,174	,726	,829
lightcontr	7,6092	11,125	,696	,840
daylightcontr	7,8506	10,989	,694	,841
ventcontr	8,0690	10,809	,766	,813

Reliability Statistics

Cronbach's Alpha	N of Items
,683	3

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
windcontr	6,5287	4,508	,251	,868
exdoorcontr	5,3908	2,752	,662	,343
indoorcontr	5,0690	3,298	,635	,413

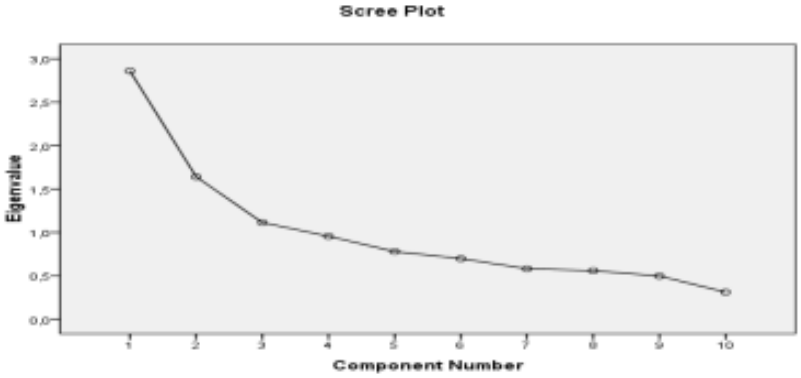
Factor Analysis for Environmental Awareness

The first steps of a factor analysis are the checking of some assumptions in order to see if a factor analysis can be conducted. To test the sufficiency of the sample, the tests of KMO measurement (with minimum 0.5) and the Bartlett's test (needs to be significant) should be conducted.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,674
Bartlett's Test of Sphericity	Approx. Chi-Square	174,057
	df	45
	Sig.	,000

Then the determinant of the correlation matrix should be checked to be over 0.00001, which is valid for this case. The next step is to check the correlation matrix and identify correlations over 0.5 but not higher than 0.9. Furthermore, the results of the scree plot and the total variance explained matrix explain that before extraction, SPSS has identified 10 linear components within the dataset and then based on eigenvalues over 1, the extraction is 3 factors.



Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,860	28,598	28,598	2,860	28,598	28,598	2,256	22,555	22,555
2	1,641	16,407	45,005	1,641	16,407	45,005	1,814	18,138	40,694
3	1,113	11,135	56,140	1,113	11,135	56,140	1,545	15,446	56,140
4	,956	9,560	65,699						
5	,779	7,795	73,494						
6	,698	6,983	80,477						
7	,582	5,820	86,297						
8	,560	5,596	91,893						
9	,498	4,982	96,875						
10	,312	3,125	100,000						

Extraction Method: Principal Component Analysis.

The most important matrix is the Rotated component matrix or Pattern matrix. After rotation for better interpretation, as it is obvious in the next matrix each question has a particular load on each component and so three components are clearly created that group questions.

Pattern Matrix[a]

	Component		
	1	2	3
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis zet ik de verwarming laag als ik het huis verlaat]	,852		
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis draai ik altijd de lichten uit als ik een kamer uit ga]	,800		
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Ik draai de kraan dicht tijdens het tandenpoetsen]	,567		
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Op het werk scheid ik mijn afval zoveel mogelijk]	,528		
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis heb ik zoveel mogelijk water besparende kranen geïnstalleerd]		,791	
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis heb ik zoveel mogelijk energiezuinige verlichting (LED) geïnstalleerd]		,663	
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis heb ik apparaten op zonne-energie (dwz fotovoltaïsche cellen, zonnecollectoren)]		,655	
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Ik gebruik zo veel mogelijk oplaadbare batterijen]			,887
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Bij de aanschaf van apparaten let ik op de energiezuinigheid]			,604
Milieubewustzijn: in hoeverre bent u het eens met de volgende uitspraken?[Thuis scheid ik mijn afval zoveel mogelijk]			,406

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 8 iterations.

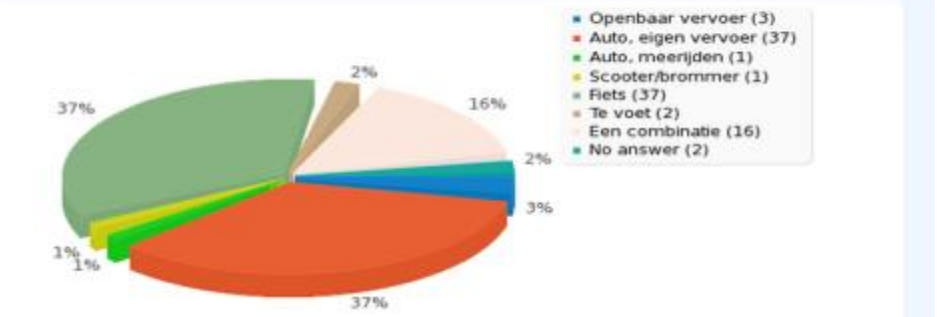
Environmental awareness – Means of transportation frequencies

With a sample of 97 valid and 2 missing responses, users were asked how they travel to the municipality. The main purpose of this question, along with the help of two other following questions, is to find out how 'green' the users of Leiderdorp are. The choice of a transport mean along with the distance of the housing from the town hall (next question) can reveal

an environment friendly user. The statistics can be seen in the next figure.

Hoe reist doorgaans u naar het gemeentehuis?

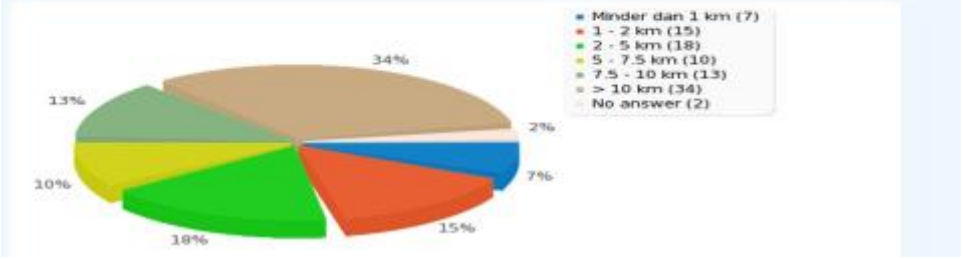
Answer	Count	Percentage
Openbaar vervoer (1)	3	3.03%
Auto, eigen vervoer (2)	37	37.37%
Auto, meerijden (3)	1	1.01%
Scooter/brommer (4)	1	1.01%
Fiets (5)	37	37.37%
Te voet (6)	2	2.02%
Een combinatie (7)	16	16.16%
No answer	2	2.02%
Non completed	0	0.00%



The next question is combined with the previous question and with a sample of 97 valid and 2 missing responses, it shows how far away from the town hall is in average the housing of employees.

Wat is de afstand van uw woning tot het gemeentehuis?

Answer	Count	Percentage
Minder dan 1 km (1)	7	7.07%
1 - 2 km (2)	15	15.15%
2 - 5 km (3)	18	18.18%
5 - 7.5 km (4)	10	10.10%
7.5 - 10 km (5)	13	13.13%
> 10 km (6)	34	34.34%
No answer	2	2.02%
Non completed	0	0.00%



According to the statistics and the similar results from SPSS, it can be noted that 34.3% stays more than 10 kilometers away from the town hall. This can be justified by the fact that the town hall is in a remote location. Moreover, this can justify in a manner the choice of the car and it can formulate the hypothesis that the choice of the bicycle is being made by users of the other categories (who live more near to the municipality).

The question of environmental awareness continues the work of the two previous questions. It is tried to find out if users acquire an environmental friendly behavior and if they are aware of sustainability issues. It is tried to find out at a first stage how many users agree or disagree with topics related to being environmental friendly and having habits that can name them 'green users'.

- **Turn off the lights when leaving a room (n=96 and 3 missing):** this aspect created a positive reaction to the users. 42.4% fully agreed and 29.3% agreed on being green

users and turning off the lights.

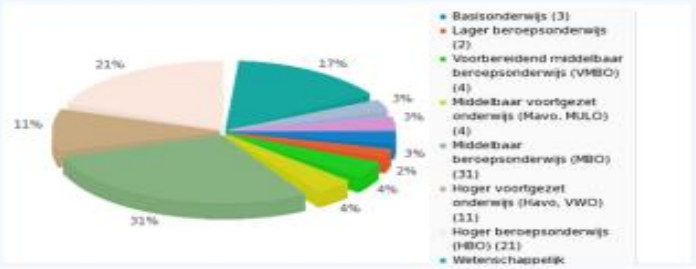
- **Decrease the heating when leaving the house (n=96 and 3 missing):** this aspect gained the most positive feedback with 45.5% of the users fully agreed and 32.3% agreed.
- **Close the tap while tooth brushing (n=95 and 4 missing):** users were again positive with 36.4% fully agreement and 31.3% agreement.
- **Owing at home devices with solar energy (photovoltaic, sun collectors etc.) (n=95 and 4 missing):** this aspect had the most negative response. 40.4% fully disagreed and 31.3% disagreed, which is somehow the reverse from the previous aspects.
- **Owing at home water saving taps/faucets (n=94 and 5 missing):** the percentages of this question are almost equally distributed. The response can be characterized neutral, as 27.3% chose to be neutral (they neither agreed nor disagreed), 26.3% agreed, 18.2% did not agree and 17.2% did not fully agree.
- **Owing at home energy efficient lighting (LED) (n=94 and 5 missing):** this question can also be characterized as creating a neutral response, with a possible positive tendency, as almost the same amount of users answered that they agreed and that they chose to remain neutral, 31.3% and 29.3% respectively.
- **Use of rechargeable batteries (n=95 and 4 missing):** users did not show a strong interest, as 29.3% of them chose to be neutral and the rest were equally divided into 25.3% with disagreement and 24.2% with agreement.
- **Be aware of energy saving/consumption while purchasing devices (n=94 and 5 missing):** this aspect created the second most positive response with a 42.4% of agreement. The next higher percentage is neutral with 24.2%.
- **Waste separation at home (n=94 and 5 missing):** both aspects regarding waste had similar percentages. 38.4% of the users agreed and 27.3% fully agreed.
- **Waste separation at work (n=95 and 4 missing):** again 38.4% of the users agreed and 24.2% fully agreed.

Education

The below figure indicates the level of education, which acquire the employees of the town hall. The sample in this question is 96 valid and 3 missing responses.

Uw hoogst genoten opleiding:

Answer	Count	Percentage
Basisonderwijs (1)	3	3.03%
Lager beroepsonderwijs (2)	2	2.02%
Voorbereidend middelbaar beroepsonderwijs (VMBO) (3)	4	4.04%
Middelbaar voortgezet onderwijs (Mavo, MULO) (4)	4	4.04%
Middelbaar beroepsonderwijs (MBO) (5)	31	31.31%
Hoger voortgezet onderwijs (Havo, VWO) (6)	11	11.11%
Hoger beroepsonderwijs (HBO) (7)	21	21.21%
Wetenschappelijk onderwijs (8)	17	17.17%
Zeg ik liever niet (9)	3	3.03%
No answer	3	3.03%
Non completed	0	0.00%



One drawn conclusion from the above statistics is that the 31.3% of the employees acquire a middle-level applied education (MBO) and 21.2% a higher education at universities of applied sciences (HBO) and 17.2% at research universities.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	,453	,981
	Cramer's V	,227	,981
	Contingency Coefficient	,413	,981
N of Valid Cases		86	

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	,581	,620
	Cramer's V	,290	,620
	Contingency Coefficient	,502	,620
N of Valid Cases		86	

Symmetric Measures

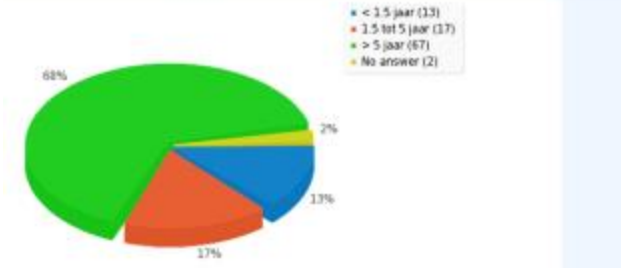
		Value	Approx. Sig.
Nominal by Nominal	Phi	,570	,674
	Cramer's V	,285	,674
	Contingency Coefficient	,495	,674
N of Valid Cases		86	

Years working for the organization

The below figure indicates the number of years that employees are working for the municipality. The sample in this question is 97 valid and 2 missing responses. The figure below shows that more than half of the employees (67.7%) work for the municipality for over than 5 years. The purpose of this question was to investigate the level of commitment that employees could have to their organization. The hypothesis is that the more years someone works for an organization, the more committed can be. The big percent and the number over the five years could indicate that most employees in the municipality are bonded with it. Further relations, if this bond could affiliate with the users' trust on the delivering of a good building, will be described later.

Hoeveel jaar werkt u al bij de gemeente Leiderdorp?

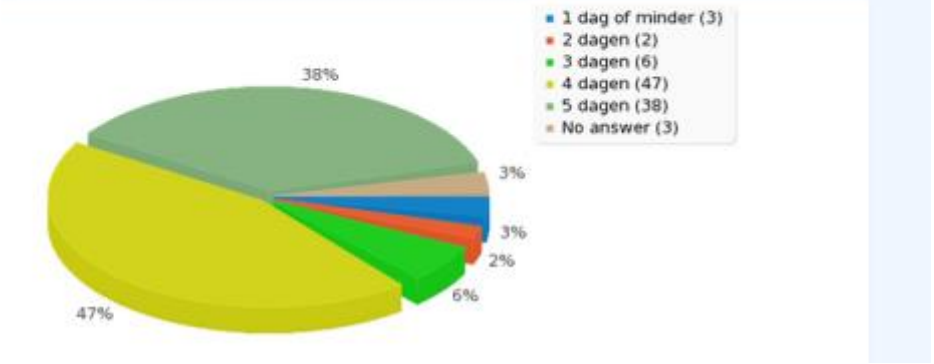
Answer	Count	Percentage
< 1.5 jaar (1)	13	13.13%
1.5 tot 5 jaar (2)	17	17.17%
> 5 jaar (3)	67	67.68%
No answer	2	2.02%
Non completed	0	0.00%



Working hours / Time spent

With the below statistics, it is investigated how much time employees spend in the town hall. This means, in addition, how many hours they work inside the building. The sample for this question is 96 valid responses and 3 missing.

Hoeveel tijd brengt u door in het gemeentehuis? Gemiddeld aantal dagen per week:		
Answer	**Count**	**Percentage**
1 dag of minder (1)	3	3.03%
2 dagen (2)	2	2.02%
3 dagen (3)	6	6.06%
4 dagen (4)	47	47.47%
5 dagen (5)	38	38.38%
No answer	3	3.03%
Non completed	0	0.00%

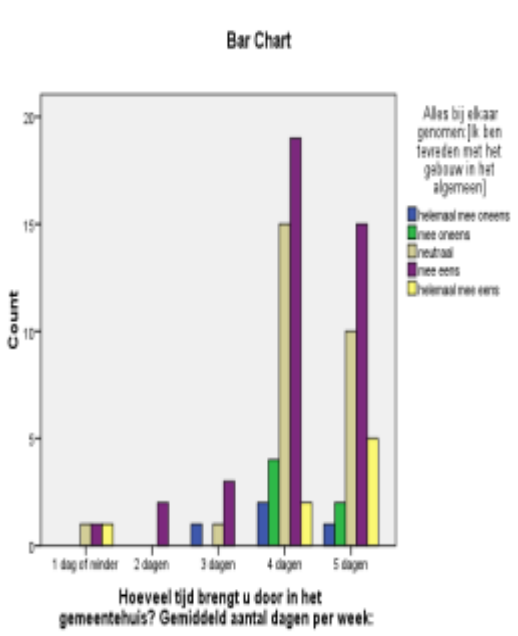


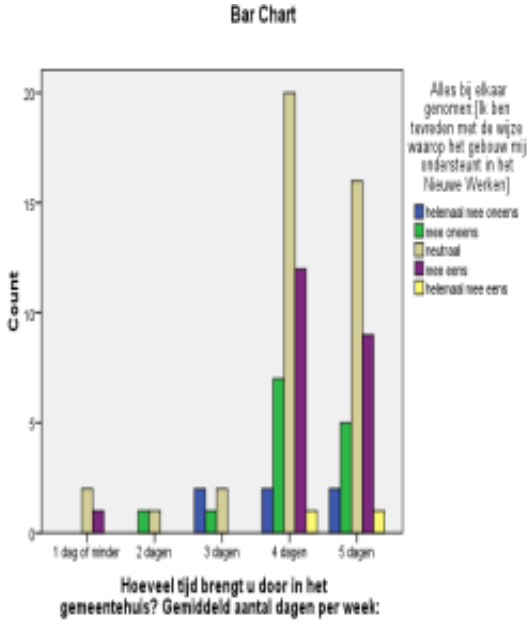
It can be said that the prevailing categories are 4 days (47.5%) and 5 days (38.4%). This can imply that the majority of employees work most of the days inside the town hall. This could relate to the concept of Nieuwe Werken and working from home, while it can be said that only 11% works outside the town hall during less than the half working days (5 days). Along with the feedback from the interviews that this concept is trying to be implemented the last months and with the above statistics, one conclusion can be that this concept is not yet so spread inside the organization.

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	,364			,793
	Cramer's V	,182			,793
	Contingency Coefficient	,342			,793
Ordinal by Ordinal	Gamma	,086	,158	,548	,584
N of Valid Cases		85			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.





Symmetric Measures

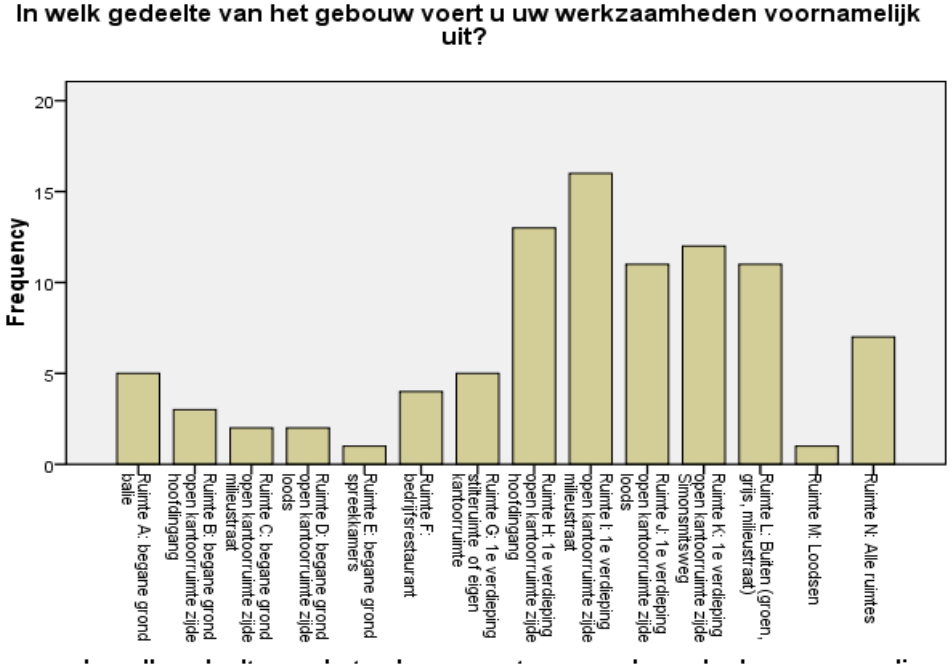
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Nominal by Nominal	Phi	,390			,677
	Cramer's V	,195			,677
	Contingency Coefficient	,363			,677
Ordinal by Ordinal	Gamma	,146	,148	,972	,331
N of Valid Cases		85			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Workplace / Spaces for main work activities

This question tries to specify where each user works and this will help in making later the correlations with other factors that relate to the location of the workspace (i.e. are users that work in open spaces more satisfied with aspects as visual privacy and acoustics?). With a sample of 93 responses and 6 missing, the percentages are shown below and more analytical in Appendix D.



From the above figure, it can be concluded that most of the respondents work in an open space office on the first floor (52.5 %) and the less used space in the building is the meeting rooms on the ground floor (1%) and the loods/engine house outside (1%).

Type of work activities

Apart from finding out where the workplace of each user is, it would be useful to find out what kind of activities users usually do. These answers can relate to Nieuwe Werken, but most importantly, they will be useful in making additional measures or corrective actions for the most answered activities.

Looking at the results in Appendix D, it is found that 45.5% of the users work at the computer very often, 25.3% are making telephones, 26.3% conferencing, 43.4% informal meetings with colleagues, 32.3% reading document files on an average scale and 35.4% make discussions with citizens in person seldom.

Experience of several areas

This question tries to research how users experience several areas and spaces inside the

building. According to their answers, solutions and preventive actions could be created in order to improve these spaces and as a result the users' satisfaction. The detailed percentages can be found in Appendix D.

- **Area A: Business restaurant/canteen (n=95 and 4 missing):** 51.5% think that it is good and 21.3% that it is neither good nor bad.
- **Area B: Common rooms on the first floor (n=91 and 8 missing):** 41.4% think that these rooms are neither good nor bad and 32.3% that these rooms are good.
- **Area C: Common rooms on the ground floor (n=91 and 8 missing):** 44.4% think that these rooms are neither good nor bad and 34.3% that these rooms are good.
- **Area D: Entrance / atrium (n=93 and 6 missing):** 47.5% think that it is good, 24.2% that it is neither good nor bad and 16.2% that the atrium is very good.
- **Area E: The pantries (n=93 and 6 missing):** 51.5% think that are good, 22.2% that are neither good nor bad and 13.1% that are bad.
- **Area G: Project rooms (council chamber and rooms from number 1 to 6) (n=93 and 6 missing):** 59.6% think that it is good and 23.2% that it is neither good nor bad.
- **Area H: Project Rooms on the first floor (7 and 8) (n=92 and 7 missing):** 46.5% think that these rooms are good and 31.3% that are neither good nor bad.
- **Area I: Meeting rooms (n=92 and 7 missing):** 54.5% think that these rooms are neither good nor bad and 29.3% that these rooms are good.
- **Area J: Toilets (n=94 and 5 missing):** 31.3% think that are good, 28.3% that are neither good nor bad, 17.2% that are bad and 11.1% very bad.
- **Area K: Changing rooms (n=94 and 5 missing):** 57.6% think that these rooms are neither good nor bad and 24.2% that these rooms are good.
- **Space L: Showers (n=92 and 7 missing):** 58.6% think that these rooms are neither good nor bad and 27.3% that these rooms are good.
- **Space M: Bicycle Storage (n=94 and 5 missing):** 31.3% think that are good, 30.3% that are neither good nor bad, 19.2% that are bad and 11.1% very bad.
- **Space N: Parking deck (n=92 and 7 missing):** 39.4% think that it is good and 36.4% that it is neither good nor bad.

Control over the building

This question opens the category of the evaluation of the working environment. As a first step, users are asked about their satisfaction regarding the control they have over their building and its building systems. This question will also try to bring to the surface any existing problems regarding the systems. The question refers to systems as heating, lighting, ventilation etc. These are described below and in detail in Appendix D.

- **Temperature control (n=89 and 10 missing):** refers to how users feel about the temperature in their building and about the possibilities, they have to control it. This could mean through the thermostats that are installed on the walls. Unfortunately, 28.3% are very dissatisfied and 18.2% dissatisfied with the amount of control they have.
- **Artificial lighting control (n=87 and 12 missing):** 31.3% of the users responded in a neutral way. They did express neither satisfaction nor dissatisfaction with the lighting systems while the other percentages are almost equally distributed in satisfied and dissatisfied users.
- **Daylight access (n=87 and 12 missing):** the same applies to their opinion about their access to daylight. 31.3% responded neutrally and 21.2% answered that they are very dissatisfied.
- **Ventilation control (n=88 and 11 missing):** created mixed responses with a tendency

to negative feelings, as 27.3% were neutral, 25.3% dissatisfied and 23.2% very dissatisfied.

- **Ability to open/close the windows (n=88 and 11 missing):** was strongly judged by users as they replied that 38.4% of them are very dissatisfied and 24.2% dissatisfied.
- **Ability to open/close the exterior doors (n=87 and 12 missing):** created neutral and a few positive responses with 34.3% were neither satisfied nor dissatisfied and 19.2% were a little bit satisfied.
- **Ability to open/close the interior doors (n=87 and 12 missing):** created neutral and a few positive responses with 36.4% were neither satisfied nor dissatisfied and 24.2% were a little bit satisfied.

Working environment and other layouts / services

While conducting a survey for investigating users' satisfaction, it is very important to investigate occupants' comfort. This is affected by many aspects, which are answered by users. Occupant comfort is closely related to all the systems of the building and other services offered. According to the level of agreement and disagreement, users expressed their positive or negative feelings for their working environment and comfort. These aspects are named below and in detail in Appendix D.

- Feeling cold (n=89 and 10 missing): 36.4% of the users were neutral on feeling cold, 19.2% agreed and 17.2% strongly agreed.
- Feeling warm (n=89 and 10 missing): 38.4% of the users were neutral on feeling warm, 20.2% disagreed and 16.2% strongly disagreed. Along with the previous aspect, this gives an insight into how users regarding temperature and heating, tend to agree on feeling cold.
- Fresh air (n=89 and 10 missing): 37.4% of the users disagree and 31.3% of the users are neutral.
- Sufficient humidity (n=89 and 10 missing): 26.3% of the users disagree while 43.4% of the users are neutral.
- Sound privacy (n=89 and 10 missing): 40.4% of the users strongly disagree and 21.2% of the users rather disagree with that statement.
- Background noises (n=88 and 11 missing): 37.4% of the users are neutral while 21.2% of the users agree.
- Ability to concentrate in an open space office (n=88 and 11 missing): 25.3% of the users strongly disagree and 20.2% of the users rather disagree. There is a 33.3% of the users which is rather neutral.
- Need to work in a silent room for more concentration (n=88 and 11 missing): 39.4% of the users are neutral and 30.3% of the users agree.
- Need to work in a silent room for aesthetic reasons (n=88 and 11 missing): 13.1% of the users strongly disagree and 19.2% rather disagree. On the other hand, 42.4% of the users are feeling neutral.
- Visual comfort (n=88 and 11 missing): 31.3% of the users are neutral while 34.3% of the users agree.
- Satisfaction with daylight access (n=88 and 11 missing): 30.3% of the users are neutral and 36.4% of the users agree.
- Sufficient space on each workplace (n=87 and 12 missing): 49.5% of the users agree that they have enough room on their workspace.
- Sufficient personal office storage space (n=87 and 12 missing): 50.5% of the users agree with the statement.
- Easy and quick access to other colleagues (n=87 and 12 missing): 22.2% of the users

are neutral. In addition, 43.4% agree and 20.2% of the users strongly agree.

- Sufficient rooms to meet and discuss with visitors (n=87 and 12 missing): 33.3% of the users are neutral and 37.4% of the users agree.
- Visual privacy (n=87 and 12 missing): 33.3% of the users are neutral and 25.3% of the users agree.
- Ability to make easily changes on the individual workplace (n=88 and 11 missing): 25.3% of the users are rather neutral while 46.5% of the users agree with the statement.
- Frequent use of the service bike (n=88 and 11 missing): 21.2% of the users strongly disagree and 24.2% of the users rather disagree. On the other hand, 35.4% of the users remain neutral.
- Good maintenance of the building (n=88 and 11 missing): 37.4% of the users are neutral while 33.3% of the users agree.
- Good cleaning of the building (n=88 and 11 missing): 35.4% of the users are neutral and 35.4% of the users agree.
- Beautiful building (n=88 and 11 missing): 34.2% of the users are neutral while 32.3% of the users agree that the building is beautiful.
- Feeling safe inside the building (n=88 and 11 missing): 26.3% of the users are neutral and 48.5% of the users feel safe.
- Feeling safe outside of the building (n=88 and 11 missing): 26.3% of the users are again neutral while 50.5% feels safe.
- Sufficient parking space (n=88 and 11 missing): 18.2% of the users disagree that there is sufficient parking space. 26.3% remains neutral while 31.3% of the users agree with the statement.
- Parking on the roof according to the rule (n=88 and 11 missing): 33.3% is neutral while 18.2% agrees. There are 26.3% of the users, who strongly agree with the statement.
- Sufficient handicapped accessibility (n=88 and 11 missing): 32.3% of the users remain neutral while 37.4% of the users agree with the statement.

Forgiveness factor

Statistics

		In hoeverre bent u het eens met de volgende uitspraken?[Ik vind de lucht voldoende fris (geen bedompte lucht, geen geurtjes)]	In hoeverre bent u het eens met de volgende uitspraken?[Ik vind het te koud]	In hoeverre bent u het eens met de volgende uitspraken? [Visueel comfort van de verlichting (Ik ondervind geen last als gevolg van schittering, helderheid, reflecties, contrast)]	In hoeverre bent u het eens met de volgende uitspraken?[Ik heb geen last van achtergrond geluid (Ventilatiesysteem, Verlichting, Apparatuur, van buiten)]	Alles bij elkaar genomen:[Ik ben tevreden met het gebouw in het algemeen]
N	Valid	89	89	88	88	86
	Missing	10	10	11	11	13
Mean		2,74	3,35	3,28	2,81	3,49
Median		3,00	3,00	3,00	3,00	4,00
Mode		3	3	4	3	4
Sum		244	298	289	247	300

Additional satisfaction factors

There also some other factors that affects users' satisfaction that could not be included in

the previous question of occupant comfort according to the working environment and are analyzed separately. These are described below and in detail in Appendix D.

- **Familiarity with the building (n=84 and 15 missing):** 43.4% of the users sated that agree on the fact of being familiar with the building, 18.2% strongly agreed and 21.2% were neutral.
- **Knowledge of the operation of the systems (n=86 and 13 missing):** 32.3% of the users were neutral about their agreement or disagreement on knowing how building systems operate and 27.3% agreed that they know how.
- **Sufficient information on the sustainability of the building (n=85 and 14 missing):** 42.4% of the users again neither agreed nor disagreed on the fact if they received enough information about the sustainability of the building, while 21.2% agreed they did receive and 13.1% disagreed.
- **Ability to report a defect/failure of the building (n=85 and 14 missing):** Almost half of the respondents, 50.5%, agreed that they know how and where they could report a flaw in the system. This could mean either failure of a building system or a deficiency or a defect or just a complaint. 19.1% were neutral in their answers.
- **Satisfaction with handling of remarks/complaints (n=85 and 14 missing):** as an extension to the previous factor, 38.4% of the users were neutral about their satisfaction, 19.2% agreed that they are satisfied on how they are complaints and remarks are dealt with and 18.2% disagreed.
- **Sustainable building (n=85 and 14 missing):** 46.5% neither agreed nor disagreed on the fact of acknowledging the building as sustainable, 21.2% agreed and 11.1% disagreed.
- **Satisfaction with Nieuwe Werken (n=86 and 13 missing):** 42.4% of the users were neutral in their answers, if they are satisfied with the way the building supports them under the concept of the Nieuwe Werken. 22.2% agreed that they are satisfied and 14.1% disagreed.
- **Sustainable catering (n=86 and 13 missing):** 54.5% were neutral to give an opinion about the catering of the restaurant, if it is sustainable or not, coming from sustainable production. 20.2% agreed that it is sustainable.
- **Sustainable equipment in the restaurant (n=86 and 13 missing):** 51.5% neither agree nor disagree that the equipment in the restaurant for hot drinks is sustainable, 18.2% agreed and 13.1% disagreed.
- **Overall satisfaction (n=86 and 13 missing):** 40.4% of the users expressed their satisfaction with the building overall, 28.3% were neutral, 8.1% strongly agreed on being satisfied, 6.1% disagreed and 4.1% strongly disagreed.

Additional comments / remarks: Answers from the last question Q15 on comments

ID4: Here it is very dry (dry eyes, throat) and a little women unfriendly by the many glass walls all the way to the floor. It's noisy here through the open space. The quiet rooms are mostly all occupied

ID6: The solar panels are missing so that it could be visible from the outside that it is a sustainable building. Also the promotion for this is missing…For example, this car is permanently charged by the solar panels present. Such a slogan can make anyone cheerful and optimistic!

ID8: Very dry air, absolutely no privacy, ventilation makes a lot of noise and when the sun shines, poor visibility on screen

ID9: Disturbing in the study is that there is not a not applicable option. Number of things, as

the use of the showers, is not applicable for me. I have scored these issues therefore very dissatisfying.
ID12: Comments should be not obligatory
ID14: It is a shame that during the development of the building not sufficient attention has been paid to installing even higher energy efficient equipment. We should look at better energy-saving equipment, such as lights and daylight sensors on the workplace ceilings, to prevent facts as atrium lighting be on the whole day, etc. Also by heating the WKO, which happens electronically.
ID15: The position of the sun and the installation of so much glass are not taken into account at all. In summer it is too hot (and the sun shines on your computer screen) and there is a huge glimpse. Anyone walking by can have a view on computer screens. Moreover, there is one outside door opening in the wrong direction because it was not taken into account how the wind blows against the building. There is now a wind tunnel that already broke the door twice when opened.
ID16: I missed some questions "I do not know" because I have never been in that spaces. I also do not see the connection with the commuting distance. I miss something about working from home
ID17: Something should be done with the acoustics. Transferable sound is large, both from the pantries and from the big workplaces (8 workplaces together)
ID18: The temperature in the building is too cold and this has not yet been solved!
ID21: I am very sorry that warm and cold external influences were not taken into account. This makes it very hot on sunny days and very cold on cold days in the workspaces.
ID25: The outdoor space of the building should be better maintained. Sweep every Monday morning. Put some flower boxes/planters on Willem Alexanderweg.
ID26: As sustainability is concerned, it may be that lights are kept on even when they are not needed. Think about the parking deck and the lighting (ground spots) around the building. It seems that no one thought that more energy could be saved from that. In addition, the building should have less lights on when there is no one is in the building.
ID27: I missed the 'not applicable' answer, so I gave answers that are incorrect. For example: ‘’I always park on the roof, as agreed’’. I do not have a car so that does not apply to me. I filled in 'neutral'. What I think of the parking I filled in 'bad', because I think that the ramp must be heated (for winter). I just do not use it.
ID28: I do not use all the rooms/spaces in the building but there wasn’t a no applicable option in the question
ID29: No comments. Sometimes you could include write an answer as not applicable for example ... Some questions are unnecessary, for example if you always come with the bike and questions about the parking deck.
ID30: Parking roof is perceived as negative, very bad toilets / urinals can often not be used and smell a little bit, always cold feet and draught, we cannot open a window, bad position of the restaurant because we have to walk through the atrium, sometimes lot of noise occurs during public meetings in the atrium. This is very unpleasant during working hours if you work in the office space on the ground floor. The entrance for weddings looks shabby
ID32: Note about the survey: you are required to fill in answers while you do not have experience with some spaces, such as changing rooms, showers. In such a case, it would be better to use an empty column or a column with ‘no experience’

ID33: Noise and lack of contact with the outside (an open window) are my biggest objections to the building. As a cyclist, I am unsatisfied with the lack of storage space both inside and out. Bonding with the building, as part of job satisfaction in the concept of HNW (het nieuwe werken – flexible working) is overlooked.
ID34: Too much noise coming from the pantry, there should be more clear separation between workplaces and pantry
ID37: The urinals are useless and unhealthy. The air that comes out from the dispose without water is disgusting. In addition, the view of the lot of public hair that sticks into this, gives you reason to vomit. In addition, there are far too few toilets in the changing rooms so that the men of the 'outdoor service' also make excessive use of the ladies toilets. The staff that works in the cafeteria does not keep the tables and chairs clean. This makes you often eat on the dirty spots of the day before.
ID41: The building is fine, with nice lighting and modern but the acoustics is a drama and this defines/constrains your work to a significant extent.
ID42: You are too much in an open view. The sun reflects on the computer screen and there is nothing to do for the glare. In addition, the air humidity could be better.
ID43: Cold and impersonal lousy shed/dump
ID45: There are not enough urinals in the changing rooms of the outdoor service. Missed opportunity!!?
ID46: ICT should be much better and the toilets on the ground floor near the pantry have been broken for months and are very unhealthy.
ID48: The toilets on the ground floor (urinals) are terribly dirty because you cannot flush them. A terrible air comes from there. In the cafeteria, tables are poorly cleaned and they are too dirty sometimes to eat. There is no toilet in the outdoor workplace so I have to go to the town hall and if the door does not work, I have to do a long walk.
ID49: Too small amount of silent rooms. It is not convenient that there are landline phones. I miss a shelf / table in the toilets to put your belongings. The red lounge sofas are beautiful to look at but they are uncomfortable; more pillows are needed in the back. It is not convenient that the building is cleaned during office hours. The white floor at staff entrances is clumsy. The cleaners can continue mopping and cannot take pride in their work. I find it very annoying that no window can be opened, especially in the silent rooms. The steep slope to the parking deck is scary.
ID50: Excellent work building
ID51: I am disappointed that the ramp to the parking deck is not heated at freezing temperatures. I miss places where you can discuss in pairs (internal) while using a computer easily.
ID52: The lighting during closing hours is not right yet. Regularly, I see the big hall lighting still burning during the weekend. I could not judge the sustainability as discussed in the last questions could not be assessed.

ID53: the interior climate should be better controlled. Nuisance of colleagues is a matter of behavior change and users are not yet sufficiently used to good use of the building and its flexible layout
ID54: It would be nice if we had better coffee and more fresh air.
ID57: The building is very noisy and therefore, there is difficulty in concentrating. The

building is often cold and therefore same concentration problems may occur (at least with me)

ID58: The noise and the vibrations are the biggest complaints. Moreover, there are only a few rooms for a personal conversation without being heard or viewed by others.

ID62: too few men toilets in the changing rooms, it is not possible to quickly empty you bladder, approximately 30 men for 2 WC

ID63: Tips: better shading, better heating, toilets that have actually to flush, more privacy at and around the workplaces and more noise control, the many white walls as place for information or art?

ID65: Especially the temperature control falls short: in my workplace, it is too cold in the winter and too warm when the sun is shining

ID67: Beautiful location

ID68: It should be possible to turn off the the lights, especially when there is enough natural light from outside

ID69: I experience the building as too cold during both the winter and the summer. There is often a flow of cold air coming from the ventilation.

ID72: The cold in the building is really an issue. There is too much noise in general, apart from the silent rooms, meeting rooms and the workplaces behind the ground floor counter. As the day proceeds, my eyes get dry and red.

ID76: Entering through the back to the bike shed: pass gets already blocked when I am out of the office from Friday to Monday. Can the number of days be extended?

ID77: I feel inadequate privacy to conduct confidential conversations. In function with many meetings avenges for direct superiors not having an own space.

ID89: the restaurant is not clean. There are only a few toilets in the building on the side of the canteen and the urinals are qualitatively bad.

ID90: the toilets for the field outside are a great drama, there are no urinals and colleagues go to the women's restroom. For several months, there are bicycles in the bike shed that are not used. Clean that shit!

ID91: Improving cleaning of toilets, workplaces, meeting rooms and canteen. Actually, the cleaning should be generally better.

Factors that influence the environmental awareness

Warnings

No variables were entered into the equation

Descriptive Statistics

	Mean	Std. Deviation	N
Sustainable everyday habits	,0036655	1,00485111	92
Uw Profiel	1,60	,493	92
Leeftijd	3,80	1,141	92
Uw hoogst genoten opleiding:	5,96	1,696	92
Hoe reist doorgaans u naar het gemeentehuis?	4,01	1,958	92

Warnings

No variables were entered into the equation

Descriptive Statistics

	Mean	Std. Deviation	N
Waste management and energy consumption	-,0056587	1,00398123	92
Uw Profiel	1,60	,493	92
Leeftijd	3,80	1,141	92
Uw hoogst genoten opleiding:	5,96	1,696	92
Hoe reist doorgaans u naar het gemeentehuis?	4,01	1,958	92

Correlations

		Willingness to invest on sustainability at home	Uw Profiel	Leeftijd	Uw hoogst genoten opleiding:	Hoe reist doorgaans u naar het gemeentehuis?
Pearson Correlation	Willingness to invest on sustainability at home	1,000	,117	,290	-,241	-,126
	Uw Profiel	,117	1,000	-,044	-,218	-,303
	Leeftijd	,290	-,044	1,000	-,169	-,019
	Uw hoogst genoten opleiding:	-,241	-,218	-,169	1,000	,060
	Hoe reist doorgaans u naar het gemeentehuis?	-,126	-,303	-,019	,060	1,000
Sig. (1-tailed)	Willingness to invest on sustainability at home	.	,133	,003	,010	,115
	Uw Profiel	,133	.	,339	,018	,002
	Leeftijd	,003	,339	.	,054	,430
	Uw hoogst genoten opleiding:	,010	,018	,054	.	,286
	Hoe reist doorgaans u naar het gemeentehuis?	,115	,002	,430	,286	.
N	Willingness to invest on sustainability at home	92	92	92	92	92
	Uw Profiel	92	92	92	92	92
	Leeftijd	92	92	92	92	92
	Uw hoogst genoten opleiding:	92	92	92	92	92
	Hoe reist doorgaans u naar het gemeentehuis?	92	92	92	92	92

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Leeftijd	.	Forward (Criterion: Probability-of-F-to-enter <= ,050)

a. Dependent Variable: Willingness to invest on sustainability at home

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-,966	,352		-2,741	,007	-1,666	-,266					
	Leeftijd	,255	,089	,290	2,877	,005	,079	,432	,290	,290	,290	1,000	1,000

a. Dependent Variable: Willingness to invest on sustainability at home

The relationship between green users and satisfaction aspects

Correlations

		Waste management and energy consumption
Waste management and energy consumption	Pearson Correlation	1
	Sig. (2-tailed)	
	N	93
Factor of knowledge and information	Pearson Correlation	,238*
	Sig. (2-tailed)	,031
	N	83
Factor of sustainability	Pearson Correlation	,007
	Sig. (2-tailed)	,952
	N	84
Factor of overall satisfaction	Pearson Correlation	,034
	Sig. (2-tailed)	,761
	N	84

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

		Willingness to invest on sustainability at home
Willingness to invest on sustainability at home	Pearson Correlation	1
	Sig. (2-tailed)	
	N	93
Factor of knowledge and information	Pearson Correlation	,136
	Sig. (2-tailed)	,220
	N	83
Factor of sustainability	Pearson Correlation	,171
	Sig. (2-tailed)	,119
	N	84
Factor of overall satisfaction	Pearson Correlation	,013
	Sig. (2-tailed)	,906
	N	84

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		Sustainable everyday habits
Sustainable everyday habits	Pearson Correlation	1
	Sig. (2-tailed)	
	N	93
Factor of knowledge and information	Pearson Correlation	,272*
	Sig. (2-tailed)	,013
	N	83
Factor of sustainability	Pearson Correlation	,056
	Sig. (2-tailed)	,614
	N	84
Factor of overall satisfaction	Pearson Correlation	,164
	Sig. (2-tailed)	,137
	N	84

*. Correlation is significant at the 0.05 level (2-tailed).

Control over the building

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Willingness to invest on sustainability at home	.	Forward (Criterion: Probability-of-F-to-enter <= ,050)

a. Dependent Variable: Control over systems

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,636	,113		23,260	,000
	Willingness to invest on sustainability at home	,265	,114	,246	2,323	,023

a. Dependent Variable: Control over systems

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Factor of sustainability	.	Forward (Criterion: Probability-of-F-to-enter <= ,050)
2	Uw hoogst genoten opleiding:	.	Forward (Criterion: Probability-of-F-to-enter <= ,050)
3	Factor of knowledge and information	.	Forward (Criterion: Probability-of-F-to-enter <= ,050)

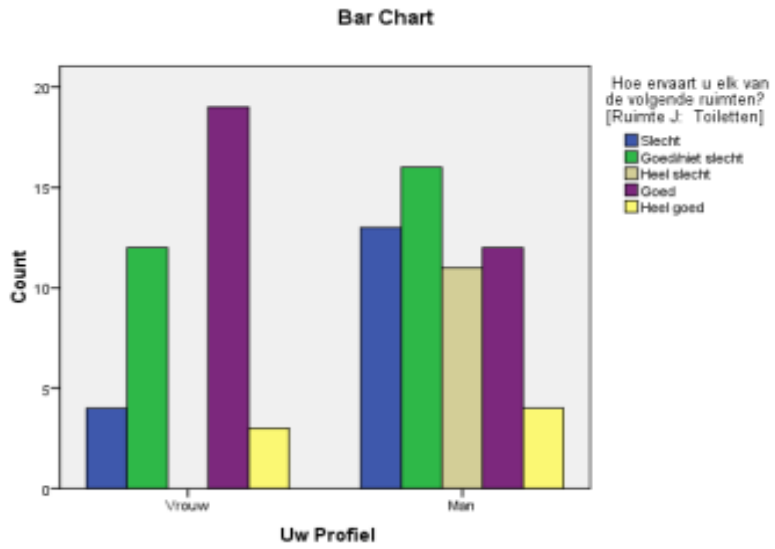
a. Dependent Variable: Control over systems

Coefficients[a]

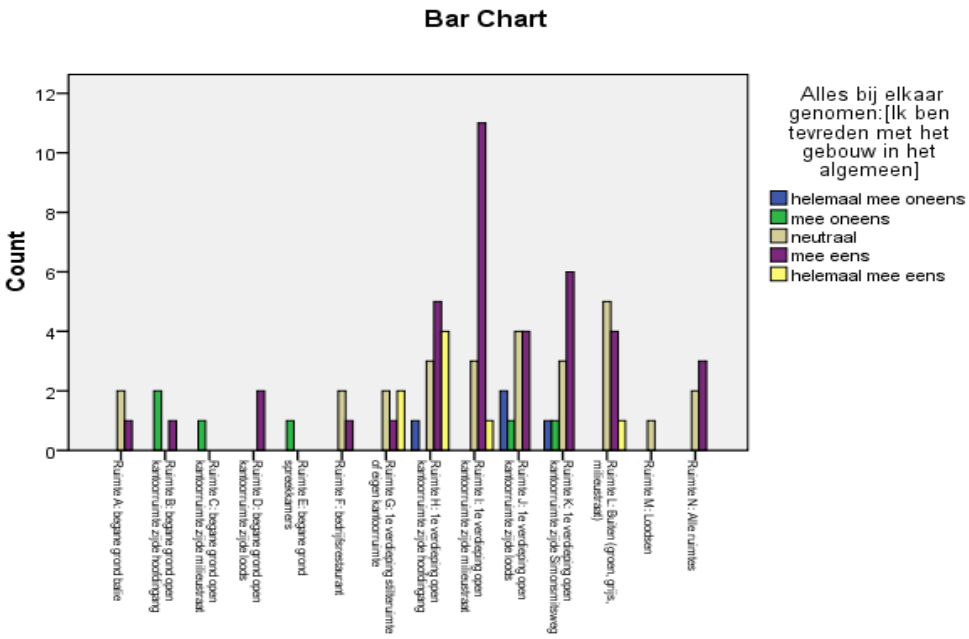
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,025	,595		,041	,967
	Factor of sustainability	,826	,185	,441	4,455	,000
2	(Constant)	1,278	,726		1,761	,082
	Factor of sustainability	,759	,180	,406	4,224	,000
	Uw hoogst genoten opleiding:	-,172	,061	-,269	-2,801	,006
3	(Constant)	,110	,843		,130	,897
	Factor of sustainability	,677	,177	,362	3,820	,000
	Uw hoogst genoten opleiding:	-,189	,060	-,295	-3,155	,002
	Factor of knowledge and information	,451	,179	,237	2,512	,014

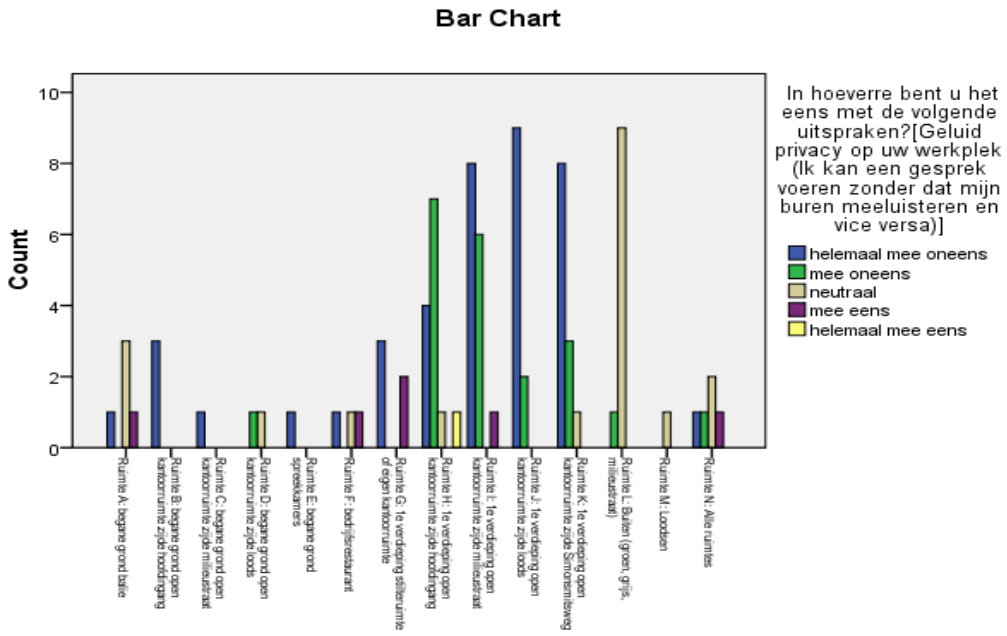
a. Dependent Variable: Control over systems

What users dislike (toilets)



Type of workspaces and satisfaction



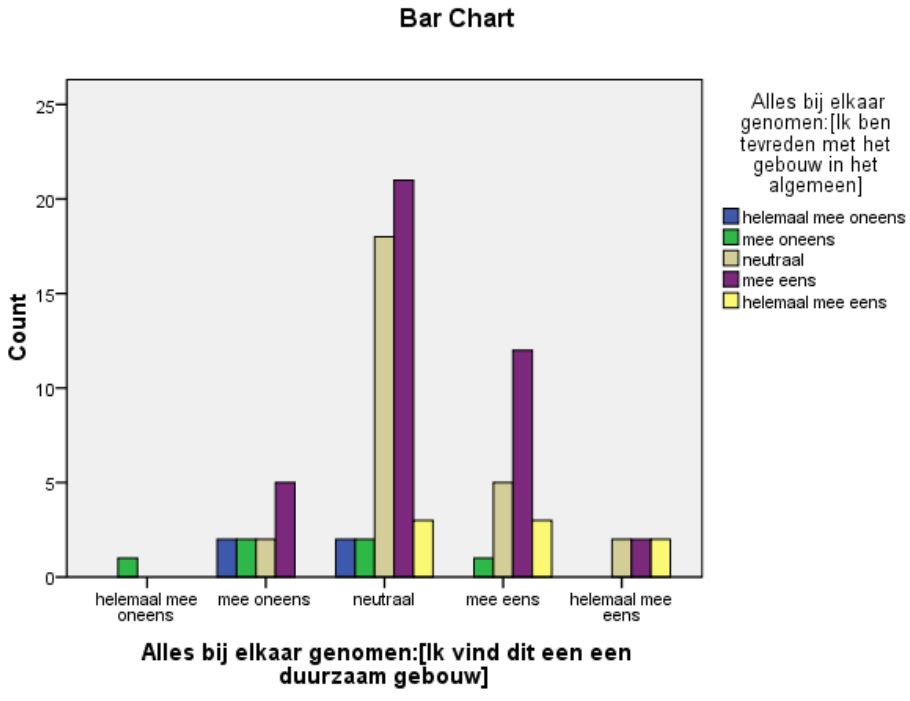


Perspectives towards sustainability and satisfaction

Correlations

			Alles bij elkaar genomen:[Ik ben tevreden met het gebouw in het algemeen]	Alles bij elkaar genomen:[Ik vind dit een een duurzaam gebouw]
Spearman's rho	Alles bij elkaar genomen:[Ik ben tevreden met het gebouw in het algemeen]	Correlation Coefficient	1,000	,304**
		Sig. (2-tailed)	.	,005
		N	86	85
	Alles bij elkaar genomen:[Ik vind dit een een duurzaam gebouw]	Correlation Coefficient	,304**	1,000
		Sig. (2-tailed)	,005	.
		N	85	85

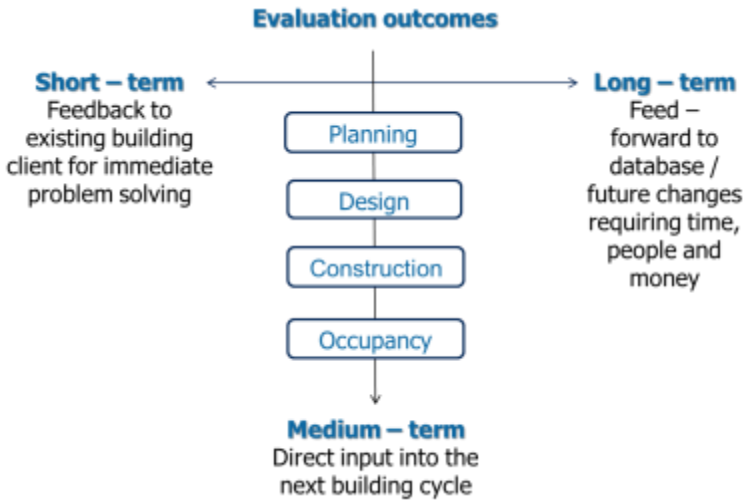
**. Correlation is significant at the 0.01 level (2-tailed).



• Appendix E

The suggested 'action list' for the Town Hall of Leiderdorp

The results from the statistical analysis gave significant feedback in order to be able to create some possible actions that the municipality of Leiderdorp could do. According to the concept of Building Performance Evaluation these actions, after the evaluation outcomes can be divided in short, medium and long term actions. The below figure is a more clear summary of the initial picture in the second chapter.



The focus of this thesis is orientated mainly towards actions that could be done immediately and without requiring too many resources. Because it is a true that when medium and long term actions are required, usually time, money and people are necessary and it is uncertain to what extent an organization is willing or able to dispose such resources.

Short-term

Needed second performance measurement with an assessment tool

First, the issue of the used assessment tool has to be solved. The municipality had used during the design the GPR tool with the results indicated in Chapter 4. However, the measurement of the sustainable building performance should not be conducted only once. Based on the unavailable information regarding technical data and performance measurements, it seems that a second measurement is mandatory. As stated in the literature research, GPR In Use is in progress and it can be said that this could be used for the second measurement in order also to have the same criteria to compare. However, considering again the literature study on existing tools, GPR seems rather inappropriate. There are tools as LEED and Open House that entail more useful and accurate criteria. Furthermore, if these tools are not preferred because of their limited use in the Netherlands, BREEAM NL is also a good choice.

Operational and Organizational actions

It was found that a type of management system is always required inside an organization. This type could be a Building Automation System (BAS) or a Building Management System (BMS). These systems monitor and check if all systems inside the building operate on normal levels. It was found that the town hall owns such a system. However, due to important role

of this system and some uncertainties inside the organization about if all the systems are monitored sufficiently, it would be suggested for a more close monitoring and a continuous updating of it.

Furthermore, in each organization a management team that would be responsible of operational and organizational issues is always needed. This could be the implementation of facility management and enhancement of the role of facility managers. The role of facility managers could focus on monitor certain building performance aspects on a daily basis, while being also responsible for user needs, comments, and represent client requirements more strongly. One example of their responsibilities could be the change of operation hours of systems in order to achieve less energy consumption and better performance. This change (from 6.00 am to 19.00 pm and not 22.00 pm) is already into consideration by the municipality.

The creation of a help desk facility, organized by facility managers, to which occupants of the town hall could turn for any aid at any time, would increase users' satisfaction. A similar mechanism, as the team of facility managers, could be the use of specialized teams in the building as 'resident experts' who will be familiar with the operation of the facility in question. Moreover, to ensure the success of such teams, feedback from the users is always needed. Therefore, the creation of an online platform for information and feedback could be lifesaving. Users will be able to post any type of comment on this forum/platform and phrase complaints, compliments or suggestions for their own building.

In addition, in the next table, some actions are described according to the issues of concern that should be first priorities for the municipality.

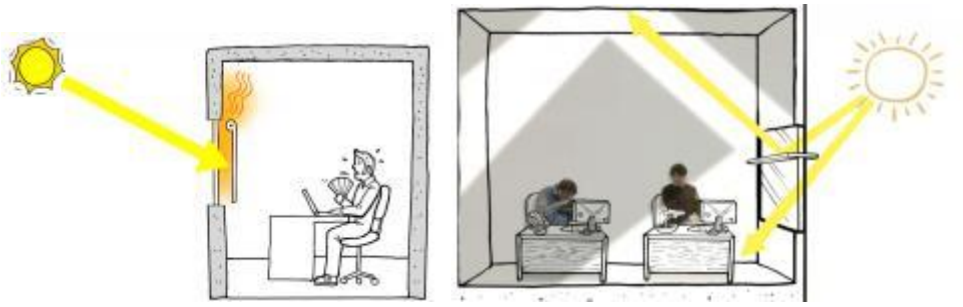
Issues of concern (as indicated by employees)	Possible actions
Heating system (sense of feeling cold and having inadequate temperature)	Double-checking the operation of the WKO with the BMS Showing of graphs to the users as evidence that WKO operates normally (derived from contractor)
Inconvenient Means of Transport	Car sharing themes Demand to regional authorities for better public transport access
Parking (dangerous during winter)	Heated ramp
Toilets and Restaurant	Better green cleaning (replacement of urinals)
Lighting system (inadequate access to daylight, too hot during the summer)	Fixing of daylight sensors Planting of trees on the correct side and orientation (probably on the southern and western side of the building) Installation of shading on windows from the exterior side

Acoustics (too noisy and need for more silent rooms)	Foam panels on the walls, creation of artificial silent rooms

Some ideas or suggestions that have proved to work elsewhere and concern actions towards the lighting system and acoustics (the most problematic systems now in the town hall) are:

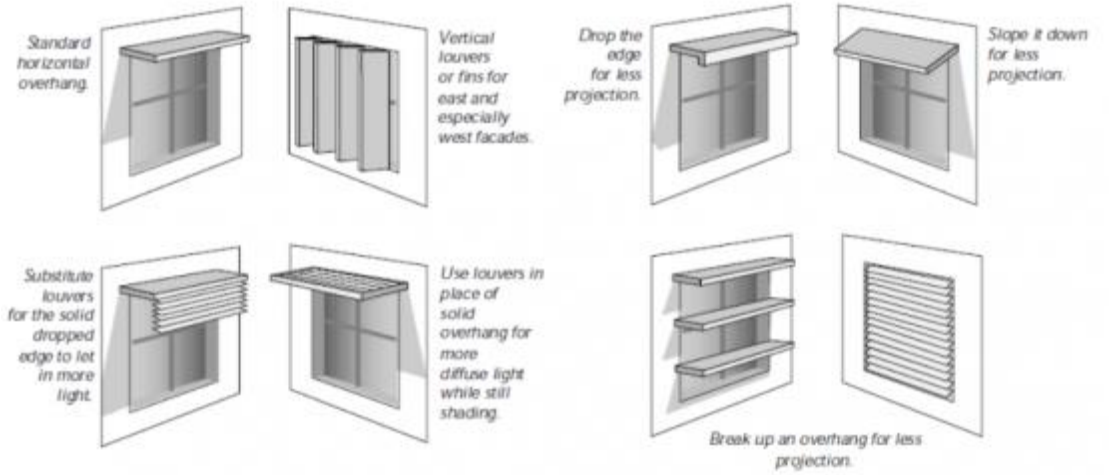
For the lighting system

The need of installing shading on windows is necessary because of complaints regarding increasing temperatures due to sunlight during sunny days and of too much glare from computer screens. With the installations of shadings, the sustainable performance of the building will be also improved by maintaining the inside temperature on the standard levels. It was found that a first attempt from the town hall was to install interior shades. However, these shades did not seem efficient, as indicated also in the next picture.



Interior shades can improve visual comfort, but do not block solar heat gain. Therefore, exterior shades are more suitable as some strategies also indicate in the next figure.

In addition, to prevent the glare form the computer screen, one easy solution is a light shelf avoiding glare and pulling daylight deeper into the room.



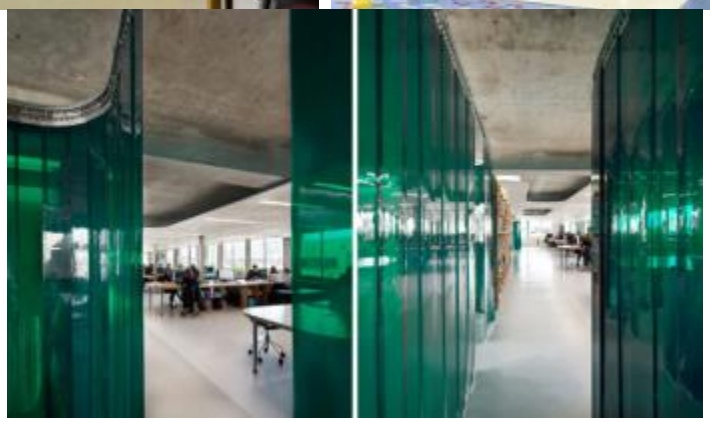
For Acoustics

The intense complaints about noise should lead to solutions that would minimize the noise level and increase users' satisfaction. One easy and cost efficient option are the acoustic foam panels, which could be easily installed and function as art on the walls.


For the need for more concentration, visual and sound privacy (expressed from the users), some options are separation methods in order to create more closed spaces and silent rooms. These changes are characterized by flexibility and therefore, the innovative character of the design with open spaces remains intact. Some examples, created from famous architects, are shown below.







Medium and Long- term

After describing some suggested actions that the municipality could do in short-term, some other possible actions that should concern the municipality more in the future could be indicated. As stated also before, such actions usually need more time, people and money and therefore it is totally up to the municipality (and every organization respectively) to decide what they are able to do.

Monitoring and Surveys

In the whole research, the importance of monitoring has been emphasized. Many assessment tools have prerequisites for frequent inspection processes and audits (as LEED has the ASHARE Walkthrough method). Along with these audits, performance reports could be created in order to show exactly how the building performs and responds to all its systems. The inspections and audits can be conducted every six months and the reports could be annual. The importance of conducting surveys has also been highlighted in this thesis. In order to find out about users' satisfaction and other issues that may concern the organization of the town hall, it would be wise to first research how users would response to possible implementation of actions and policies. One example occurred in the town hall, was the implementation of the Nieuwe Werken. However, it seemed that many users are not satisfied with this. It is possible that if a survey was conducted beforehand with asking the opinion of employees, they would be more tolerant and open to the concept afterwards. In general, significant surveys that can be conducted are Occupant Satisfaction Surveys (as the one conducted for this research) and Thermal Comfort Surveys at least once a year.

Documentation

Additionally, another important aspect for the organization is to have documentation for every aspect that concerns the building performance and the users. As it will be described later on, creation of manuals are important. These manuals can be divided into the two next categories with the below characteristics:

- Building User Manual (either online or provided as a hard copy) for the user
  - Simple explanation of the operation of the systems
  - Report of annual energy consumption
  - Transport Possibilities
  - Waste Policy (Promotion of recycling)
- Operation and Maintenance Manual for facility managers
  - Technical and more in detail explanations and instructions for the operation of the systems
  - If existing contractors and outsourcing, demanded information
  - Monitoring and Maintenance strategies

Validation of the results through the workshop

The above actions along with the results from the statistical analysis were presented to the town hall and it can be stated that this presentation and the feedback afterwards worked as a validation of the conducted survey. The most important conclusions from this were that the results met the expectations from both sides, which means that hypotheses were proved correct based on the initial literature study and these hypotheses and other frequencies were expected from the side of the municipality. There are some negative emotions on some features on the building which require attention and adjustments and these are mainly toilets, acoustics, Nieuwe Werken and the lighting system. Furthermore, one positive unexpected result that created partly enthusiasm to the town hall was the high forgiveness factor, which implies the positive willingness of respondents/users inside the town hall. At the end, after discussion, it was concluded that developing monitoring and evaluation strategies for the above issues will be another priority for the municipality. In addition, it is agreed that applying the appropriate monitoring tool for keeping the building sustainable is also an urgent matter and the choice between GPR and other tools will be discussed. Finally yet importantly, it is also agreed that it is of foremost importance the promotion of sustainable behavior and enhancing the 'greenness' inside the users.