Eindhoven University of Technology

MASTER

Reducing the energy consumption in the office environment

how people in the office environment can be influenced to save energy
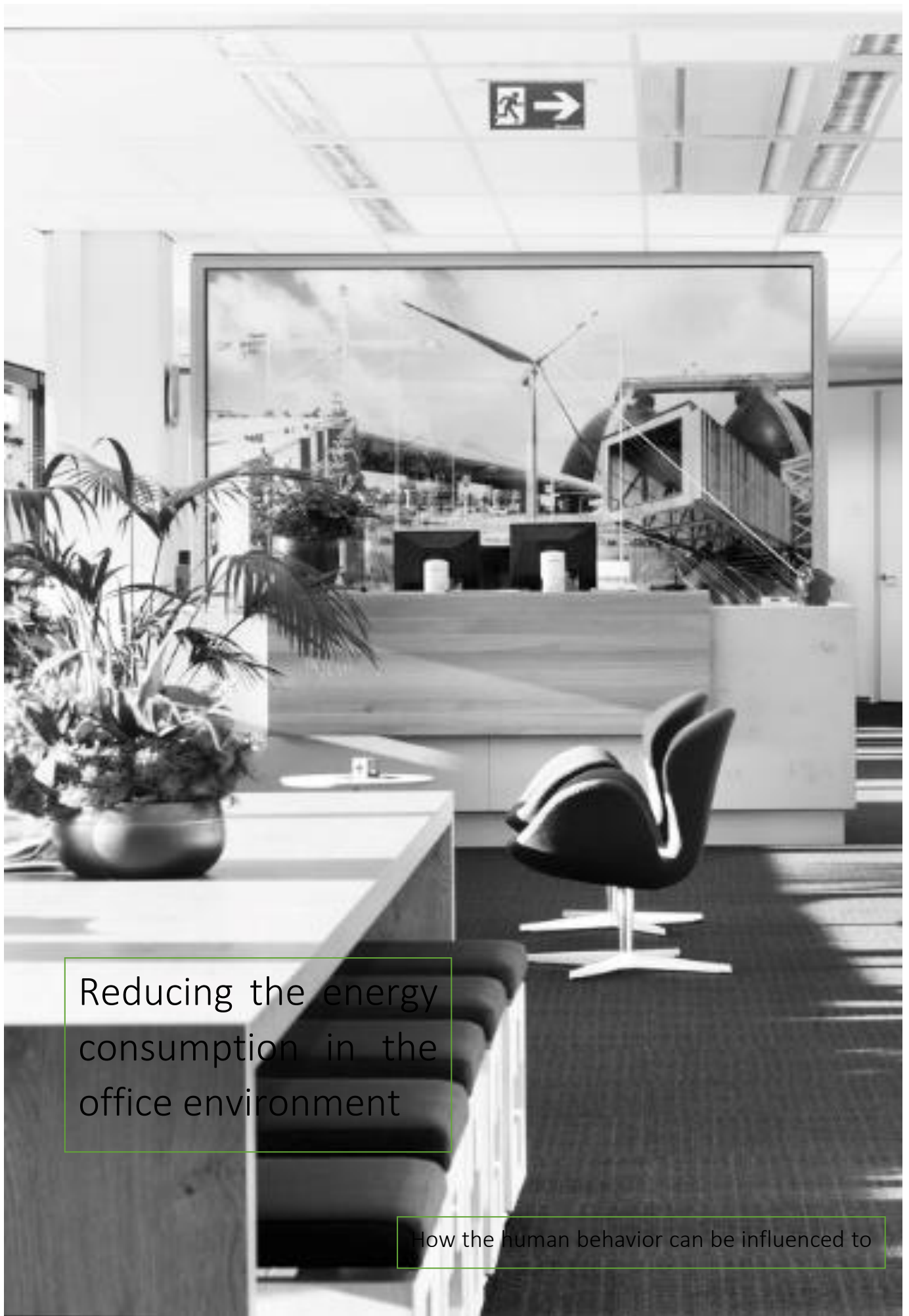
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How the human behavior can be influenced to

Master of Science Thesis

Reducing the energy consumption in the office environment

How people in the office environment can be influenced to save energy

by

J.H.E. van Eeden
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Construction Management and Engineering

at Eindhoven University of Technology

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Cover image on the front page: Witteveen+Bos beeldbank

J.H.E. van Eeden

Preface

The master thesis is the result of my graduation project about how the people in the office environment can be influenced to reduce the energy consumption. This project will complete the study Construction Management and Engineering at the University of Technology Eindhoven. The research is collaborated and conducted in the office environment of Witteveen+Bos, which is a consultancy company which is located over the world.

I would like to thank the graduation committee for their support and expertise during the last months. It was interesting to learn about the possibilities to save energy in the office environment, however, it will be hard to motivate all the people. It was nice to get familiar in the office environment of Witteveen+Bos, and therefore I like to thank the people who made this possible, provided information and for their contribution of this project.

Also a special thanks to my friends, family and boyfriend for their support, help and interest in the research. It was nice to receive supporting words, but most of all the motivation!

Enjoy the report,

Anne van Eeden

December 2016

J.H.E. van Eeden

Summary

Reducing the amount of CO_2-emission is an important topic during the international climate conferences. Here fore, agreements for 2020 made by the European Commission. The current share of energy consumption of the built environment is approximately 35% of the total energy consumption in The Netherlands. Whereby the ratio between the residential and non-residential buildings is around 50-50 (RVO, 2015). The share of gas in this total amount is around the 40% (Aardgas in Nederland, 2016) and the CO_2-emission is around 25% of the total CO_2-emission (Kadaster, 2011). Through developments and innovations in the built environment, the possibilities and capabilities have changed. Nowadays people can realize Zero Energy buildings and even Positive-energy buildings. The government is supporting the plans to realize such buildings to reduce the energy consumption and reduce the amount of CO_2-emission. However, not only new buildings should be considered to reduce the energy consumption. People believe that sustainability mainly can be achieved by building new buildings, but attention to the preservation of the existing office buildings is likely to remain in the background (Agentschap, 2010).

Therefor the question raised, why wait until people revoke ZEB and PEB buildings and influence them to adjust their behavior for energy conservation, while the majority of the built environment consists of existing offices. Therefore during this research, the possibilities to influence the human behavior to reduce the energy consumption in the office environment will be researched. The question will be answered by conducting a case study in the office environment of Witteveen+Bos. The people in the office environment will be researched, in combination with the office environment and PLUSwerken, whereby the possibilities and the preferences of those people will be investigated.

First a literature study was conducted to research the possibilities to reduce the energy consumption by influencing the people within the office and residential environment. Hereby the possibilities were investigated for influencing the human behavior, the possibilities for energy conservation and the difference for implementing these possibilities between the residential and office environment. The key aspect which must always be kept in mind is the fact that the most important difference between the residential environment and working environment is the responsibility of the bill. In the residential environment people are responsible, but in the working environment, they are just occupants, and the bill is not their responsibility (Murtagh, et al., 2013). Besides, the energy costs are a fraction of the total costs of the company expenses, and therefore not the prime focus point. This is pointed out as one of the important aspects based on this review.

Further the awareness needs to be created for the occupants, to change their behavior. Therefor the research concluded that five forms of interventions can be implemented to achieve energy reductions. The first intervention is rewarding. The human behavior can be rewarded with social rewards and monetary rewards. However, the monetary rewards, suggest a bigger motivation, but the effect is lived out shorter. The second intervention is in the form meetings, presented as presentation and workshops. During the intervention information will be shared about the energy consumption. The participants will receive feedback about the energy use and revenues and react based on the received knowledge. The third intervention is game-intervention, during this intervention, people participate at an online platform, which is connected to their energy consumption. In case they use less energy compared to the average, they receive benefits within the game. If the participant use more energy than average, they receive disadvantages within the game. By receiving information in terms of feedback, people like to behave, and change differently, to receive the benefits. The fourth intervention is sharing information. This is presented in different ways, such as emails or information screens. Whereby the occupants of the building receive information, and reject based on the information, for example if the energy use of the elevator shows a peek, people are more stimulated to take the stairs. The last intervention is feedback, this is divided into two forms, public

feedback and private feedback. Using private feedback, people receive feedback based on their usage, and with groups feedback people receive feedback based on the group, this stimulates more of a group feeling.

Followed by a field research in the PLUSwerken environment of Witteveen+Bos. This environment is based on the "flexwerken", which is type of working is a flexible concept for working. Desks in the office environment are not assigned to one person, which means people can sit wherever they want and the desks are provided with the necessary facilities to carry out the work. During this field research, observations were conducted at the offices in Amsterdam, Antwerp and Breda. The observations were necessary for the habitual behavior of the people in the environment, even as for the possibilities of implementing. During the observations informal interviews were held to question people about their experiences and needs. Further the use of the spaces was investigated, what are the main routes, which spaces are frequently occupied.

To answer the question about who are the people in the office environment of Witteveen+Bos, interviews were held. During these interviews, questions for the questionnaire were answered and confirmed after which they could be tested and used, and a picture was created of the employees of Witteveen+Bos. Besides, the interviews were useful to discuss possible solutions and other possibilities which can raise awareness for energy reductions in the office environment.

The questionnaire was distributed to 10% of the Dutch population of the offices of Witteveen+Bos. The responds rate was 63%. After collecting information about the socio-demographics, work, attitudinal and socialization factors, the respondents were asked to answer 16 questions containing 32 profiles for possible implementations which can be implemented to reduce the energy consumption. During these questions people had to select their choice they prefer the most, containing the interventions as the results of the literature study, namely, presentation, workshops, information screens, and game intervention. The profiles were supplemented with three attributes, the required effort for the participant for preparation and participation, the frequency of the repeat of the intervention, and the level of interaction during the intervention.

The results of the choice experiment show that the information screens is the most preferred intervention. When comparing the attributes, it is remarkable that the respondents prefer the lowest level of effort and interaction, and the longest time between the interventions. Based on the results the main question could be answered. How can the human behavior in the office environment be influenced to reduce the energy consumption? The results show that if people will participate to reduce the energy consumption, they prefer this based on the lowest effort. The most preferred profile contains the information screens, low effort, even as the interaction, with a weekly frequency. However, using one intervention will possibly have affect for a certain period, a combination of interventions will be based on the marketing strategy have a longer effect on the human behavior. Therefore a combination of information screens, combined with a competition and presentation will be suggested as a strategy to influence the human behavior to reduce the energy consumption. By proving information about the energy consumption of the building, in combination with feedback, people will come be aware about their contribution on the energy consumption. This will influence their behavior and actions within the office environment.

Samenvatting

Het terugdringen van de CO_2 uitstoot is al jaren een belangrijk onderwerp tijdens klimaattoppen door de afspraken die zijn gemaakt bij de Europese Commissie. Het huidige energie gebruik van de gebouwde omgeving bedraagt momenteel ongeveer 35% van het totale energie gebruik in Nederland. Hierbij is de verhouding tussen de woonomgeving en de kantoor omgeving ongeveer 50-50 (RVO, 2015). Het aandeel gas van het totale energie gebruik is rond de 40% (Aardgas in Nederland, 2016), en is ongeveer 25% van de totale CO_2 uitstoot (Kadaster, 2011). Door de veranderingen en de ontwikkelingen in de bouw is men in staat om energie besparende en zelfs energie opwekkende gebouwen te realiseren, waardoor een deel van de CO_2 uitstoot teruggedrongen kan worden. Maar als de totale CO_2 uitstoot terugdrongen dient te worden, is het ook belangrijk om te focussen op de bestaande bebouwing. Mensen zijn overtuigd van het feit dat duurzaamheid behaald kan worden door het realiseren van nieuwe gebouwen, maar er is ook aandacht nodig voor het verduurzamen en behoud van de bestaande gebouwen (Kadaster, 2011).

Daarbij moet er gedacht worden aan de vraag: *"Waarom wordt het gedrag van mensen pas aangepast voor nieuwe neutrale of positieve gebouwen, terwijl de meerderheid van de gebouwen in Nederland, bestaande bouw is?"* Daarom is er tijdens dit onderzoek gekeken naar de mogelijkheden om het menselijke gedrag aan te passen in de kantoor omgeving om energie te besparen. Dit is onderzocht in de kantoor omgeving van Witteveen+Bos. Hier is door middel van een case studie, onderzocht hoe het gedrag van de mensen in de werkomgeving beïnvloed kan worden om energie te besparen. Er is gekeken naar de mogelijkheden samen met de voorkeuren van de mensen in de kantooromgeving van Witteveen+Bos, waarna dit in kaart is gebracht.

Het onderzoek begon met een literatuur studie waarbij de mogelijkheden om energie te besparen zijn onderzocht in combinatie met het menselijke gedrag. Hierbij is gekeken naar het menselijke gedrag in verschillende omgevingen, kantoor omgeving evenals de huislijke omgeving, en hoe dit beïnvloed kan worden. Een belangrijk aspect waar altijd rekening mee dient gehouden te worden is, dat mensen in de privé omgeving anders omgaan met energie gebruik, omdat men in deze omgeving verantwoordelijk voor de rekeningen is. In de kantooromgeving is hier geen sprake van deze verantwoordelijkheid, en op de rekening van de verantwoordelijke zijn de energiekosten maar een fractie vergeleken bij de andere kosten zoals personeel en vastgoed (Murtagh, et al., 2013).

Uit het onderzoek blijkt dat het creëren van bewust zijn bij de mensen in de kantoor omgeving erg belangrijk is om energie te besparen. Dit is gebleken uit de vijf interventies die zijn beschreven om het energie gebruik te verminderen, waarbij bewust zijn is gecreëerd. De eerste interventie is het belonen. Het belonen van het menselijke gedrag kan op twee manieren gebeuren in de vorm van een sociale beloning of financiële beloning. De financiële beloning klinkt meer stimulerend, alleen is het, gebaseerd op onderzoek, maar van korte duur, terwijl de sociale beloning veel langer effect heeft. De tweede interventie is in de vorm van voorlichtingen. Hierbij kan gedacht worden aan een presentatie of workshop, waarbij kennis gedeeld kan worden over het energie gebruik en energie besparende maatregelen besproken kunnen worden. De derde interventie is een game interventie, bij deze vorm wordt er gebruik gemaakt van een online platform waarop mensen aangesloten zijn, die hun gebruik bijhouden. Indien mensen minder energie gebruiken, ontvangen zij voordelen voor hun spel, indien meer gebruik dan gemiddeld plaatsvind, ervaren zij nadelen in het spel. Hierdoor worden mensen meer bewust van hun gebruik ten opzichten van hun omgeving. De vierde interventie is het delen van informatie door middel van e-mails of informatieschermen. Hierdoor ontvangen mensen informatie over het gebruik in het gebouw, een voorbeeld kan bijvoorbeeld zijn een scherm bij de lift die laat zien wat de lift aan energie gebuikt, mocht dit een piek laten zien, zijn mensen

vaker bereid om de trap te nemen. De laatste interventie die in de literatuur wordt besproken is het gebruik van feedback in twee vormen, persoonlijke feedback en groepsfeedback.

Na het bestuderen van de mogelijke interventies, zijn er observaties in de kantooromgeving van Witteveen+Bos gehouden. Hierbij is PLUSwerken ingevoerd, de manier van "flexwerken", een flexibele manier voor werken in de kantooromgeving waarbij niemand een vaste werkplaats heeft. Mensen hebben geen eigen bureau en zijn dus vrij om te gaan zitten waar men wil. Alle bureaus zijn uitgerust met een extra scherm en kantoor benodigdheden, om het werk te kunnen verrichten. De locaties waar dit is ingevoerd en die bezocht zijn: Amsterdam, Antwerpen en Breda. De observaties waren nodig om de omgeving van de mensen te ontdekken, en ook hoe de mensen zich in deze omgeving gedragen en om eventuele oplossingen te bedenken. De observaties zijn aangevuld met informele interviews waarbij mensen hun ervaringen en wensen of klachten konden bespreken. Tijdens de observaties is er gekeken naar het gebruik van de open ruimtes, de routes die mensen gebruiken en hoe het gebruik is van de afgesloten werkruimtes.

Om de vraag te kunnen beantwoorden wie de mensen in de omgeving van Witteveen+Bos zijn en wat zij belangrijk vinden, zijn formele interviews gehouden. Deze input is later gebuikt voor het opstellen van een vragenlijst. Het doel van de interviews was om de interventies te bespreken, hoe zouden deze ontvangen kunnen worden. De belangrijkste informatie die benodigd was tijdens deze interviews was de vraag: Hoe bereid zijn de mensen in de kantoor omgeving van Witteveen+Bos bereid om energie te besparen? Daarnaast was er gevraagd of de geïnterviewde nog andere oplossingen kon bedenken om mensen bewust te maken om energie te besparen.

Om te vast te stellen wat men in de werkomgeving van Witteveen+Bos belangrijk vindt, is er een vragenlijst samengesteld die is verspreid onder 10% (96) van de Nederlandse werknemers van Witteveen+Bos. Hierop heeft 63% gereageerd, 60 respondenten, waarbij informatie is verzameld over hun achtergrond, zoals bijv. geslacht en opleiding. Maar ook vragen over energie zijn gesteld. Het onderzoek bestond uit 24 vragen en 16 keuzes. Deze keuzes gingen over de interventies waarbij mensen uit twee keuzes, voor hen de beste konden kiezen. Hierbij zijn vier interventies gebruikt: presentatie, workshop, informatieschermen en game interventie. Waarbij verschillende attributen waren gekoppeld zoals de moeite die de interventie kost, de mate van herhaling en het niveau van interactie. Op basis van de uitkomst van deze keuzes is er een plan bedacht waarop energie bespaard kan worden in de werkomgeving van Witteveen+Bos.

De resultaten van het keuze experiment concluderen dat de informatie schermen de meeste voorkeur ontvangen. Waarbij een opvallend gegeven is dat mensen altijd kiezen voor de laagste vorm van moeite en interactie, en de langste tijd tussen de interventie willen. Gebaseerd op alle resultaten is het mogelijk om de hoofdvragen van het onderzoek te beantwoorden: hoe kan het menselijke gedrag beïnvloed worden in de kantooromgeving om energie te besparen? Het meest gekozen profiel in het onderzoek is het profiel met de informatie schermen, in combinatie met een wekelijkse update, lage interactie en de minste moeite. Gebaseerd op de marketing strategie, is het toepassen van een interventie niet genoeg om mensen voor een langere tijd te beïnvloeden. Daarom is een combinatie voorgesteld van informatie schemeren, samen met een interne competitie en presentaties om het menselijke gedrag te beïnvloeden. Bij het verstekken van informatie over het energie gebruik binnen een gebouw, in combinatie met feedback, worden mensen bewust van hun bijdrage met betrekking tot het energie gebruik. Dit zal leiden tot een beïnvloeding van hun gedrag en acties in de kantoor omgeving.

Table of content

List of figures

List of tables

Glossary

Nieuwe werken   Flexible way of working. Office space with no assigned desks. The office space consisted of different spaces to stimulate the productivity of the employees within the office environment. Whereby all the spaces are provided with accessories and furniture.

PLUSwerken   Nieuwe werken concept based on and implemented by Witteveen+Bos

Traditional way of work Everybody has an assigned desk in a room, which is private or shared.

NZEB   Nearly zero energy building. Building which uses sustainable energy only and whereby the energy performance coefficient is zero. The amount of the energy consumption the building needs is generated by itself.

PEB   Positive energy building. Building which uses sustainable energy only and whereby the energy performance coefficient is zero. The amount of the energy consumption the building needs and extra is generated by itself.

BENG   Bijna energy neutraal gebouw. Dutch concept of NZEB.

Chapter 1

Introduction

This chapter introduces the topic for this research. The motivation for this research will be described in paragraph 1.1, where the background of the subject will be discussed. The relevance of the research will be described in paragraph 1.2, the problem definition. The research boundaries, which will set limits to the research possibilities, will be discussed in paragraph 1.3. However the fact that the research will be conducted at the offices of Witteveen+Bos, the company will be introduced as well in 1.4. During the research the main question will be divided into sub questions which will be discussed in paragraph 1.5, even as the research design. Finally, in paragraph 1.6 the reading guide described the aim of the following chapters.

1.1 Background

The current share of energy use of the built environment is approximately 35% of the total energy consumption in The Netherlands. Whereby the ratio between the residential and non-residential buildings is around 50-50 (RVO, 2015). The share of gas is around 40% in this total amount (Aardgas in Nederland, 2016) and the CO_2-emission is around 25% of the total CO_2-emission (Kadaster, 2011). In 2007 plans and targets to the reduce the CO_2-emission have been set and described in the Environment Management Act. The European Commission agreed to reduce the CO_2-emission in 2020 with 20% relative to the CO_2-emission of 1990(EEA, 2016). Through developments and innovations in the built environment, the possibilities and capabilities have changed. Nowadays people are able to build Zero Energy buildings and even Positive-energy buildings. The Dutch government is working on a policy to reduce the energy consumption, which is called 'Nationaal Plan' to foster BENG(Bijna Energie Neutrale Gebouwen) buildings. In English known as NEZB (Nearly zero energy buildings) or PEB (Positive energy buildings). The plan claims that new buildings should meet the requirements for a NEZB from the end of 2018 for governmental buildings, and other buildings must meet these requirements from the end of 2020. The government will stimulate this by setting clear goals for the parties involved by establishing clear rules and regulations, raising a broad support for residents and users, and by encouraging adequate knowledge among actors by providing space for experimentation.

However, not only new buildings should be considered for reducing the energy consumption. People believe that sustainability mainly can be achieved by building new buildings, but attention to the preservation of the existing office buildings is likely to remain in the background (Agentschap, 2010). For many non-residential buildings the combination of legal obligations and financial simulations is insufficient to achieve the policy targets. On the longer term there are plans to deal with existing buildings to make them energy efficient (Vringer et al., 2014).

The owners/managers and tenants of the non-residential buildings are not concerned with the energy savings. Consciously and unconsciously the Environment Management Act is ignored. This is mainly due to the lack of enforcement and partly because for many of them it is not a priority. The knowledge about the cost effectiveness of energy saving measures are often unknown. Energy savings should be encouraged and greater awareness must be created by owners and tenants as well as by more stringent enforcement of the Environmental Management Act. The proposed Energy Performance Assessment may help if the implementation of the measures would become compulsory. The government is developing a policy which promotes to renovate existing building into NZEB buildings (Vringer et al., 2016).

1.2 Problem definition

The government is working on a plan to reduce the energy consumption in the built environment by designing requirements for a policy to achieve more NZEBs. Research has shown that energy-efficient buildings often need considerably more energy in use than originally predicted (Ornetzeder, Wicher, & Suschek-Berger, 2015). The way in which the buildings are used at this time might be just as important and interesting to research. The user actions are unpredictable and can have an adversely effect on the energy efficiency in a building (Kolokotsa, Rovas, Kosmatopoulos, & Kalaitzakis, 2011). The energy consumption of the buildings is not the result of the building itself but the result of the use by people of the building (Janda, 2011). Energy waste in organizations has several causes. One of the causes is the behavior of the employees, for example; unnecessarily burning of lights; not switching off the heating and the unnecessary use of devices. This is often not a matter of unwillingness, but lack of clear frameworks. Guidelines and rules might make a big difference (Jonkers, 2010). Therefore can be stated that people within the office environment have knowledge about sustainable behavior, but due to the lack of guidelines they do not feel the urge to apply this behavior within the office environment. Masoso (2009) claimed in an article that the behavioral change has more energy saving potential, compared than that of technical solutions (Masoso & Grobler, 2009).

1.3 Boundaries

The main objective in this research is to research the possibilities to reduce the energy consumption by influencing the human behavior within the office environment. However, due to the lack of time and resources there will be a couple of limitations compiled. The first limitation is the fact that the research will be conducted within the environment of Witteveen+Bos, meaning other office environments will not be involved for this research, which makes this research a case-study. The second restriction is the research into the physical conditions in relation to the climate of the space. In the current environment of Witteveen+Bos people have access to a thermostat and are able to open windows, for heating and cooling. However, the ventilation and air-conditioning are unavailable therefor it will be impossible to measure the preferred environment for the people within the office environment of Witteveen+Bos.

1.4 Witteveen+Bos

Witteveen+Bos is established in 1946 by Prof.ir. G.S. Bos and ir. W.G. Witteveen, with the aim to advice on urban planning and infrastructure, and established an engineering company. Their mission was to "work to help people to live safely" (Bos, 2016). Nowadays, the company is spread worldwide with more than 1.000 employees and a leading company at the Dutch market. The company is headquartered in Deventer and counts nine other offices across The Netherlands and Belgium. In addition, the company has also offices spread over eight other countries around the world. The research will be conducted in the office environment of Witteveen+Bos. The reason to choose for this company is the fact that they are consultants which are involved in all kinds of projects from infrastructure to the development of buildings for different kind of clients. From governmental assignments to private assignments, which makes their present knowledge a broad spectrum. Many projects are multidisciplinary and can include complex issues. Witteveen+Bos has developed over the last years their own way of "het nieuwe werken" called 'PLUSwerken' which is implemented in four of their offices in Amsterdam, Antwerp, Breda and Dubai. It means that the workplaces are available to everyone, thus not assigned to a specific person. This way of working will be implemented at the Leeuwenburg office in Deventer, after the renovations which are planned for next year.

The building will be provided with new insulation, and new installations for heating and cooling will be installed. During the renovation the building will be renovated into a more energy-efficient building, but not be transformed into a NZEB. At this moment the building and floors are used in the traditional way of working. Which means that the floors are organized with individual offices assigned to a specific person.

The research which will be conducted in office environment of Witteveen+Bos will be a case study. Using field research to research the environment of PLUSwerken in Amsterdam and Breda, whereby people in the working environment will be asked about their experiences related to PLUSwerken. This means PLUSwerken will be observed, by analyzing how people will use the floors and their movements through the building. To investigate the thoughts, experiences and expectations concerning PLUSwerken and how this influences their work and productivity.

1.5 Research questions

The main question for this research can therefore be formulated as followed:

How can the human behavior be influenced in the office environment of Witteveen+Bos to reduce the energy consumption?

This main question can be dived in the following sub-questions:

1. What is the relation between the human behavior and the energy consumption?

2. Which methods and approaches are used to influence the human behavior in order to reduce the energy consumption?
3. What kind of intervention strategies can be applied in the office environment?
4. Does the PLUS environment influence the preferences for interventions to reduce the energy consumption?
5. How can the people within Witteveen+Bos be grouped to investigate the differences of preferences?
6. Are there differences in preferences for the interventions based on groups within the environment of Witteveen+Bos?

Question 1
Before it is possible to make statements about how the human behavior can be influenced to reduce the energy consumption, it is important that the human behavior is described even as the energy consumption. Therefore, this question is included to describe the relation between the human behavior and the energy consumption.

Question 2
Before it is possible to research how the human behavior can be influenced to reduce the energy consumption, previous researches need to be studied. By describing and studying these methods and approaches, plans to influence the human behavior can be made.

Question 3
There are already research conducted in the human behavior in relation with reducing the energy consumption. However, interventions need to be studied, which proved they could influence the human behavior in order to reduce the energy consumption. For example, in the residential environment, people receive information using TOON (Eneco, 2016) about their energy consumption and act on this, but which methods can be used in the office environment.

Question 4
Within Witteveen+Bos there are two concepts for the way of working, traditional and PLUSwerken. Does the way of working have influence on the preferences for intervention which will be used to reduce the energy consumption, compared to the people in the traditional work environment.

Question 5
The employees within the environment of Witteveen+Bos is divers, people work in different sectors, have different backgrounds, other interest, but is it possible to make groups, which can be used for implementing intervention strategies to reduce the energy consumption?

Question 6
Question 5 will be used to make groups within the office environment of Witteveen+Bos, but are there differences of preferences between the groups or do the groups have the same preference for a type of intervention?

1.5.1 Research design
The research consists of various phases, during these phases different methods will be used to collect data. The first phase will consist of a literature review to collect information about previous researches and possible interventions to reduce the energy consumption by influencing the human behavior.

During the second phase field research consisting of observation and informal interviews will be conducted at the offices in Amsterdam, Antwerp and Breda will be conducted. Hereby, the occupants in their office environment will be observed by investigating the use of spaces, routes combined with their behavior at the desks. Also information about their experiences will be collected using informal interviews.

In the third phase interviews will be held to collect information about the people in the working environment of Witteveen+Bos, interventions and other solutions to influence the human behavior in order to reduce the energy consumption.

During the fourth phase, surveys will be distributed to receive information over the people in the working environment and their preferences for interventions.

In the fifth phase the results of the survey will be analyzed, which will be written into conclusions. After the conclusions will be drawn, a plan for implementation will be drawn, this is shown in a other color because all other phases are based on collected information, however, the implementation is an assumption of which interventions will work based on data but is never been testes before in a combination and therefore it will be an assumption. In Figure 1 the design of the research is showed.

Figure 1 Research overview

1.6 Reading guide

In Chapter 2 the literature review is discussed, where the relation between the human behavior and the reduction of energy is researched. The methods and approaches to influence the human behavior in order to reduce the energy consumption will be discussed. In chapter 3 Witteveen+Bos is discussed, were information about the company, the office environment and the energy use are discussed. Even as the observations as the interviews. This information formed the input for the hypothesis which are also included in chapter 3. Followed by the design and explanation of the questionnaire in chapter 4. Which information will be collected and how will this information be used will be described. Chpater5 consist of the results of the survey. The conclusions, discussion, recommendation and implementation for the results will be found in chapter 6.

Chapter 2

Literature review

This literature review describes the relation between the energy consumption and the human behavior in the office environment. The relation between these elements is complicated, however it is possible to easily define the two elements separately. Combining them together with the aim to reduce the energy consumption is harder. Most articles included in this review have the aim to reduce the energy consumption using approaches and methods whereby possible solutions are described from different point of views. In this literature review interventions strategies from the residential and office environment will be discussed. The methodologies and approaches of the residential environment might help to describe the relation between the human behavior and energy reductions, but this research is mainly focusing on research in the office environment. The difference between the residential and the office environment is the fact that people behave different in these environments in order to reduce the energy consumption, where the responsibility of the bill is appointed as one of the factors.

2.1 Introduction

Over time, the energy consumption in the built environment has increased (Lopes et al., 2012). The energy consumption within the office environment in Europe has grown between 1990 and 2009 with nearly 30% of the total energy demand of the European services sector (EEA, 2012). The energy consumption in the built environment of the Netherlands is approximately 35% of the total energy consumption, in which the ratio between the residential and non-residential buildings is around 50-50 (RVO, 2015). The share of CO_2-emission in the built environment in this segment is around 25% of the total CO_2-emission of the Netherlands (Kadaster, 2011). Based on the targets which have been set and accepted by the European Commission, the CO_2-emission should be reduced in 2020 with 20% related to the CO_2-emission of 1990 (EEA, 2016). Therefore, reducing the energy consumption is required where possible. Due to new technology and knowledge, nowadays new buildings can be realized as Zero Energy buildings or even Positive-energy buildings.

It is outstanding that people are able to build buildings which are (nearly) energy neutral (NZEB = nearly zero energy buildings) or even energy positive (PEB = positive energy buildings). However, if the occupants of the buildings are not informed and supported to save energy in those buildings, the best designed buildings in the world can consume more energy than conventional buildings. Only a change of mindset can lead to a reduction in the energy consumption (Lenoir et al., 2011). At the moment, The NZEB and PEB buildings are realized in the Netherlands as individual houses and office buildings (RVO, 2015). Through this change of building types in the built environment, the human behavior in the built environment needs to change as well.

People believe that sustainability mainly can be achieved by the realization of new buildings, however, not only new buildings should be considered for energy savings. It is also important to preserve and reduce the energy consumption of the current built environment. By implementing adjustments and educating the building occupants, it possible to make changes in the total energy consumption of the Netherlands. The users of buildings have major influence in the energy consumption. Therefore, this research will investigate the energy consumption which can be influenced by the users of the office environment, this will be mainly the electricity consumption.

Households in the residential environment, have been studied and stimulated to reduce the energy consumption, by informing them about the use, and how it is possible to reduce the energy consumption in their residential environment. By comparing the behavior of the users/occupants of households with the office environment, there is a difference in responsibility. Considering the residential environment, people are responsible for their own energy bill, while in the office environment they are not responsible. Therefore, Murtagh et al. (2013) concluded that this difference leads to a contrasting behavior between the residential environment, where people could try to reduce the energy within their household, and the office environment where they do not mind about their energy consumption. However, other articles discuss that the human behavior in the office environment can be influenced, as will be discussed further in the review.

The aim of this literature review is to create an overview of intervention strategies to study how the human behavior can be influenced to reduce the energy consumption in the office environment. There has already been research into the behavior of occupants and how this behavior can be influenced for the energy conservation. However, these researches are mainly focused on the residential environment. Before describing keywords, interpretations of the energy consumption and the human behavior in the office environment, a few concepts need to be discussed. The difference between energy efficiency and energy conservation, in the context of energy behavior. The terms energy conservation and energy efficiency are often overlapped in energy researches and policy making contexts.

In many studies, the energy conservation is a concept that refers to the reduction of the energy consumption associated with a frugal lifestyle, which includes a form of regulation or spontaneous changes in consumers' preferences resulting in behavioral changes. This concept often implies a more moral aspect of behavior rather than a strictly economic one. Since effort is required from the end-users perspective in order to engage energy saving. On the other hand, energy efficiency

refers to the adoption of specific technologies that reduce the overall energy consumption without changing the relevant behaviors and achieving the maximum obtainable services. In the literature, some authors argue that the term energy efficiency should not be used in relation to energy behavior (Amasyali & El-Gohary, 2016; Karjalainen, 2011). This is because energy efficiency often focusses on the technical solutions instead of human behavior. Therefore, from this point the term energy efficiency will only be used for technical solutions and the term energy behavior will be used in the context of people.

2.1.1 The human behavior

The human behavior is formed over time and influenced by different kind of factors. It is influenced by the capacity of mental, physical, emotional, and social activities experienced during the human being's life. These experiences can be formed by culture, society, values, morals, ethics, and genetics. Before the human behavior can be predicted it is important to understand one.

The human behavior can be described in different aspects: motor(physical actions), social-affective aspects(emotions and feelings), and cognitive aspects (thoughts) (Carver & Scheier, 1981).The combination of these three aspects form the human behavior. Those aspects are created on the following determinants of behavior: psychosocial aspects, organic physical factors and aptitude factors. The psychosocial aspects are formed and influenced by the received education, friends/relations, the surroundings, experiences and perceptions. The social relations of the human being are influenced on different scales: micro, mezzo and macro (Zastrow & Kirst-Ashman, 2007). The micro system refers to the individual based on the biological, psychological and social system. This system focusses on the individual needs, problems and strengths. It helps them to make the most effective choices possible. In the mezzo system, it is about small groups, including the family, work groups and other social groups with different purposes. These groups can come together for assessments, or interactions for example. Herby they are influenced by their peers or any other participation within the group. The macro system refers to larger groups which are focused on the social, political and economic conditions and policies that affect the human resources and quality of life. Whereby the improvement of the social and economic context is important.

The physical factors are formed by hormonal and biochemical aspects. Aptitude is formed by the factors of heredity and character. However, the organic physical factors are hard to influence and the human behavior cannot be changed easily. By educating the human and bringing them in contact with other people, it is possible to influence the aptitude factors and psychosocial aspects, and thereby the ability to develop knowledge. However, By understanding, learning or using acquired abilities or attitude, the human behavior can be influenced. The influence results in awareness, and learns people about consequences and to process information, that results in acting on their knowledge. Having the knowledge of the human behavior, aspects can be used to influence this behavior with the purpose of energy conservation. This might support a strategy to do so, and helps to understand why this intervention strategy might work.

2.1.2 Energy consumption in relation to human behavior

As mentioned before, many articles have been written about the energy consumption and how it can be reduced in a residential environment. However, The interest about reductions in the office environment is grown over the last couple of years. Before focusing on the office environment, it is also important to understand the relation between the energy consumption and the energy behavior of the occupants in general.

The human behavior in the relation to the energy consumption can be described as: actions and decisions which are taken by building occupants that impact the energy consumption of the building. These behaviors include actions taken on objects within an occupant's personal control, as well as actions taken by the occupants themselves (Klein et al., 2012). This statement is supported by Peschiera et al.(2010), which stated that the occupant behavior plays an important role in the energy consumption and the energy saving potential which can be improved by the occupant behavior.

Herring (2006) mentioned, that people can save money by being more energy conservative. This is needed because the overall energy use in western Europe has increased in the last decade. Despite of the improvements, of making buildings (more) energy efficient. Herring suggest that people prefer the efficiency of buildings more in a form of higher level of energy service, then reducing the energy consumption. On the other hand, Janda(2011) mentioned that the energy consumption in buildings is considered to be more a social problem rather than a technical one. The influence of the occupants in the buildings is effecting the energy use in a negative way. One of the main reasons for the incensement of energy consumption could be the fact that people spend the majority of their time inside buildings. They do not know everything about a building, and struggle with the fact about how to behave in the buildings. By educating them about how to behave and to raise awareness of using energy consumption information, the 'gaps' could be minimized, which could lead to a reduction in energy consumption. However, O'Brien and Gunay(2014) disagree with this statement by arguing that the occupants play an unprecedented role concerning the energy use in the office buildings. They are often perceived as one of the main causes for underperforming buildings, while occupants are not illogical and irrational, but they rather attempt to restore their comfort in the easiest way possible. But, according to Lopes et al. (2012), the fact that the occupant behavior has a large effect on buildings' energy consumption is well accepted.

However, to understand the needs of the occupants within the buildings it is important to understand the relation to the building. Nowadays, people are spending more time inside buildings than outdoors, which makes that the buildings are an important part of their lives. As was mentioned, in the residential environment, the occupants themselves are responsible for the energy bill, and reductions of the energy consumption are noticed in the form of money savings. However, in the office environment they are not responsible and makes it less interesting because they do not notice the savings, because it is not their responsibility (Klein, et al., 2012).

2.1.3 Human behavior as instrument in relation to the energy consumption in combination with feedback

In the literature, most of the research on energy behavior has been essentially focused on the residential sector. These predominantly field experiments where about testing instruments to promote more energy conserving behaviors. By using the field experiment, the researchers can try to establish the behavioral determinants for energy use, and environmental concerns, but mostly about particular values, attitudes and norms.

Besides behavior there is another human aspect which may have a major influence on the human actions: the habitual behavior. This type of behavior is defined as automatic and routine behavior which individuals repeat and the things people do automatically without conscientiously weighing the advantages and disadvantages. Although the habitual behavior is functional and based on the psychosocial aspect, it may deliver sub-optimal results in relation to energy conservations. Habits are automated goal-based behaviors and tend to be repeated in certain circumstances when their outcomes are generally satisfactory, but often involve misperceptions and selective attention on information that reinforces the habitual behavior (Lopes et al., 2012). An example is to switch of the lights when you are done in the room. The habitual behavior is harder to research because this includes observations. By observing the human, the habits become clear, which makes it possible to influence them with for example, feedback. Feedback is a modification, adjustment or control of a process, which could be the result or effect to the process, especially by a difference between a desired and an actual situation; it creates a response. It is an approach to learn, and it helps to explain why environmental information and education is necessary for behavioral change. Learning is an active process and learning about practical issues is related to reality as it presents itself (Darby, 2001). Feedback is a way to confront people about their behavior and habits and is used as one of the interventions to learn people how to reduce the energy consumption. Feedback is intended to create awareness and it influences the occupant's behavior. Darby (2001) investigated 38 feedback studies based on energy savings. In most of the studies included direct feedback, which is personal feedback based on their own energy consumption. The savings concerning direct feedback resulted in 5-20%, while the indirect studies resulted in lower savings. The change in behavior can occur when a person is aware of an issue, the person thinks his or her actions have influence, and feels capable of

engaging in such action (Delmas and Lessem, 2014). If the goal is to prepare people to accept more responsibility for their role in the built environment, education should be much more comprehensive, integrated, hands-on and iterative (Janda, 2011). The general population tends to treat buildings as object instead of a dynamic system with many opportunities to reduce the energy consumption. Therefore, there is a need to learn the occupants how to behave within the buildings, whereby feedback could help as an instrument, to influence the human behavior to reduce the energy consumption.

2.2 Research approaches on energy conservation and the human behavior

Different types of research approaches were mentioned in the literature of how the energy consumption could be linked to the human behavior and will be mentioned in this paragraph. However, The focus points of the researches differ: some are focused on the energy consumption, while others are more focused on the human behavior. There are also researches where both aspects of energy consumption and human behavior were merged in the research approach. While discussing the research approaches and methods, the aim of the approach or method, why this approach or method is used, the results, and how this is related to the energy consumption and/or human behavior will be described. The following approaches and methods will be discussed based on the results found during the literature review: 1. Simulation based research on the influence of the human behavior in relation to the energy consumption, 2. Social psychology based research on the human behavior and their motivations, 3. Experiment based research in the office environment equipment to reduce the energy consumption, 4. Algorithmic research on social influences and 5. Case study based research. These approaches will be used to create an overview of how the researches were conducted. It helps to find out, which approach can be used for a certain type of research in the office environment. The advantages and disadvantages will also be discussed.

2.2.1 Simulation based research on the influence of the human behavior in relation to the energy consumption

The simulation based research is a tool based on software that can be used to simulate possible predictions for a certain situation. To simulate the situation, information is needed to build a model. In this case, the predictions will be about the energy consumption in combination with human behavior. The predictions are made based on a base scenario. In most of the researches, the current situation is considered as the base scenario. Information of the base scenario is than collected from measured energy consumption and observed daily routines. During these observations, the occupants are not informed about the measurements, to prevent behavioral influence caused by the observant. Before making the predictions using the simulations, different scrips are needed that describe different human behavior and energy consumption scenarios. The scripts also describe different adjustments or implementations which influence the human behavior and/or the energy consumption.

In the research of Azar and Menassa (2012), the simulation-based study emphasized that the occupancy behavioral parameters, (for example: the use of equipment and lights, during and after working-hours,) had a significant impact on the energy consumption. The simulation comprised an agent-based model of the energy consumption which forecasted a model to account for different occupant behaviors and led to a reduction of the energy consumption, considering the location of the building. The research was conducted in 30 office buildings in the USA, after determining the building characteristics. The base model, with different types of climates in the simulation was carried out to see how the different types of climates effected the energy consumption, based on the same office characteristics. These climates were included because the investigated offices were located all over USA, therefore the climate could have influence on the energy consumption. There are states where the average outside temperatures is above 25°C, meaning that the air-conditioning is more used compared to states where the are cold and temperatures are below 0°C and heating is required The results of this study can be used for real-life applications. For example: building designers, building stakeholders, or policy makers can use this model to obtain better designs for new buildings or to reduce the energy consumption in their existing buildings.

Seppo Junnila (2007) used a multiple case study approach to estimate the potential effect of the end-user on the energy consumption in office buildings. The study was conducted in the banking environment of four Nordic countries. During this

research, simulation studies were used to investigate the influence of equipment and lights on the energy consumption. By inventorying the number of equipment (laptops, desktops, displays, office servers, printers, and photocopiers) and their energy consumption in combination with interview and walkthroughs in the office spaces a script for improvements was created. These scripts were used to simulate seven situations containing improvements for the office equipment, and lights. The unique value of this research is that the study quantifies the potential influence of good facilities management with end-user activation on the energy conservation of office buildings. The study implies that the end-user-energy-management services are needed in order to reduce the energy consumption. For the end-user-management power management (PM) was used. PM is a tool which can be installed on devices in the office environment, which, determines the number of hours per day a device is in use. PM is also able to reduce the amount of power a device uses, when it is turned on, but is not in active use. This can result in energy savings, however, depending on the type of device the results can differ. This study did not include results about achieved energy savings. However, based on the devices, different results can be achieved.

In another simulation-based research by Klein et al. (2012), a multi-agent system was used for the simulation. For this research the multi-agent simulated the considered occupants with different energy characteristics based on three levels of energy usage, as well as potential changes to occupant usage due their peers influences. The systems demonstrated promising results for the energy reduction (12%) while retaining the comfort. A system was designed which operated based on fixed schedules and the maximum design of occupancy assumptions. It controlled the temperature, airflow and the light set points for facilities vis the centralized building management system (BMS). The occupant detection technology included motion sensors, cameras, infrared sensors, radio frequency identification, wireless sensor networks and CO_2-sensors. However many of the simulations have only been evaluated based on the outcome of a single zones, while they are not representing the complexity of the whole operation in the commercial building. Additionally, the majority of the simulations attempted only to affect building devices and ignore the possible benefits of simultaneously affecting occupant behavior. The behavior of the occupants, which was used for the simulations, was based on users information, user preferences, and a meeting relocation agent. The combination of information from the real-world feedback, building/occupant data and suggestions of the occupants were collected and generated to create optimal policies for the simulation models.

Using the simulations as a research approach has its advantages. The first advantage is the fact that it is possible to test the influence of adjustments before placing them in the room. It is also possible to generate data which can be used in comparable situations. Using this approach makes is also possible to construct highly complex scenarios. There are also disadvantages, first the complexity of the simulation, in which the developer or system does not know how to correct a certain problem. Some data, that will be used in the model, can be interpreted differently. The costs for making a simulation can get very high. Besides all other disadvantages, making a simulation involves a long time (Funke, 1998).

2.2.2 Social psychology based research on the human behavior and their motivations

The social psychology research is based on the idea of a survey. For this type of research, occupants of buildings were asked to be respondents or participants. The occupants have to fill out a questionnaire, designed to investigate if there are connections between assumptions and factors based on the outcome of the questionnaires. The aim is to research how people react, in certain situation and how situations. For this research approach different references will be described, to discuss the different possibilities which can be researched based on surveys.

The first reference was a research conducted in the residential environment by Abrahamse and Steg (2009). This research focused on testing the existence of socio-economics (such as: income, education and household composition) and psychological correlations in the Dutch residential energy use. The participants were asked to fill out an internet-based survey three times, each one before the measurements were conducted to test the outcome of the survey with the energy savings. The first measurement took place before implementation of the interventions, the second and third measurements took place two and five months after implementation of the interventions. The interventions consisted of feedback and

installing small information screens providing information about the energy consumption. The aim was to research if there is a correlation between energy use, socio-demographic variables and psychological variables. The results were analyzed using correlation and regression analysis. The outcomes concluded that the household energy consumption is related to both income and household size but not to psychological variables. This research is a combination of interventions and surveys to see the intervention had an influence on the results. It is possible using this approach to test the relation between the actions people think they do and if what people say they do match.

Another interview-based study was performed in Finland, where the research was conducted in the residential and office environment. 1000 respondents showed that people make significantly less effort to save energy in offices than in homes. As a result of the research, Karjalainen (2011) stated that one of the reasons is that the occupants in the office environment have less motivation to save energy, because they are not responsible for the energy bills themselves. Secondly, the energy costs in the office environment are low compared to the personnel costs ((Wargocki & Seppänen, 2006; Junnila, 2007). Based on this economic perspective, people are more focused on providing a productive office environment then reducing the energy consumption.

The third reference, a research of Amasyali and El-Gohary (2016), was about the impact of the occupants values on the influence of human behavior. The research was conducted in three states in the USA, using an online survey. The aim of the study was to understand how the influence of the human behavior in the office environment is different compared to the values of the human behavior in the residential environment. This research was conducted by asking the respondents to rank the importance of the values for the residential as well as for the office environment. The results were classified by importance in the offices and residential environment associated with the satisfaction levels. Based on the results, the situation between the residential and office environment could be compared, between the different environments, and even between different states. The outcome shows that the health factors are the most important in both environments. Furthermore indoor air quality is mentioned in the top 3 in both environments. However, there is a deviation in the third aspect; in the residential environment energy cost saving is important, whereas in the office environment personal productivity is deemed more important. Remarkable is the fact that energy saving costs for the respondents in the office environment is ranked as very last. The outcomes are shown in Table 1.

Table 1 Ratings and ranks of values form people in the residential and office environment adapted from (Amasyali & El-Gohary, 2016)

Values	Residential overall		Office overall	
	Mean	Rank	Mean	Rank
Health	5.28	1	5.35	1
Energy cost saving	5.07	2	4.60	7
Indoor air quality	5.00	3	5.08	2
Thermal comfort	4.95	4	5.00	5
Personal productivity	4.83	5	5.08	2
Visual comfort	4.80	6	5.01	4
Environmental protection	4.59	7	4.65	6

2.2.3 Field experiments based research with office equipment to reduce the energy consumption as case study

Using the experiment based research for the office environment is the third research approach. This type of research is conducted in the non-residential field, where the office equipment is observed, measured, and conclusions are drawn on those results. This type of research points out the general equipment in the office environment and how it is used. Therefore it creates an overview of behavior in this environment.

Webber et al. (2006) executed a field research of office equipment in the USA during non-working hours around 2005. The equipment at schools, offices and medical buildings have been studied. By labeling the equipment in the following status categories: on, low power or off. The results showed that less than 50% of the devices were left on during the nights and weekends. Inventories of the equipment were listed and rounds after working hours were made to list the equipment which were still on. To reduce the energy consumption the use of the program for Power Management was installed on devices. The devices are set up to automatically be shut off or turned to low power during a certain period of inactivity, leading to a reduction of the energy consumption in the end. Reducing energy using power management will only be a success if the users do not change the settings, which happened in some of the research locations, where people did not feel the urge to use this program and disabled the function. However, there was an average reduction of 6% achieved.

Based on the pervious findings another research was carried out by Masoso and Grobler (2009), with the convection that behavioral change has energy saving potential, comparable in the most cases, higher than technical solutions. This research is conducted in Botswana and South-Africa. Results show that more than 50% of the energy consumption was used during the non-working hours compared to the official working hours between 07:30-16:30h. These results were obtained via measurements. Within the energy use, all the aspects in the office environment were included, from office equipment to the climate installations. The results were groundbreaking and confronted the importance of the energy consumption in the office environment. This article was referenced 145 times during the literature review of the office environment and it emphasized the urge for research into energy conservation in the office environment. It demonstrates the potential for improvements for energy efficiency of climate and building installations and the need to investigate the opportunities for energy conservation in the office environment. To increase the efficiency, The installations were adjusted to the office hours and a stable climate within the building was created. The installations within the building were incorrectly programmed. Besides, the users of the building easily left on the lights and equipment when leaving the building.

In the field-experiment executed by Murtagh et al. (2013), the energy use of individuals was researched at 12 university offices in UK. The energy behavior of the occupants in the office environment was researched and based on analysis of the energy consumption. This resulted in proving feedback for the users of the office buildings. By analyzing the energy consumption, the results were shared via email to the users. The results of the users office building were compared to the results of energy consumption of the other (eleven) involved buildings. After a certain period the occupants were asked to fill out a survey of their experiences of their involvements. However, the feedback did not correlated with the report of the participants and their pre-environment behavior and the actual energy-linked behavior. The users within the office buildings consumed more energy at their desks than they really needed. Nevertheless, a reduction of the energy consumption was achieved after month 3 and 4 of the study. Using a combination of direct and indirect feedback in the environment of the university resulted in more awareness among the employees. 60% of the participants was made more aware through the individual feedback program. Based on this study it can be concluded that the individual feedback has some benefits, motivations beyond energy reduction are needed to engage people to change their energy behavior.

The last reference contains a case-study research in Austria by Ornetzeder et al.(2016). This research was about exploring the relationship between the energy performance in green office buildings and the well-being of occupants. The set of behavioral patterns such as: information rules (patterns to identify the common communication patterns between the objects and the realized patterns to increase the flexibility to carry out the communication), legal requirements and building technologies, differ compared to the residential setting. The use of the office building differs in relation to the residential setting. This was the motivation to research the difference between the human behavior and energy consumption. They explored the interrelation between the forms and patterns of the energy consumption on the one hand, and user satisfaction, comfort and well-being on the other hand. For this research qualitative and quantitative data was used of a recently finished research project in Austria. Their own fieldwork consisted two qualitative case studies (in Vienna and Graz) and an online survey for the users of an energy efficient building. Among the data of the fieldwork, secondary data of

energy-monitoring research was used for an analysis. They were able to show that it is possible to align two levels of energy demand with high or at least sufficient levels of well-being. The data revealed that high overall satisfaction correlates with workplace satisfaction, perceived indoor environmental qualities, perceived options for individual control, and satisfaction with the facility management. The use of more energy was not corresponded to a greater sense of well-being.

By comparing the references, the main advantage for the field research approach can be drawn. Field experiments are needed to conduct a case study. By observing and questioning the situation, location and the occupants, statements about the office environment can be made. However, a disadvantage if the fact that mostly the results are casework, and the results cannot be used as standard for other situations, besides the information, observations and other data which is needed takes a long time to collect.

2.2.4 Algorithmic research on social influences

The algorithmic approach uses formula to predict a possible outcome. By using different variables which are observed in a certain environment, or values based on previous research. It is possible to create an algorithmic formula to predict a certain relation for the investigation.

Jain et al. (2013) used this approach to predict if social influence may lead to energy savings. The question remains unanswered but by using the algorithmic approach based on stochastic and by social network test procedures, it was possible to explore how the social influence impacts the energy consumption behavior. They applied the approach to an empirical data set of users which were exposed to a unit-level socially contextualized feedback. To define the variables in for the formula, observations and surveys were needed. During these survey the social influence effects on peer network energy consumption were successfully characterized and isolated using adapted social networks.

The advantage of this method is the fact that it is possible to predict acertain outcome, based on a relation. However, lots of data have to be collected that needs to be proved before the formula can be drawn. The variable needs to be substantiated and calculated.

2.3 Interventions strategies to influence the human behavior

Using interventions might help to add value to the office environment and develop a positive workplace (Youssef-Morgan & Sundermann, 2014). Interventions will create awareness by the users in the office environment, by providing them with information, which might change their behavior (Janda, 2011). Therefore, if information about the energy consumption will be shared it is possible to influence them. Abrahamse et al. (2005) suggested that proving information is a necessary strategy to enhance knowledge on the underlying problem and to inform appropriate actions. However, information alone seems to have minor effects on energy consumption behavior. Besides it affects the behavioral change when it is combined with other strategies, such as committing to a course of action, goal setting, or frequent feedback. Strategies might help to create awareness to achieve a change in behavior. However, the combination of multiple strategies can be a solution. It is hard to define the right combination for the long term (Karjalainen, 2011). Before interventions can be applied, it should be clear that is an attempt to change an individual, group and/or organizational characteristics. These need to be malleable, open to change, developable and manageable (Youssef-Morgan & Sundermann, 2014).

Similar to intervention studies conducted in private households, proving information was considered by Siero et al. (1996) as necessary, but seldom sufficient, to change the strategy of the staffs behavior. In a university setting was shown that written information and prompts led to short-term changes in behavior. It seems important to choose an appropriate psychological theory to explain energy use behavior at the workplace, and to take into account the specific action context. Unlike private households, the workplaces in the office environment have no direct financial incentive to minimize the energy use within their office environment. Therefore, it is possible to assume that motivations for users in households and users in organizational settings are different. A possible motivation behind the change the energy use, the behavior in

private households could be personal benefit, as a reduction in energy consumption results in monetary savings. In organizations, the incentive structure is different, meaning people have to be stimulated sue to the lack of personal benefits. The intervention strategies are meant to influence the behavior of the people in the office environment. There were four types of interventions described: 1. Information flow about the energy consumption, 2. Demonstrations to stimulate energy conservation, 3. Rewarding the desired behavior and, 4. The use of game intervention. These interventions will be discussed their influence on the energy consumption and the human behavior and possible outcomes.

2.3.1 Information flow about the energy consumption

The first intervention strategy is to share information about the energy consumption. Information is a commonly used strategy to promote energy conservative behaviors. The information may contain general information about energy-related problems, or specific information about possible solutions, such as various energy-saving measures. Providing information serves to increase the occupants' awareness of energy conservation and their knowledge about possibilities to reduce these consumptions. During this intervention, the occupants will receive information in a direct matter such as email, or in an indirect way such as information on screens/displays or on posters/flyers. This method is highly developed in the residential environment in the form of tablets which are placed in the houses to measure the consumption. The information will be processed and translated for the users into graphs and overviews. The users within the household can obtain the information about their energy consumption at any time gain insight about the specific consumption. Such an analysis is harder to conduct in the office environment, because of the scale difference between these two environments. Another difficulty us related to the sensors, which should be placed at for each workplace to present an overview of the individual energy consumption in an office. Data from the residential already focusses on this smaller scale.

The Eltihis Tower in Dijon is an example of an intervention in which the users of the building were provided with information about the energy consumption. In this case, an information display was placed near the entrance of the building. This display shows the daily energy consumption of the building but also the realized savings based on historical data. The results are based on the calculation of 1.600 sensors which are placed all over the building, and therefore it is able to categorize the consumption. The occupants experience the information flow on the display positively, and anticipated based on the information. For example, if the elevator shows a high peak in the energy consumption compared with the previous days, people are more motivated to take the stairs. Via the display the users of the Eltihis tower became aware of what is happening in the building, and try to act based on the gathered information that they received.

Another example of sharing information as intervention is using email. Employees of twelve university buildings could assign to a program and receive monthly feedback in the form of an email containing graphs and summaries about their building's energy use of the previous month. It was suggested that feedback of this kind should be designed to be simple and concrete with a temporal reference to the other buildings as well as a reference to any targets or goals. By using the emails as intervention and providing the users on the university campus about the energy consumption, a reduction was achieved of 7% (Carrico & Riemer, 2011).

2.3.2 Demonstrations to stimulate energy conservations in combination with feedback

Demonstrations to stimulate the energy conservation will be discussed using meetings. The meetings in the form of workshops make it possible for people to share experiences and information. During the meetings, feedback can be shared based on the energy consumption publicly as well as privately, or a combination of both.

Using public feedback informs the occupants about the possible behavioral impact which is publicly disclosed and it allows an environmentally friendly behavior. This type of behavior can be executed using comparative feedback. This method turns out to be a powerful strategy for changing the behavior of employees within organizations. Receiving information about the performance of other groups and can lead to several group-dynamic consequences. Comparative feedback starts with emphasizing the existence of the own group. When people become aware of the existence of another group with whom they may compare themselves, their own group is formed. For example: employees of different floors in a building, or people of their own department. Another example are people form a team: when two or more individuals interact socially, dynamically, recursively and adaptively, they have shared goals, provide feedback, have independencies goals, and have held meaningful and high level of tasks. (Thayer, Rico, Salas, & Marlow, 2014). The teamwork, just like peer pressure, influences behavior, attitude, performance outcomes and judgement on the productivity (Sales et al., 2007). The effectiveness of the environment in which employees operate is influenced by three competences. **Fout! Verwijzingsbron niet gevonden.**Figure 2 specifies these competences which are: 1. Knowledge-based, 2. Skill-based and 3. Attitude-based. The knowledge-based competencies include the cognition that members hold about their team member, the task and the environment of the representation of the team.
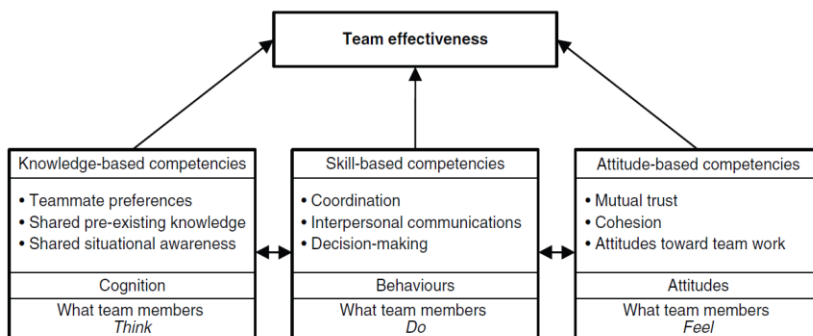
Figure 2 Team effectiveness adapted from (Cannon-Bowers & Sales, 2006)

Skill-based competencies include the behavior of team members to engage in, communication and decision making within the team. It represents the activities of the team. Finally, attitude-based competencies represent the feelings of the team, including trust, cohesion and attitudes toward teamwork. These competences together form the ABC of the teamwork: attitudes, behaviors and cognitions (Cannon-Bowers & Sales, 2006).

According to social identity theory of Siero et al. (1996), people will in general strive for positive self-image, especially when they are in a group. Their membership in a group itself is perceived as part of their identity. Research in this field has shown that emphasizing the social identity of individuals leads to a strong personal identification with one's own group which can have various psychological and behavioral consequences. Within an organization, employees have similarities in which they can identify and create a connection. When comparing the behavior between the different groups, the combination of concrete feedback about their own performance and about the performance of other groups of employees results in a comparative orientation, and more effort from employees, and leads to more energy savings which, even 6 months after the termination of intervention, are considerably higher than before the start of the intervention. (Siero, Bakker, Dekker, & Burg, 1996).

During the research of Mulville et al. (2014) comparative feedback was also used in meetings. The feedback was used to evoke a feeling of competition, social comparison and even as social pressure which then leads to a change of behavior. The aim of the research was to understand the relation between the influence of occupant behavior and the variation in energy consumption within the office structure. During the first meeting, there was feedback provided based on the regular historic energy consumption of an office-based level in combination with the goal-setting for the energy conservation. The second meeting became more an intervention where the group of participants was spilt up into two groups. The first group received individual feedback, while the other group received group-based feedback of the occupants within the office. For the group who received private feedback, this strategy led to a change of behavior. The group with group-based feedback improved their behavior and the energy conservation. Without the comparable feedback, people did no longer feel that they were watched and reverted into their original patterns. From these results it can be concluded that public feedback

can help to create and maintain normative behavior after the feedback is withheld, thereby producing longer-lasting changed than private feedback (Handgraaf et al., 2014).

Another form of feedback is the use of private feedback, which is individual information, mostly is privately disclosed, about the user's own energy use or environmental impact. The results of Delmas and Lessem (2014) suggested that while private information alone was ineffective, the combination of public with private information resulted in a 20% reduction of the electricity consumption achieved through lower use of heating and cooling. Public information was particular effective for above median energy users. This study was conducted in a dorm environment, were people obtained the information about their own energy consumption by checking a dashboard shown in Figure 3. This dashboard shows their current and historical electricity consumption, compared to the average energy consumption. This dashboard also shows, how the usage is divided: air-conditioning and heating, plug loads and lighting.
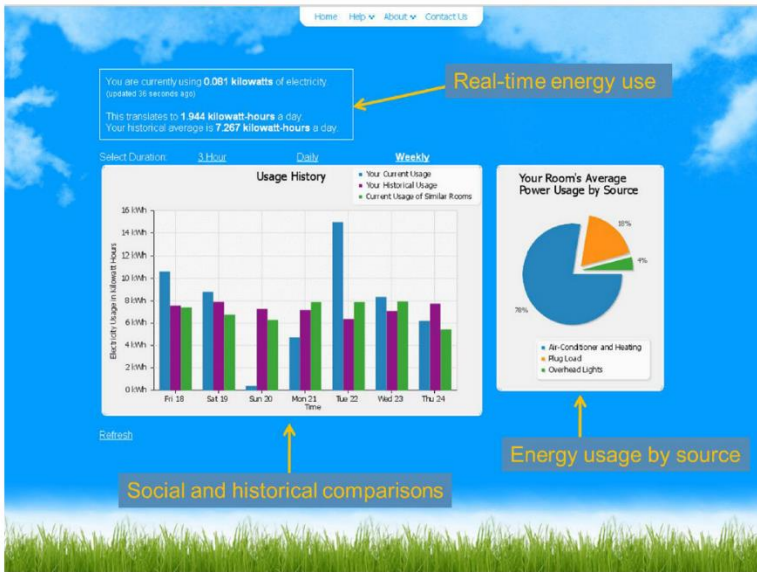
Figure 3 Information dashboard of the energy consumption adapted from (Delmas & Lessem, 2014)

Using a workshop as a way to inform people about the energy consumption is researched by Geller (1981). Providing households information about energy-savings by individual booklets with information about their energy conservation. The workshop led to higher level of knowledge about energy conservation. Although the information did influence underlying determinants of energy use, it did not result in behavior changes (Geller, 1981).

2.3.3 Rewarding desired behavior

The third intervention strategy is based on rewards that intend to change the behavior and is proved to be effective, although it is short-lived (Matthies et al., 2011; Karjalainen, 2011). In the review, two kinds of rewards were mentioned: social and monetary. In case the goal was achieved, the occupants were rewarded. There are three possibilities: the occupants can be rewarded financially, meaning they will receive a financial reward. Another possibility is to reward the occupants socially. The achievement of the goal will be celebrated within the group by expressing the appreciation. Or a combination of the both is possible.

Social rewards are more competitive in the sense that each participant can see how the other participants perform during the competition (Petersen et al., 2007). It leads to more conservations about how the reduction could be realized, and to more positive emotions. The social rewards can also be used in combination of comparative feedback. However, by rewarding people personal, people become more personal involved.

Besides the social rewards, there are also monetary rewards. The monetary rewards may be used as motivation to conserve energy, the rewards can be paid in the form of the savings or a fixed amount. In the research of Handgraaf et al. (2014), the effects of the social and monetary rewards were investigated. The hypothesis was formulated as, social rewards are more effective than monetary rewards. The research was conducted at a Dutch company where they researched the influence on human behavior for 13 weeks. Besides testing the hypothesis of rewarding, they tested if there was an influence on the behavior when the rewards were issued in private or in public. By public rewarding it may have given more meaning to individual scores and a thorough understanding of one's personal score may activate a desire to improve. The public social rewards were the most effective during all the interventions and post-intervention periods, eight weeks after the interventions, resulted in the highest energy conservation of all conditions. Overall the social rewards were the most successful, both for the short term as well as the long term. Interestingly, despite their popularity with the policymakers, private monetary rewards were the least successful. The results and effects of the monetary and social rewards of this investigation are shown in Figure 3.

Figure 4 Percentages of energy savings including the type of reward during the study adapted from (Handgraaf, Jeude, & Appelt, 2013)

The study indicates that the energy savings are related to psychological variables which can be influenced from policy perspectives. Where interventions or policy measures have the aim to promote energy savings this intervention strategy might influence the target specific variable. Based on the outcome of the research of Handgraaf et al. (2013), rewarding people using the monetary reward will not change the human behavior to reduce the energy consumption. A possible motivation to engage in energy saving behavior at the workplace, more altruistic motives come into view, like to support the organization in energy savings and monetary savings, to contribute to environment protection, or to comply with expectations from colleagues and superiors. (Matthies, Kastner, Klesse, & Wagner, 2011).

2.3.4 The use of game intervention

The last intervention strategy is about the conservation of energy consumption by using a game intervention. The game is used as a tool to create awareness. Orland et al. (2014) researched the influence of the game on the occupants in the office environment. For this game intervention an "energy chicken" was created. The health of the chicken was influenced by the energy consumption of specific devices which were assigned to a specific participant. The report showed that the average plug-load energy consumption was reduced by 13% where 7% was reduced during work days and 23% during the non-work hours. However, the effect of the game intervention was not as what was hoped. The behavioral changes were not sufficient enough as was expected. The feedback, which was received after the game-intervention, stated that the awareness of the participants had increased, the results of the energy consumption show otherwise.

2.4 Discussion

Based on the literature it is possible to state that the human behavior can be influenced or even be changed to reduce the energy consumption. One of the causes was mentioned by O'Brien and Gunay (2014), which suggest that the knowledge about the energy consumption is missing. The difference of the human behavior between the residential and office environment needs to be reduced or made equal, which might suggests that the occupants needs to know how to behave and how to adjust to the situation. Besides the difference in environments, which is associated with conflicting

responsibilities and the lack of knowledge, might be confusing and therefore might influence the human behavior in the different environments. The possibility to change and influence the human behavior in the residential area, might now needed to be focus on the office environment. The gap between the environment and responsibilities, must be reduced.

The different research approaches described the methods which could be used to influence the human behavior in the office environment to reduce the energy consumption. Methods were used to simulate real-world scenarios, observe people, calculating and predating relations and investigate humans social psychology. In case of the simulation based research, information from real-world situations was collected to simulate different scenarios. The research of Azar and Menassa (2012) used an agent-based model for the characteristics for 30 buildings in the USA, while Klein et al. (2012) simulated a scenario for a commercial building using a multi-agent system in which the behavior of people was involved. However, the situation may be different, the simulations provided possibilities, which may be used in the future for designs, policies or otherwise, to make buildings smarter, based in the information gained form this approach.

As mentioned in the discussion of the social psychology based research approach the need for surveys was mentioned. However, the fact that what people say they do, and the things they actually do can differ *(Murtagh, et al., 2013)*. This social effect needs to be considered in the execution of upcoming researches. The three different references that were mentioned by discussing this approach, conducted the research in different fields and countries. Where Abrahamse & Steg (2009) conducted their research inside households in The Netherlands, Karjalainen (2011) (Finland) and Amasyali & El-Gohary (2016) (different states in the USA) were interested in the relation between the households and the office environment. This shows the worldwide interest for investigating the human behavior in relation to reducing the energy consumption. However, there was one issue that they had in common, the difference of responsibility of the energy bill in the different environments. The fact that people behave differently between the residential and office environment, in relation to the energy consumption, is remarkable. Amasyali & El-Gohary (2016) pointed out in their research that there is also a difference of the occupant's values, and therefore, people behave differently. The difference and importance of the values between the different environments, are connected to the comfort of a person in a certain environment. If the human behavior want to be researched using the social psychology research approach, the outcomes of the surveys should be measured or tested to prove that the participants actually do what they say they do.

Investigating case studies, the field experiment approach was conducted in different forms. It started with the inventory of the office equipment in combination with the use of power management for devices and led to different type of settings and occupants of the office environment. The attention into this field was attracted after groundbreaking results were booked by researching the energy consumption of the equipment after non-working hours. The data of the energy consumption was leading for all the researches, while other factors varied. However, the human aspect was pointed out to be important, the willingness of the occupants could not be predicted. Therefore, field-experiment is useful source, to study the office equipment and making observations in the office environment field and book results.

The last approach which was mentioned, was the algorithmic approach. Using an algorithmic formula, the possibility to predict the relation between the energy consumption and the human behavior can be sustained mathematically. The variable in this formula calculated the influence of the social network around a person. However, before the variables were set, observations and questionnaires were needed to determine the value of the variables.

The mentioned interventions show that human behavior is influenced to reduce the energy consumption, starting with rewarding. The participants received information when they were rewarded. The rewards were in the form of monetary and social rewards. However, the social rewards were proved more effective in the office environment, where the monetary reward where proved to be more effective in the residential environment. Because of the complicated relation between the residential and office environment, the responsibility in the environment was appointed as the main reason, why people are more involved to reduce the energy consumption in the residential environment, compared to the office environment.

Besides, reducing the energy consumption in the residential environment is the responsibility of the people themselves. If they are convinced about the importance of reducing the energy consumption, they will act on it. Such actions are harder in the office environment, where policies are made at an organizational level.

When mentioning the demonstrations, the information about the energy consumption was shared using a meeting or workshop. The meetings were used to provide feedback about the energy consumption, achieved goals and to set new goals. This was proved useful, because it included a group effort which is proven to stimulate people because of their need to preform like others and to belong in a group. Besides the meetings, the idea of the workshop might also be interesting. It is a form in which people can interact, share information and be able to drop their ideas. The intervention of the meeting was based on one reference, due to the lack of references regarding this subject. It was conducted in the eighties in the residential environment, but might be a powerful intervention, because it has a prospective in which people need to participate actively.

Another intervention in which participants were actively involved, was the game intervention. This intervention was promising based on the outcomes of the feedback survey on the end of the research. People pointed out that they became aware how to act to save energy and how to achieve this, but the measurements at the end, proved otherwise. Once again was pointed out the fact the things people say they do and the thing they actually do are two separate things. Where private feedback turned out to be ineffective, public feedback was useful and had the power to creates the feeling of competition. This lead to situations in which people changed their behavior to reduce the energy consumption based on the fact that others behave the same. This resulted in certain pressure to change themselves. The use of information meetings led to the share of information and contribute in the group feeling within organizations. When discussing the need of feedback the last intervention strategy can me mentioned. The use of information, which showed that people react on certain information and thereby change their behavior to reduce the energy consumption. In both cases, the information on the display near the entrance of the hall and the information which was send by email, the occupants reacted on the information on the display or the email. The email, containing information and feedback about the energy consumption, can easily be implemented while the display needs many sensors before it is able to provide updated information.

2.5 Conclusion

Based on the findings of this literature review, it is possible to state that there is a relation between the energy consumption and the human behavior. There are many different methods which can be used as research approaches, but there was one issue they had in common: the human behavior in the office or residential environment in relation with the energy consumption. The aim of the researches was to understand the complicated relation between the human behavior and the energy consumption.

The urge to reduce the energy consumption has been discussed several times. Some of the articles stated that this not only essential in the residential area but also in the non-residential area, such as schools, hospitals and office buildings. There were already researches into the energy consumption in office buildings, however these researches are focused on certain elements, such as, equipment, installations, or building characteristics. Or in case of
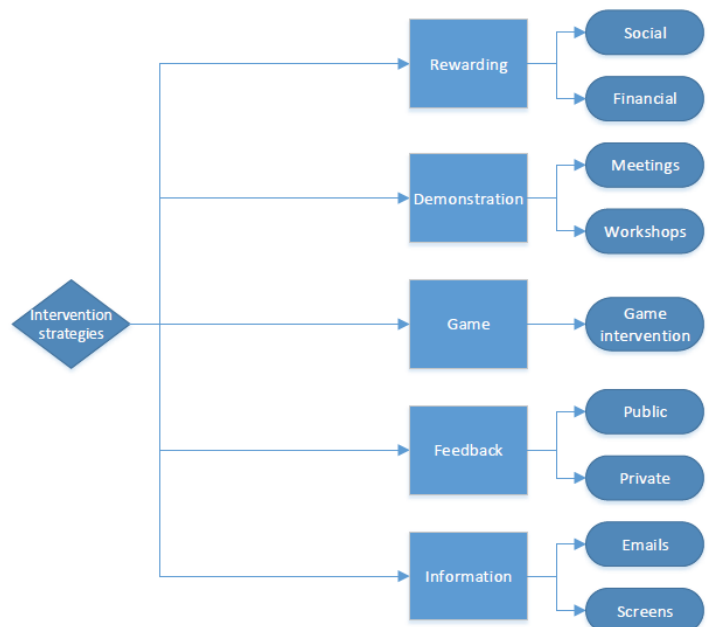
Figure 5 Intervention strategies

intervention, they use one type in order to influence the human behavior to reduce the energy consumption. This provides an opportunity for a new research to investigate if it is possible to try a combination of intervention strategies to research how the human behavior could be influenced to reduce energy in office buildings. Besides, based on the research, the long term effect is not always tested after the implementation. This is a point of attention for further research.

Based on the research approaches the intervention to influence the human behavior in order to reduce the energy consumption are shown in Figure 5. The outcome of this figure will be used for further research and treated as possible solutions which can be used in the office environment. All the intervention strategies result in reductions of the energy consumption. Besides this, all intervention strategies had a second point in common, they all need to share information in a certain way, before results can be achieved.

Chapter 3

Energy and Witteveen+Bos

Before a recommendation can be given, the relation of Witteveen+Bos towards energy needs to be investigated. Therefore the energy policy will be described in paragraph 3.1 followed by the energy strategy. In 3.3 the energy consumption will be discussed because this has to be known in order to reduce it the concept of PLUSwerken with the observations will be described in 3.4. after all this information is known the conclusion will highlight the most important point, which will be needed for the rest of the research.

3.1 Witteveen+Bos

The case study is conducted in the office environment of Witteveen+Bos. This environment is chosen, because of the fact that Witteveen+Bos is working on a sustainable world and the majority of the people within this environment is higher educated. The aim of the renovation of the office building in Deventer, is to reduce the energy consumption and implementing PLUSwerken. By implementing PLUSwerken, less office spaces are needed, because the work places are more efficient, because of the flexibility. Besides, the amount of higher educated people it is interesting to test a couple of hypothesis. Straughan and Roberts (2006), stated that people which are higher educated are more concerned about environmental issues. Therefore, during this chapter Witteveen+Bos will be discussed based on the energy policy, energy consumption, PLUSwerken, and observations will be discussed. After these paragraphs hypothesis based on the literature review and the observations within this environment will be discussed.

3.2 Sustainable design principles

Witteveen+Bos designs are based on six sustainable design principles. The application of these principles usually takes place within the assignment/contracts/projects for both clients as well as within the company. When the principles are applied as early as possible within the projects the best result and impact will be achieved. The description of the principles is as followed (Witteveen+Bos, 2016):

Principle 1: Nature & Climate

To strive to nature-related and climate-proof elaborations. The subjects of nature and climate are not static but dynamic and change over time. The vision is set to design with this principle in mind and adjust where possible to design together with nature. The starting point is knowledge and understanding of the ecosystems and natural processes. This allows to contribute to conservation of biodiversity and development of a green and healthy environment for human and society.

We strive to climate proof designs, by keeping expected climate change in mind as much as possible. We try to minimize the cause of climate change by reducing the emission of greenhouse gases of our projects and try to adapt our designs to cope with the consequences of climate change.

Principle 2: Chain

By working out assignments the organization uses the chain approach. We strive to consider the devised solution and the whole underlying chain of processes and materials in conjunction as much as possible. The goal is to provide sustainable solutions, that, considering all links of the chain, provide the optimum result. If it is possible the circular approach is taken into account for technological and biological cycles to enrich the environment and to use renewable energy. This way, no waste products will be created and it helps to useful deployment of products into a new life as possible and the circular economy will be encouraged.

Principle 3: Optimization of functions

The aim of development and (re)design issues for both above- and underground is to search for the right features on the right place wherein the (use)values will be optimized. The social values for the society will be determined by the degree in which an area, building op project performs useful to its functions. The social benefits arise when the functions will be fulfilled by the society needs.

Principle 4: Welfare

The well-being and physical needs of humans such as: safety & security, appreciation & recognition, fulfillment, health, social cohesion, cultural history, experience and other aspects of social sustainability is a guiding principle for the design process. Social sustainability implies an ongoing process, aimed at making things better for people in

several dimensions. This principle is based on the pyramid of Maslow, which can be found in Figure 6. This pyramid about the freedom of choice is based on mobility, economic safety, social participation and self-actualization.
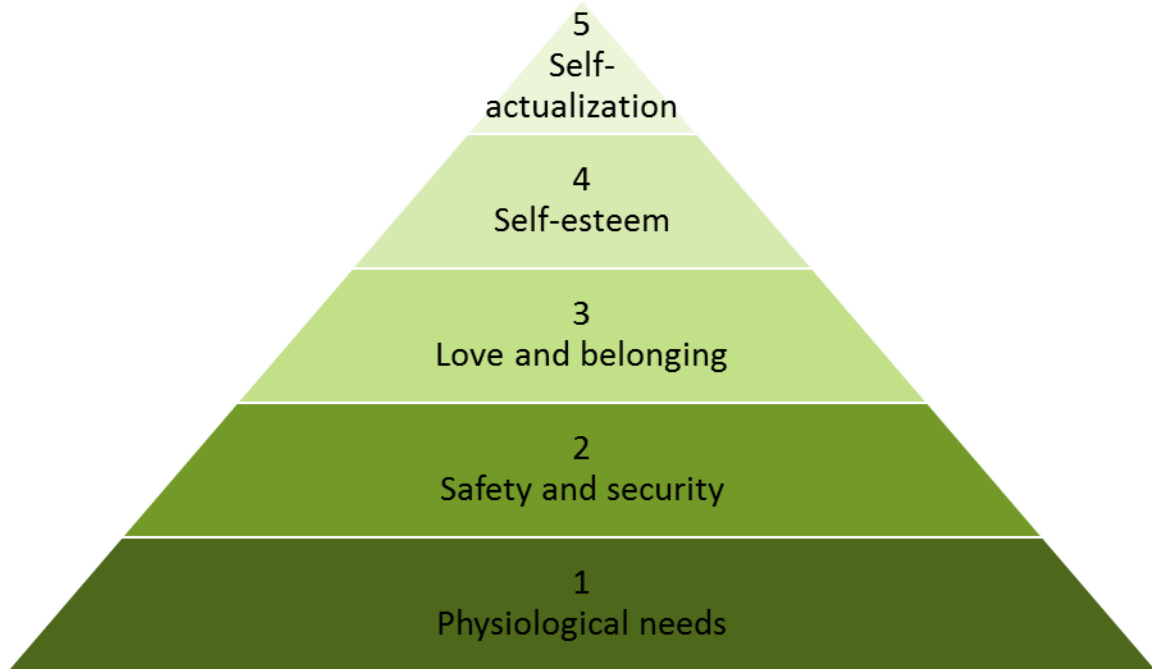
Figure 6 Maslow's hierarchy of needs adapted from (Stum, 2001)

Principle 5: Participation

Participation of stakeholders and users is important in the decision making process of development and design processes. Good communication is vital because the importance of sustainable design has to be carried out as widely as possible. Through knowledge and engaging the wishes of the stakeholders in a meaningful and structured manner, plans and projects become better. The public support is enhanced and a smoothing process of decision-making is the result.

Principle 6: Trias-principle

Witteveen+Bos is committed to reduce greenhouse gas emissions, for both the own emissions and within the designs, in their designs, by using the TRIAS principle and the CO_2 performance ladder. The TRIAS is a three-step approach for energy-efficient and sustainable designs. It is about reducing the demand and avoiding the unnecessary use of materials and energy, use unlimited resources where possible, and use limited resources wisely and efficiently. The CO_2 Performance Ladder helps companies to reduce CO2 emissions. Witteveen+Bos hereby achieved the highest level (level 5). Here we look at four categories:

A. *CO_2-footprint*
B. *CO_2-reduction measures*
C. *Communication about CO_2 emissions and CO_2 reduction targets*
D. *Participation in CO_2-reduction initiatives*

3.3 Energy consumption

In the year report over 2015 (Witteveen+Bos, 2016), the global CO_2-emissions of the company is mentioned. These are shown in Figure 7. In this figure the electricity is only 1% of the total worldwide CO_2-emissions of Witteveen+Bos. In

combination with the heating and cooling it is 12%. This shows that reductions are possible. However, transport is the biggest contributor, air travel and business cars in particular.
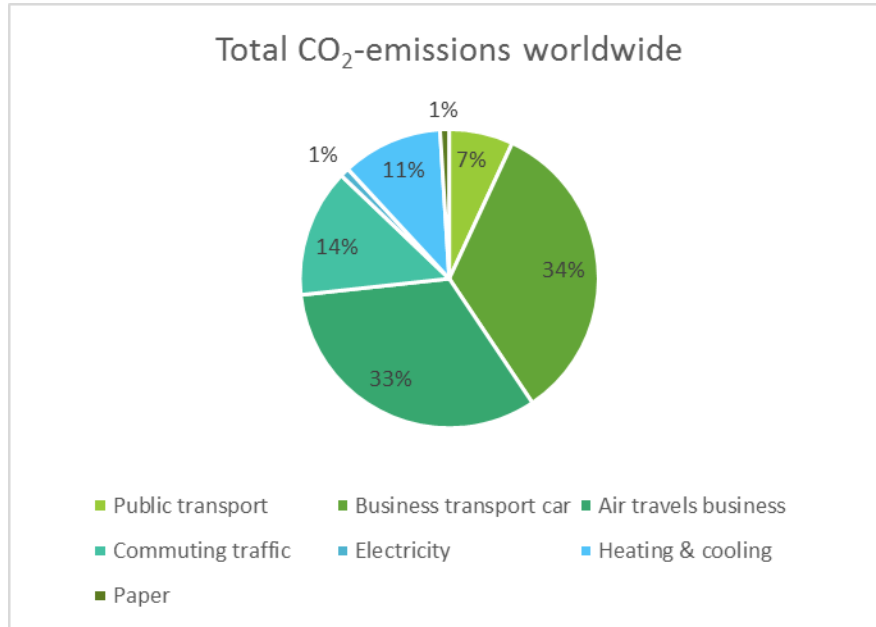
Figure 7 Total CO$_2$-emissions of Witteveen+Bos adapted from (Witteveen+Bos, 2016)

This research focuses on reducing energy consumption, mainly electricity, in the office environment. however it is always important to have knowledge about the total consumption and in how the relations of the different sectors is divided. Therefore, in Table 2 shows the deviation of the energy consumption in energy related issues, and the traveled distances of the company in 2015. It is important by learning the numbers, that the company is spread over the world, and sometimes trips are needed to meet clients for example. A one way trip Amsterdam – Jakarta for example is 11.351 km (Reisbijbel.nl, 2016).

Table 2 Energy consumption worldwide adapted from (Witteveen+Bos, 2016)

Energy consumption		
District heating	143	GJ
Gas	250.977	m^3
Electricity	1.591.193	kWh
Paper	33.081	Kg

Transport	[million km]
Business cars	0.02
Commuting traffic business cars	0.3
Business trips private cars	3.2
Commuting traffic private cars	2.6
Air travels	8.7
Public transport	7.1
Total km	**21.8**

3.4 PLUSwerken

PLUSwerken, Witteveen+Bos's new implementation of a flexible working environment is currently implemented in four of their offices in Amsterdam(2014), Antwerp(2015), Dubai(2015), and Breda(2016). Their other offices use a more traditional way of working i.e. everyone has his/her own office. With PLUSwerken workplaces are not assigned and occupants can choose where to sit. At the locations there is a various selection of workplaces, which are available for everyone, the desks are equipped with several facilities such as; external screen, office accessories (pen, pencil, markers, post-it notes), keyboards, plug-in stations etc. Employees of Witteveen+Bos have their own company laptop, which make it able to change workplaces. One of the main advantages of this way of working is saving office space, everyone is flexible, and all the places can be used by everyone. This gives them also the possibility to easily change office, and meeting other colleagues (TNO, 2011). The statements shown in Figure 8 show the positive influence on "het nieuwe werken" after six months of implementing this concept.
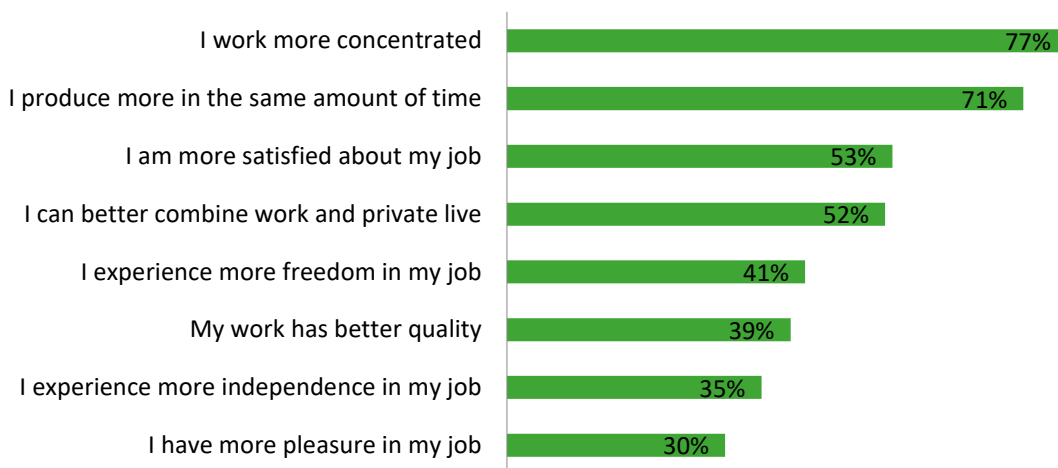
Figure 8 Statements about "Het Nieuwe Werken" adapted from (TNO, 2011)

However, there are disadvantages to the new way of working; working spaces become less personal and storage is located at an fixed location. This also means employees have less storage space available. Research shows that workers function in three distinct work modes, varying from individual to group work and meetings, to operate throughout their workday. Focus mode(high level of concentration), active mode(medium level of concentration), and collaborative mode(medium or low level of concentration) (O'Neill, 2011). These work modes can be connected to different type of workspaces.
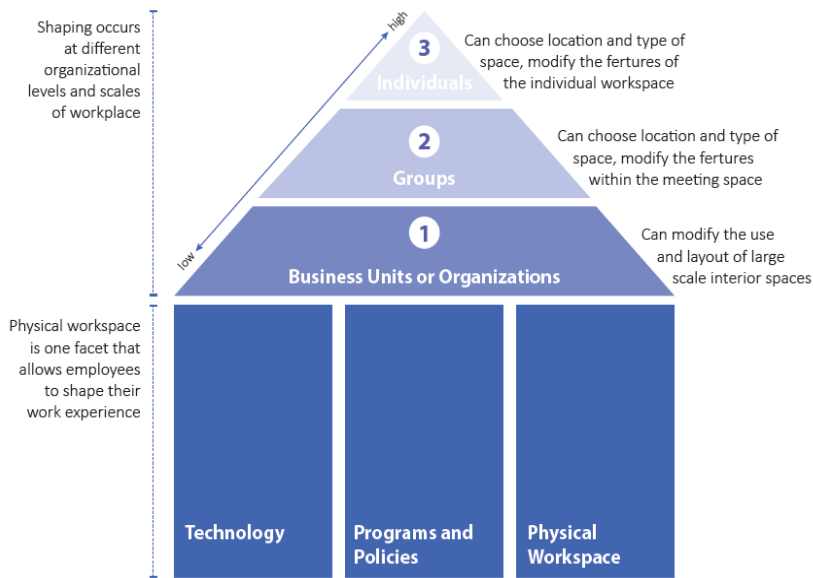
Figure 9 Shaping the work experience adapted from (O'Neill, 2011)

O'Neil (2012) mentioned the importance for the employee to work in an environment which can be shaped by the employee itself. "Shaping" the work experience occurs when people manipulate elements of their physical environment, they can choose their work location or type of space, or select their time of work. An overview is shown in Figure 9.

At this moment, the number of Desktop PC in the PLUSwerk environment is low. Only a few of this type of computer can be found in this environment. Every employee is in possession of a work laptop. In Table 3 the energy consumption of equipment in the office environment is shown, to give an impression of the energy consumption of different type of devices. By reducing the amount of desktops and replacing them with laptops, energy savings are already realized.

Table 3 Representative power levels for office equipment adapted from (Webber, Brown, & Koomey, 2000)

Type	On [W]	Low power [W]	Off [W]
Desktop PC	55	25	1.5
Laptop PC	15	3	2.0
CRT monitor	85	5	0.5
LCD monitor	15	1.5	0.5
Copier	185	76	8.7
Laser printer	77	25	1.0

This paragraph will describe the different type of spaces to work, meet, and support the employees to conduct their work in the PLUSwerken environment. They are typically used in for office activities and each supports different activities, the level of concentration for the spaces will be mentioned, for the insight of the space. The workplaces: open offices (for 2-4 persons in which direct communication is possible, separated by screens, relatively little level of concentration), team spaces(semi-open workspaces from 2-6 people, suitable for teamwork, medium level of concentration), focus rooms(enclosed workspace for 1 person, short-term activities, high level of concentration or suitable for confidentiality), shared rooms(enclosed workspace, for 2-4 persons, for collaborative work in small groups, medium level of concentration), team rooms (enclosed workspace for 4-10 people, suitable for projects, medium level of concentration), work lounges (lounge like workspace for 2-6 persons, short-term activities for collaboration and interaction, low level of concentration).

The meeting spaces, used for interactive processes are present in the following types: meeting room(enclosed small room for 2-4 persons, or large room for 6-12 persons, for formal and informal interactions), meeting space(open or semi-open space, for informal conversations), BIM room(enclosed room for 2-4 persons, a big screen, space for interaction around computer), brainstorm rooms(closed meeting space for 5-12 persons for brainstorm sessions and workshops).

Various support spaces: print area (semi-open space with facilities for printing, scanning, and copying), storage space (in the form of cabinets for information and personal storage, or an closed space for storage of office supplies and files), pantry area (open space for coffee and tea adjacent to the break area), locker area(open space for storage of personal belongings),

waiting area (space to receive visitors), circulation space (set up to take different routes between the spaces), phone booth (to answer the telephone, set up to reduce the volume and not to disturb colleagues).

One of the offices of Witteveen+Bos is the Leeuwenburg in Deventer. This building will be renovated in 2017, and afterwards PLUSwerken will be implemented in this office. This concept will be combined with housing, ICT and behavior. The brick-bytes-behavior is the primary process of Witteveen+Bos to facilitate: multidisciplinary and integral collaboration. The combination is composed as followed: the office environment which is flexible for the bricks, the technology within the office to support occupants are the bytes and the human which is needed for the behavior and the culture within the office.

3.5 Field research

Field research, or case study, is an example of a research paradigm and uses both quantitative and qualitative methodologies to help understand phenomena. It is a process- or means-oriented manner of research which helps the researcher to comprehend why certain effect or characteristics occur, or not. The observations and relationships are considered independent of theories, and controlled by the needs of the researcher. The aim of field research is to collect information and data from outside a laboratory or library, observing people in their natural environment. Case studies use multiple methods and tools to collect data form the environment of the researcher which considers temporal and contextual aspects of an phenomenon under study, without control or manipulations (Meridith, 1998). The aim is to understand as fully as possible the occupants by studying them by the 'perceptual triangulation' (Bonoma, 1985), the multiple entities as supporting sources of evidence that the facts being collected are indeed correct. The research is mostly connected to a certain case study. This can be conducted in different forms: Formal interviews, direct observations, participation in the environment and discussions. The method is generally characterized as qualitative research, however it includes quantitative dimensions. Field research is a learning situation in which researchers have to understand their actions and activities as well as those of the people they are studying. The data depend upon the field, and the involvement of the researcher, the ability and the visualizing of things which other people in the area of study may fail to notice. With case studies, the data collection is assembled using, observations, triangulation, and logic rather than mathematics or statistics to makes our deductions and inferences (Gerwin, 1981). When human themselves are a subject within the study, protocols must be devised to reduce the risk of observer bias and the acquisition of too theoretical or idealized explanations of the workings of a culture.

During the observation the researcher observes the behavior based on a social research technique. It involves the direct observations of a phenomenon in their natural setting. Thereby it is important to keep records in the process. The notes register the experiences and participations of the researcher of the local scenes, which will be written up after the observations. Another method to collect date is via interviews. This can be conducted in different formats depending on the preferences of the researcher, the purpose of the research and the questions which need to be answered.

To study the environment of the employees it is important to understand the employees. The employees are in their environment to work and earn money; however, employees have other needs besides money which can be fulfilled in their jobs. Two of these needs are a sense of control and the need for social contact. Both of those needs have the potential to result in an desired outcome for the employee and organization. The employees' control over important aspects of their jobs has long been considered a factor in their pride, motivation and satisfaction. Their social interactions in the workplace can be a source of both pleasure and pain, the same as outside of the workplace. The essence of job control is the degree to which employees have influence on their activities and the conditions under which they work to correspond to their needs and goals. There are reasonable grounds to assume the general need of people for control or authority in their lives (Gagné, 2003; Sheldon & Hilpert, 2012). This shows the importance environment for the employees. With this information observation were conducted at the offices of Witteveen+Bos where PLUSwerken was implemented.

During the observations the people in the PLUS environment and the use of the spaces were observed. The offices of Amsterdam, Antwerp and Breda were in total 29 times visited, whereby Amsterdam has been visited 7 times, Antwerp once and Breda 21 times. During these visits people were asked informal questions about their experience in this environment. The observation started in May 2016. At this time, PLUSwerken was two weeks implemented in Breda. This meant that people were trying to find their way around the office. During the first observation session several conversations and the behavior of employees were observed. Examples of these conversations included a conversation of two women telling each other that the new way of working was a real improvement compared to the traditional way of working. Another employee took an office room consisting of 4 places for him alone. This behavior was interesting, because there was space enough were he could sit alone, however, he did choose to use a four person room just for himself. The question this raised was whether this was a habit of convenience or that this was a deliberate choice. During later observations, when PLUSwerken was implemented for a longer period of time, the same person was just sitting at one of the places in the open flex environment. One of the things I found really remarkable, is the open space, but they are comfortable to work. Furthermore the noises of other occupants do not bother my own productivity. An overview of the information gathered during the observation can be found in Appendix 1.

The overview of the observations shows the different type of people working in this environment. People who are stationed in the PLUS environment just sit with their colleagues, people that are new, or do not work often in this environment, ask if the places are free or look for a place alone. There is an obvious difference in the behavior of people. In Antwerp for example, which is a PLUSenvironment, people have assigned places. This was obvious through the amount of personal belongings and papers on the desk. In Amsterdam and Breda this kind of behavior was only observed at the desks of the secretaries. In Amsterdam it is possible to walk around within the offices. The office is designed in a circle which causes people to take other, or longer, routes to their destination. Research shows (Voort, 2004) that change of environment can stimulate people, and therefore this type of behavior is stimulated in the PLUS environment, for example in the office environment of Breda and Amsterdam. The office environment in Breda is opposed to Amsterdam is not a circle, but by placing objects on the main routes, people will be stimulated to think about their route choice. Although stimulating employees to change their environment more often is a positive development in the offices of Breda and Amsterdam, there are other office environment issues that still need improvement, such as, the lighting. In Breda for example almost all the lights are controlled by sensors except for the focus rooms (lights are on the entire day) and the toilets (lights are manually operated) the focus rooms are only used for short periods of times, meaning no more than an hour, but lights in these rooms are on for the entire day while the use of those rooms is very limited. The PLUS environment in Amsterdam was implemented 2 years earlier than Breda, and in this environment all the lights are controlled manual.

During the observations, the people seem really productive and were also discussing this among each other. This way of interaction is stimulated in this environment but there are also screens between the desks, which make it possible to exclude yourself form the interaction. Because of the flex desks, the barrier to interact is low, which causes that people sometime catch up when passing by, for example about assignments of other work related issues. In Belgium the observation was different compared to Amsterdam and Breda. This office is a PLUS environment, however everyone has their own desk which is personalized. There are only four places which can be used as flex desk. In Belgium het nieuwe werken, is not as important as in the Netherlands, was the conclusion after questioning the people in this environment.

The informal conservations with the employees in these environments a couple of matters were brought up. Some people mind the limited storage of personal files. This is sometimes resolved by printing information for an assignment at the beginning, and throw it away when the assignment is finished because it cannot be stored after the assignment is finished. If a solution can be found for this, people will not print unnecessary papers for every project. People acknowledge that they prefer this new way of working, even when they were skeptic about PLUSwerken in the beginning. It seems that there is a

type of power management within the offices, based on when the external screens at the desks. In the morning the screens are always off.

During the observation phase also the office spaces are observed, and the main and sub routes are processed and collected on maps of the environment. These maps are shown in Appendix 2 for Amsterdam and Appendix 3 for Breda. Also the use of spaces is marked based on the density of the occupancy. By doing this, the main routes and the use of places can be charted and might be helpful by proposing solutions to reduce the energy consumption at the offices of Witteveen+Bos.

Based on this observations the following information was collected. People experience this environment stimulating and improving their productivity. In Breda, the first period was for some people learning to adjust to this environment, however, within two months everyone was used to this way of working. The PLUS environment is experiences simulating for the people in this environment, because of the possible interaction with colleagues, and the openness of the environment. but also because the environment supplies spaces for all kind of work, which means people can chose the environment the prefer to work in, at all times. Within the office environment the routes are inviting to differ, which means that it does not always have to be the same, which is also stimulating the people in this environment. The office environment does not included lots of space for personal storage, which some people find annoying because they print now more than the prefer, due to the lack of space. In Belgium, PLUSwerken was implemented, however, everyone has their own assigned workplace, because they experience this more convenience and "het nieuwe werken", is not a supported issue in the Belgium.

3.6 Interviews

During social studies interviews can be used to explore and understand a diversity within a social environment. It is possible to discuss social and policy issues, either as an independent research strategy or in combination with some form of statistical inquiry. For a small-scale research, semi-structured interviews are common to use. The interviewer uses a detailed structure which will be worked out during the interview. It is a flexible technique, and helpful in case-studies. The person being questioned has a fair degree of freedom in answering and to expressing (Drever, 1995). The detailed structure will contain questions, which will be answered in all of the interviews. By doing so, the interviews can be compared with each other and the results can be used as foundation. The questions can be divided into four categories: contextual, diagnostic, evaluative and strategic (Ritchie & Spencer, 2002). In case of contextual questions the aim is to identify the form and the nature of what exists. By diagnostic questions it is about examining the reasons for, or causes of what exists. In case of evaluative the appraising, the effectiveness of what exists is questioned and by strategic it is about identifying new theories, policies, plans or actions. This resulted in the following framework of examples for questions:

- Conceptual: Are people concerned about energy issues?
- Diagnostic: What stimulate people to involve in reducing the energy consumption, or not?
- Evaluate: How can the you make sure goals can be achieved?
- Strategic: Can you think of implementations which can be used to reduce the energy consumption?

These questions were asked during an interview with two people of Witteveen+Bos. These people are involved in projects to think about solutions to reduce the energy consumption. The aim of these interviews is to collect data about the people of Witteveen+Bos, who is the engineer in the environment of Witteveen+Bos and how can they be influenced to reduce the energy consumption.

During the interview the aim of the research was explained and the way to intervene was explained. The meeting was open, and the interviewee could react however they liked. The first interviewee was sceptic about the interventions, however, implementing feedback and interaction were considered to be useful. Rewarding was something that in his experience only works for a short period of time. The screens were seen as useful, however, the need to be interesting, otherwise nobody will care. An idea which was mentioned by this interviewee, was creating a community around this subject. People will be

involved and the effect will be there hold for a longer term. However, if a community is formed, the initiative needs to be kept alive, which means that people really need to be involved and stimulated if results will be achieved.

During the second interview, it was more about the issues within the system The interviewee suggested to see the office as a system in which results can be achieved. Additionally he suggested to also think about the perspective of the people that have influence on the energy consumption. The interventions were received enthusiastically, but the interviewee urged to also think about the type of employees in the office environment. These employees are mainly young people, which are using social media. Social media therefore is a platform that can be used to reduce the energy consumption. At last the interviewee advocated on the fact that when reducing the energy consumption within the company the transport mode must also be kept in mind and this could maybe be influenced in the same matter.

These interviews were useful in pointing out the perspective of people in the office environment which helped to create an idea about the people in the working environment of Witteveen+Bos. These people are stimulated, and want to achieve goals. However, it is always important to keep in mind that it is about the office environment will always be different than their private environment.

Before the questionnaire was send out, a conversation with an employee of communication was held. During this conversation, the idea and interventions were presented and nicely received. At this moment there is a plan to replace the information boards at the offices in 2017, by screens. Which also makes it possible to implement the information screens which is one of the interventions.

3.7 Hypothesis

The aim of the questionnaire is to chart the employees within the office environment of Witteveen+Bos. This makes it possible to answer statements about these employees. Based on the interviews, the population within the offices is described as young, and higher educated. Meaning that this will differ from the average age of the Dutch population is 39 years (GG, 2016). Further are the levels of education in the Netherlands as followed divided low 22%, medium 43% and high 35% (GG, 2016). Therefor the following 9 hypothesis are formed:

1. **Women are more considered about the impact of their actions.**
   Women are, according to the research of (Straughan & Roberts, 2006), more considered about the impact of their actions than man. The female population within the company is 27% (Witteveen+Bos, 2016). However, is would be interesting to investigate if this applies in the office environment of Witteveen+Bos.

2. **Women, older and well-educated are more engaged in energy issues**
   The average age within the company is 37,6 year. Within the Dutch population of the company 81% followed HBO or WO education and 19% followed a MBO education (Witteveen+Bos, 2016). This means that the majority of the population in the working environment is well-educated. This makes it interesting to test this hypothesis, with a female population of 27% in the office environment.

3. **Younger people are more likely to be sensitive about environmental issues**
   It is generally believed that young people are more likely to be sensitive about environmental issues. Testing this hypothesis is interesting because the average age within the company is 37,6. To test this hypothesis in relation to the environmental issues makes it able to learn about the point of view of the people in the office environment of Witteveen+Bos. How sensitive they are about the environmental issues in relation to energy savings.

4. **The higher the level of education, the bigger the concern of environmental actions**
   More than the majority of the people in the work environment of Witteveen+Bos is higher educated. This makes it able to test the hypothesis within the company and to investigate if the level of education is related to the environmental actions. .

5. **PLUSwerken improves the productivity**

This hypothesis is based on the statement of TNO (2011), which provided an overview of statements about flexwerken, and the opinion of the respondents. PLUSwerken provides the employees the environment in which they prefer to work, however they please. It will be a logic effect that the employees work more productive in this environment. therefor this hypothesis will be tested.

6. **PLUSwerkers are more sensitive for the behavior of their peers**

   Based on the fact that people work in the same space, it is easier to be influenced by their peers. Therefore, this hypothesis will be tested, in order to see if this is behavior is present in the PLUS environment.

7. **There is no difference between the preferences for the intervention to reduce the energy consumption based on the working environment**

   For this hypothesis the respondents are divided into two groups based on their environment: PLUS and traditional environment. The hypothesis test that there will be no difference between the way of working and preferences for interventions for reduce the energy consumption. This assumption is based on the idea that the way of working will not influence the preference of people.

8. **There is difference between the preferences of interventions to reduce the energy consumption based on location**

   The location where people work might have a influence on the intervention to reduce the energy consumption. This assumption is made based on the different location of the offices. Mostly the base location of an employee is appointed on their residence. Therefore, people in Amsterdam, might be differently concerned about environmental issues because of the urban environment, then a person who works in Heerenveen. In Heerenveen is a lot of nature.

9. **There is a difference between the preferences of intervention to reduce the energy consumption based on sectors**

   The assumption is based on the fact that the sectors within Witteveen+Bos might have other perspective. Some are more focused on energy while other sectors are for example a supporting division. Therefore, the preference for intervention will be tested in relation to the sector the employee is active.

3.8 Conclusion

Witteveen+Bos is working on towards a sustainable environment. In the Netherlands, as well as in the rest of the world. This starts with the implementation of the six sustainable design principles, which should be implemented in every project. Followed by the PLUS environment, which should motivate people to work however they please. However, the CO_2-emissions of the electricity consumption of the company is only 1% of the total CO_2-emission combined with heating and cooling, it is 12% of all CO_2-emission. It is always important for people to be aware of their contribution to make their environment more sustainable.

During the observations the PLUS environment was explores, the behavior of the people in this environment was observed. And information was collected using observations to investigate the behavior of humans in the spaces and by conducting informal interviews, to learn about their experiences. The Interviews where useful to create a framework to describe the employees of Witteveen+Bos. Followed by making statements which can be used to test how people in the office environment of Witteveen+Bos can be described using hypothesis.

Chapter 4

Questionnaire

In this chapter the questionnaire will be discussed. First the aim of the survey will be elaborated in paragraph 4.1. This is followed by the design of the of the questionnaire in paragraph 4.1.1. The composed questions are based on different factors: the socio-demographics, attitudinal and socialization factors. Next is the explanation on the design of the choice experiment of the intervention strategy. The interventions will be discussed and the attributes will be introduced at the end of paragraph 4.1.1, as well as the profiles tested in the questionnaire. The methodologies to analyze the data will be explained in paragraph 4.2. In paragraph 4.3 the data collection will be elaborated and the needed number of respondents and the questionnaire platform will be discussed. In paragraph 4.3.4 the response on the questionnaire will follow and in the last paragraph, 4.4 the conclusion can be found.

4.1 Survey

As a survey a questionnaire will be conducted using an online platform. The questions will be formulated based on the results of the interviews, observations and literature study. The questionnaire will consist of two parts. The first part will include demographic questions followed by statements. The second part is a choice experiment. The aim of the questionnaire is to collect data about the employers in the working environment of Witteveen+Bos. This data is used to answer the questions; 'How can the target group of Witteveen+Bos be described?', 'Do they care about saving energy?', and 'Will they help the company to reduce the energy consumption in their working environment?'. Also the preferences for interventions reducing energy consumption will be collected using the survey. The next step is to investigate if there is a relation between the different variables for interventions and if the target group is willing to change their behavior in the working environment to reduce the energy consumption.

4.1.1 Questionnaire design

As mentioned before, two research approaches will be used to profile the pro-environmental behavior and preferences of the participants of the questionnaire. First the profiling methods based on socio-demographic, psychographic and behavioral criteria will be used. Socio-demographics seem less appropriate to serve as a base for profiling the participants, though can be used to describe and identify segments within the company of Witteveen+Bos. Moreover, socio-demographics as well as personality characteristics represent general characteristics independent of energy conservation issues as they influence general behavioral patterns rather than specifically energy-related behavior, but also indirectly affect energy consumption (Bernadette et al., 2011). Socio-demographics are theoretical dimensions of environmental consciousness domain and form the framework which is wanted to create profiles of the participant (Diamantopoulos et al., 2003). However, besides the socio-demographic other information of the participants is wanted, to make statements about knowledge of green issues, attitudes towards environmental quality and environmentally sensitive behavior. Therefore the information of attitudinal and socialization factors is also important, before the choice experiment can be conducted. The attitudinal and behavioral factors inform about the variance regarding pro-environmental behavior.

Socio-demographic factors

The socio-demographic factors are characteristics used to define sociological and demographic factors. These factors are used for marketing research as well as analysis in social science or other studies. Sociological characteristics are objective and tell the researcher something about the social relation of the participant, for example: composition of household, membership in organizations, social groups, and values. Where demographic characteristics are more facts related to a person such as: age, gender, place of residence or level of education.

The combination of both will help gather background information of the participant. Based on literature, the factors are connected to the environmental behavior and therefore used in the questionnaire.

Gender

The first characteristic is the gender. According to literature, (Brunner et al., 2011; Diamantopoulos et all, 2003; Roberts, 1996; Rowlands et all, 2002; Straughan & Roberts, 1999; Gilg at all, 2005), women consider the impact of their action on others more careful. The development of unique sex roles, skills, and attitudes has led most of the researchers to argue that women are more likely than men to be concerned about green issues. Some researchers suggest that older, well-educated, with a good income and political liberal females are more engaged in green consumption. However, the gender-based investigations are still far from conclusive, although will be used in this research.

Age

The general belief is that younger individuals are more likely to be more sensitive about environmental issues compared to elderly individuals. However, the results are not harmonized, some researchers (Brunner et al., 2011; Diamantopoulos et all, 2003; Roberts, 1996; Rowlands et all, 2002; Straughan & Roberts, 1999; Gilg at all, 2005) explored that age is correlated

to green attitudes and behavior, but did not found significant relationships. Another (Straughan & Roberts, 2006) found a relation of attitude based on "depression-era" conservations and/or behaviors stemming from a general increase in social and charitable activities among the middle aged. One of the arguments was about people which grown up in a time period with environmental concerns, these might still be an issue in their daily life and may therefore be more likely to be sensitive to these issues.

Level of education

Education is positively correlated with environmental concerns and behavior. Statements in researches (Brunner et al., 2011; Diamantopoulos et all, 2003; Roberts, 1996; Rowlands et all, 2002; Straughan & Roberts, 1999; Gilg at all, 2005) claim that the higher the level of education the bigger the concern for the environment and a greater likelihood of participation in environmental protection activities. Therefore the levels of education are selected as factor for the questionnaire.

Base office

All the employees have a base offices. Mostly the base is the location closest to their home. The options for this question are the following locations in The Netherlands: Amsterdam, Breda, Den Haag, Deventer, Heerenveen and Rotterdam. In Deventer there are three locations: Leeuwenburg, Stationsplein and Twickelostraat. The goal for including the base office location is to investigate if it has influence on the objective about energy consumption. The size of the offices are different, and the contact between peers can therefore be different. Because of the fact that PLUSwerken is implemented in only 3 of the 8 offices, there is a difference between offices. PLUSwerken stimulates working in a more open workspace, and this might cause another social environment and social interaction between co-workers. More interaction could also lead to more pressure of peers in their environment.

Working location

Within the company there are four areas of expertise called PMC (Product- and Market combination). This information tells something about the professional point of view of the participant. The areas within Witteveen+Bos are: 'built environment', 'water management', 'energy, water and environment' and 'infrastructure and mobility'. This will be further neared to the number of their PMC group. Further there are six departments which support the sectors, these departments are: Finance, legal affairs, general affairs, property affairs, secretaries, and P&O.

Area of expertise

Within the company there are four areas of expertise which are called PMC (Product- and Market combination). This information tells something about the professional point of view of the participant. The areas within Witteveen+Bos are: built environment, water management, energy water and environment and infrastructure, and mobility. This will be further neared to the number of their PMC group. Further there are 5 departments which support the PMC's, these departments are: Finance, legal affairs, general affairs, property affairs, secretaries, and P&O.

PLUSwerken

During the questionnaire the respondents will be asked about the frequency of working in an office with the PLUSwerken concept. This question will be asked because of the outcome in relation to the work productivity and is based on an article of TNO which claims that the majority in their research agreed with the statement about an increased work productivity in offices with the new way of working (TNO, 2011). A question based on this statement is added in the questionnaire to see if people in the working environment of Witteveen+Bos agree with it. A large part of the target group at the offices of Witteveen+Bos are not working in the PLUSwerken environment, they will receive a statement about their expectation if this way of working would influence their productivity.

Financial reward

Based on the intervention strategy overview, rewards are a strategy possible to use to stimulate people to reduce energy consumption. Therefore a question will be asked on if people feel stimulated in case they will be awarded with a financial reward. However, because one of the interviews mentioned that a reward will not stimulate this persons behavior and the literature supporting this by stating that this intervention only works for a certain period of time (Handgraaf et al.,2014; Karjalainen, 2011; Matthies et al.,2011). The options of answering the question are yes or no, it is thus a self-evaluation.

Competition

Another intervention of the intervention strategy was the feeling of competition. Competition can be described as the behavior of peers which influences the behavior of the participant (Delmas & Lessem, 2014;Mulville et al., 2014). Therefore questions in this questionnaire are adopted to investigate if competition could influence their behavior. However, this involves a self-evaluation, the first question is based on a statement in which people have to answer on a 5-lickert scale if the energy behavior of peers influences their energy behavior. After this question the question will be asked if they are sensitive for competitive behavior. In case this question will be answered with yes, they will receive a follow-up question, namely if this will still be the case in the working environment. This is to obviate the possibility that employees come to their office primarily to work, and not to join a completion. However, a competition could stimulate their behavior to work and can function as a satisfaction in their working environment.

Attitudinal factors

The attitudinal factor can be describes as the level of stated willingness for environmental development. Several studies have attempted to identify psychographic correlations of green attitudes and behaviors. They do provide some interesting insights into the nature of the green consumer. In order to discuss what the attitudinal factors are the following factors will be described: Perceived customer effectiveness, liberalism, altruism and ecological concern. These questions will be answered in the form of statements on a 5-Likert scale.

Perceived customer effectiveness

The perceived customer effectiveness (PCE) is a character which measures the extent to which a respondent believes the ability of an individual consumer to affect environmental resource problems. Researchers have addressed the premise that consumer's attitudes and response to environmental appeals are a function of their beliefs that individuals can positively influence the outcome to such problems (Rowlands et all, 2002; Roberts, 1996; Gilg at all, 2005). Webster (1975) found that the socially conscious consumers are strongly convinced that he or she can do something about pollution and tries to consider the social impact of his or her purchases. This question will be asked in a 5-likert scale statement and can be found in appendix 7 as question 8 in the questionnaire. It relates the energy behavior of offices in The Netherlands and their part of energy consumption compared to the total amount.

Altruism

Altruism is about the concern for the welfare of others. The individual performs an action at the cost of themselves, but benefits directly or indirectly from it. The opposite of altruism is egoism. In case of reducing the energy consumption, an altruism individual performs based on the greater good. While a egoistic individual does not care and acts how he or she likes. In Figure 10 a scheme can be found about the relations within the altruism behavior of individuals related to environmentally friendly behavior. In case of egoistic behavior, there is a negative effect on the willingness to behave positively for environmentalism. However the biospheric-altruism is hard to predict in case of willingness to behave environmentally (Straughan & Roberts, 2006). Besides this fact, it is a character which helps to create a profile of the participant in relation to their willingness to behave in order to reducing the energy consumption. The question concerning this subject was left out due to the length of the questionnaire. However, the relation between the PCE and the ecological concern is connected to the attitudinal factor. Therefore the figure and this concept is important in understanding how altruism is connected to PCE and the following subject, ecological concern.
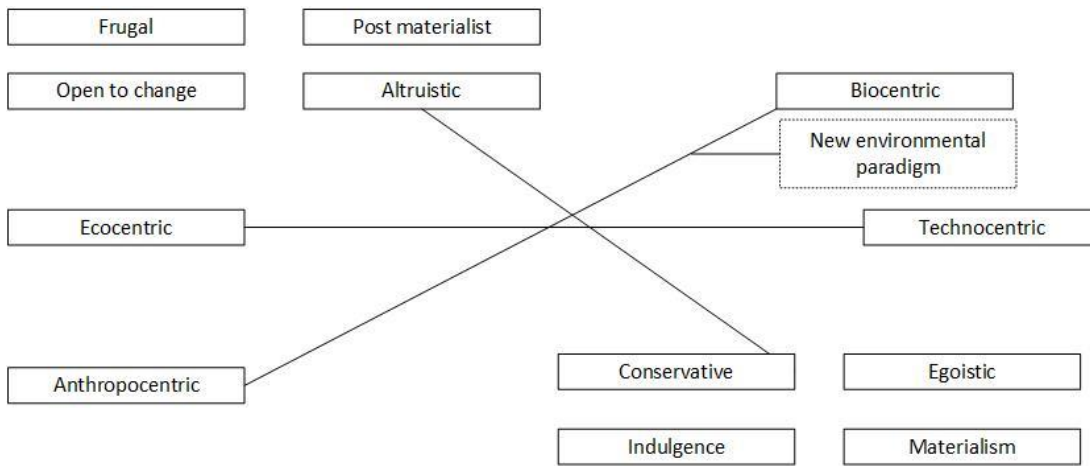
Figure 10 Conceptualization of the social and environmental values adapted form (Gilg, Barr, & Ford, 2005)

Ecological concern

Ecological concern is about the relationship between attitudes and behavior which has been explored in variety of contexts. In the environmental literature, it has been explored as the relationship between the attitudinal construct, environment concern, and various behavioral and measures and/or observations. The general environmental attitude and individual perception was observed for the necessary societal change, in combination with the concept of sustainable development. The researchers examined the environmental concern as a correlation of environmentally friendly behavior and have found a positive correlation between the two.

Through human history, environmental impact has largely been a by-product of human desires for physical comfort, such as: mobility, status, family, and so forth, and for the organizations and technologies which humanity has created to meet these desires (Roberts, 1996). This development has given environmentally significantly behavior a second meaning. It can now be defined from the actor's standpoint as behavior that is undertaken with the intention to change (normally, to benefit) the environment. However, in this case the ecological and environmental concern is about the social responsibility. The ecologically conscious occupant will score higher in measures of environmental concern.

Socialization factors

The socialization factor is based on the Value-Belief-Norm (VBN). It is about the consumer talks with others about products. This model is developed by Webster and it suggests the social conscious of the consumer to be more involved in community affairs. This approach has altruistic motives, because it presumes the environmental quality as a public good. The VBN theory is based on the assumption that values drive the behavior of individuals by activating beliefs about human-environmental relations, and their consequences, and that the individuals responsibility is to take appropriate actions. In Figure 11, a schematic representation of the variables in the VBN theory of the environmentalism behavior of humans can be found. This helps to understand why people behave in a certain way based on their values and beliefs.
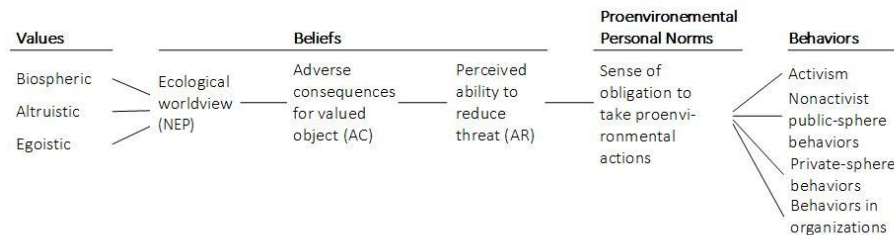
Figure 11 Schematic representation of variables in the VBN theory of environmentalism adapted from (Stern, 2000)

Communication

After the socio-demographics and attitudinal factors, the socialization factor is about consideration in other social context. This is about the suggestion of the socially conscious consumer involved in the community. Researchers have linked the personal influences to consumption-related behavior. Their spouse, family members, friends, colleagues and neighbors can influence this behavior. People with more green behavior talk more about their energy saving behavior, or frequently discuss about energy and environment issues (Rowlands, Scott, & Parker, 2002). To be able to make statements about the communications a couple of questions will be asked. The first question involves a statement about the energy saving behavior of others to influence the participants own behavior. This question will again be answered by a 5 point scale. Another question will be about the frequency of discussing saving energy with other people. Based on these answers the socialization of the respondents can be described.

4.1.2 Choice experiment

After the questions containing socio-demographics and other factors the participant will receive 16 questions for the choice experiment. The aim of the research is to investigate, which attributes are the most preferred by the participants.

First the profiles will be mentioned, and how it contributes in the awareness about energy consumption. After the profiles, the attributes containing the levels will be explained, and why these are chosen. To design a choice experiment the following steps are important (Hensher, Rose, & Greene, 2005):

1. **Relevant attributes selection:** relevant attributes, which will be used to research the choice preferences of the respondents need to be selected, otherwise the intended outcomes are not composed.
2. **Leveling the attributes:** the defined attributes need to be clarified with the relevant levels. The levels are given in the experiment mostly by text. The levels need to be described clearly to retrieve the correct outcomes.
3. **Design of experimental task:** based on the selected experimental plan the alternatives are formed. They will be randomly places in choice sets with the same frequency. A fixed group of choice sets form the basis for the experiment.
4. **Data collection**: the experiment will be executed by a survey. The type of research determines the group of respondents, which can be random or already selected.
5. **Model estimation:** the outcomes of the experiments are coded and estimated.
6. **Hypothesis testing**, validation and simulation.

Intervention strategies

During a choice experiment the following intervention strategies will be used in combination with attributes to research the preferences of the participants. An overview of the possible interventions are shown in **Fout! Ongeldige bladwijzerverwijzing.**. There are four possible interventions which will be described.

Intervention:
- Presentations
- Workshops
- Screens
- Game intervention

Presentation:

This intervention will be in the form of a meeting where there is a sender, the presenter of information and a receiver, the public. A known form within the company is a lunch lecture during which information will be presented and questions can be asked. The aim of this presentation is to inform the public about the energy consumption and how the participants can participate by reducing their energy consumption. The results of the previous period of time can be shared as example. It is also possible to present ways to reduce the energy consumption.

Workshops:

During this intervention there is a group's leader who will lead the workshop for a maximum of 16 participants. The meeting is interactive where experiences and knowledge are shared and participants will be expected to be actively involved. The aim of the workshop is to create a platform where participants can actively interact with each other and think about ways to reduce the energy consumption together.

Information screens:

This intervention uses information screens. These screens will be located within the building to inform people about the energy consumption within the building. The screens will show different forms of information; the current use, the average use of the week compared to that specific moment, but also the current savings for example. The aim is to inform the passers about current energy use of the building, information about the savings, or the generated energy of the building, for example the rainfall which is converted into energy. An example could be the use of the elevator of the day, or the amount of rainfall which is converted into energy.

Game intervention:

The energy consumption of the workplace will be measured, and the data will be converted to an online platform which will be by use of an online game. This game will be used by the employees and is connected to their account. The energy consumption of the participants will be lead to advantages in the game if the energy consumption is better than average, and to disadvantages in the game when they use more energy than average. The aim of the game is to create awareness among the participants about their energy consumption.

Attributes

The interventions will be based on certain attributes. These attributes are assumptions, and chosen based on the fact that it is applicable to all four interventions. The assumptions are used, because there is no previous research into this subject where more interventions are used to research how the human behavior can be influenced to reduce the energy consumption. The attributes will be used to create choice sets for the intervention and to investigate which is the most preferred.

Attributes
- Effort
- Frequency
- Interaction

Effort:

Based on the interviews the effort is included because people want to know how an intervention will influence their schedule. The effort is therefore described in an amount of time which is needed to prepare and participate in the intervention. Also for the levels of effort assumptions are made based on information of the intervention mentioned in the literature and experiences. The levels are defined as: a **little** (max. 30 minutes), **normal** (±60 minutes) and **much** (>70 minutes).

Frequency:

During the interviews the frequency of interventions is discussed. An outcome was that how less frequent a intervention was repeated the better it was, based on the fact that people feel the urge to fulfill their job and do not like distractions which are mandatory. This attribute indicates the frequency of the intervention and addresses the timeframe to which the participants receive updates of the status of the energy consumption, the savings and the revenues of energy of the building. The frequency is based on literature, where the frequency for emails was set for daily, weekly and monthly. The assumption that the level of quarterly could also be interesting this was included for the frequency. The frequency of updates will be presented in the following possibilities: **daily**, **weekly**, **monthly** and **quarterly.**

Interaction:

Within the office there are different types of people. The level of interaction is based on assumptions and observations. Within the office, there are people present which always like to share their ideas and opinions while others prefer less interaction and for them it could be a threshold to join an intervention and the level of interaction is high for them. Therefore, the level of interaction is about the expectation of the level of interaction during the interventions, which are defined as: **little** (no expectations of interaction during the intervention), **normal** (interaction during the intervention is welcome), and **much** (interaction during the meeting is expected).

Intervention profiles

Based on the interventions and attributes profiles were designed. Due to the lack of information about different interventions used for combined research, the profiles are based on assumptions and logic reasoning. This means that some attributes could not be applied to an intervention based on impossible combination. The explanation for the attribute levels will be discussed in the following paragraphs, followed by an overview of the created choice sets. An overview of the choice sets and the combinations which were used in the questionnaire is shown in appendix 8, the experiment design, and a summary of the profiles is shown in The levels of the attributes for the intervention game intervention include:

Effort: normal, much
Frequency: daily, weekly
Interaction: little, normal

This intervention is based on an online platform. However, to receive information about the energy consumption people have to access this platform regularly. Therefore the effort is normal or much. Because of the fact the interaction needs to be accessed regularly, the frequency will be daily or weekly. The level of interaction is the same as the information screens, there is not a platform where people can leave comments.

Table 4.

Presentation

The levels of the attributes for the intervention presentation include:
Effort: little, normal
Frequency: monthly, quarterly
Interaction: little, normal

Because of the fact that during the presentation the public receives information, the effort is little of normal. In case the duration of the presentation is between 20 until 45 minutes, much effort does not fit in the profile. The person attending the presentation maybe wants to read into the subject in forehand or afterwards wants to find out more about the subject. That is when the intervention has the levels little or normal. A presentation is only interesting if it is monthly or quarterly, because otherwise the interest for such a subject could be lost. Or it could cost the public and the organization of such interventions too much time and effort. During the presentation it is possible to ask questions, therefore the interaction is not expected but always welcome.

Workshop

The levels of the attributes for the intervention workshop include:
Effort: normal, much
Frequency: monthly, quarterly
Interaction: normal, much

The workshop preparation for participant is different. However the duration of a workshop can differ, from an half hour till a full day. Sometimes people who are engaging in a workshop like to prepare on forehand. They read into the subject, to be prepared. This askes a big effort compared to the scale of the effort. Therefore the levels normal and much are included

for this intervention. Because of the effort, and because a workshop is more effective when a longer period of time between the intervention is presented the levels monthly and quarterly are assigned to this intervention. During the workshop, participants are expected to be involved and interaction is expected. This means that the levels normal and much will be used for this profile.

Information screens

The levels of the attributes for the intervention information screens include:

Effort: little, normal

Frequency: daily, weekly

Interaction: little, normal

The information screens will share information containing the energy consumption. They will be located at locations where they will be useful for people to use and see. The effort for these screens is little or normal. This is based on the fact that the screens send information to the occupants of the buildings, and people receive information when the see the screens. The information will be updated daily of weekly. This is based on the information which was collected by the energy sensors and sources. The interaction for this intervention is little to normal. There is no platform where people can interact, other than mutually.

Game intervention

The levels of the attributes for the intervention game intervention include:

Effort: normal, much

Frequency: daily, weekly

Interaction: little, normal

This intervention is based on an online platform. However, to receive information about the energy consumption people have to access this platform regularly. Therefore the effort is normal or much. Because of the fact the interaction needs to be accessed regularly, the frequency will be daily or weekly. The level of interaction is the same as the information screens, there is not a platform where people can leave comments.

Table 4 Overview of the interventions

Intervention	Effort	Frequency	Interaction
Presentation	little / normal	monthly / quarterly	little / normal
Workshop	normal / much	monthly / quarterly	normal / much
Screens	little / normal	daily / weekly	little / normal
Game	normal / much	daily / weekly	little / normal

4.2 Methods for analyzing

4.2.1 Analysis

After conduction the survey, the results are analyzed. The aim is to find a profile for the user's preference of the working environment in relation to minimize the energy consumption. For the data analysis there is a need for two types of data collection. To analyze the results of the survey, different types of methodologies will be used. The first part of the analysis of the social demographics will be charted using frequencies. Hereby it is possible to create profiles based on the received information of the respondents. The characteristics will be used further to test the hypothesizes. These statements will help to profile the respondents based on statements related to energy consumption and their personal environment. To analyze the results of the choice experiment, conjoint analysis will be used.

4.2.2 Socio-demographic factors

Socio-demographic characteristics will be included to examine if the respondents represent a certain target group within the offices of Witteveen+Bos. These characters can be used to explain a small part of variance regarding pro-environmental

behavior. The socio-demographics characteristics are independent of energy consumption but they might influence behavioral patterns. This data can be used to create certain profiles to intestate the rest of the data. The data will be analyzed using Excel. Due to the small group of respondents, the significance is not presentable and therefore left out of the results.

4.2.3 Choice experiment

Conjoint analysis is often the preferred method to investigate choice behavior because it gives a good estimation of the consumers preference (Rao, 2014). This multivariate technique for measuring individuals' preferences and choice behavior can be used for new, not yet existing alternatives (Kemperman, 2014). Using this technique the activities, services, facilities, or a product can be decomposed in different attributes, and the individuals have also a certain preference of value of the attributes.
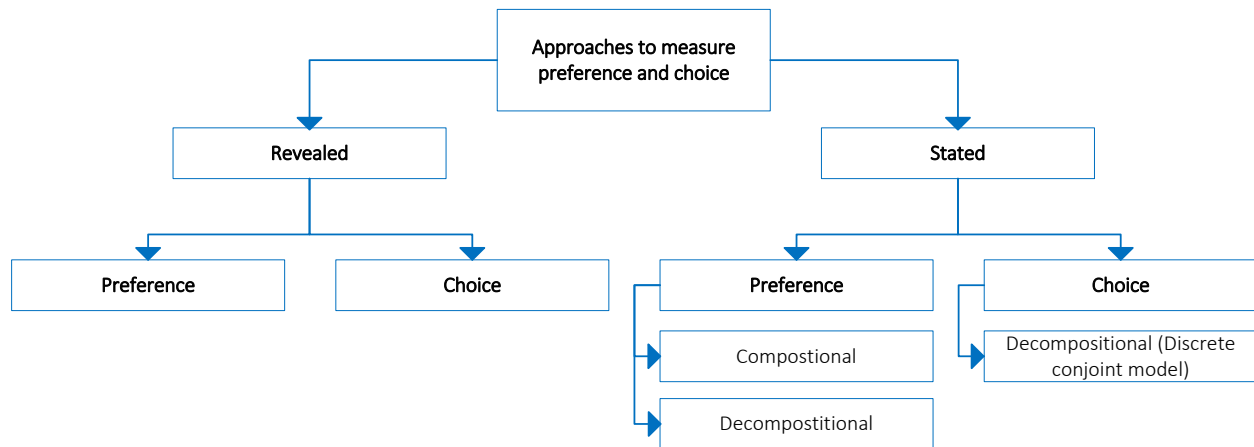
Figure 12 Measurement approaches adapted from (Kemperman, 2014)

In Figure 12 an overview of approaches to measure preferences and choices is shown. This model assists the choice of the method that will be used. Because of the fact that the information on alternatives can be assimilated differently by individuals the stated method will be used. In case of preference the participants of the questionnaire have to evaluate the profiles one by one. While by choice the respondents chose the best option between the profiles. The choice method is preferred in this case which means that the decomposition discrete choice will be used. However, the 'no-choice' option in this research will not be included. Based on the fact that people have to be involved which makes the no-choice not an option. However not including the no-choice option leads to reduced fit and biased estimation of linear attributes (Haaijer, Kamakura, & Wedel, 2001). The no-choice alternative may lead to respondents avoiding difficult choices, this detracts the validity of the use of the no-choice. The no-choice alternative gives no information about preferences of attributes of the choice alternatives, which is the main reason of executing the conjoint choice experiment (Haaijer M. , 1999).

The main reason for leaving this alternative out of the questionnaire is the fact that the alternative may lead to avoid respondents to make difficult choices. The questionnaire will be distributed to a small population of the company (97 people, 10% of the Dutch population of the company). If only 30% of those participants participate in this research, 26 surveys will be answered. Consequently making it difficult to judge.

The discrete choice analysis will be used to answer the question about the attributes which are important or unimportant to the participant. This will be done based on the levels of the attribute which are the most and least desirable in the participants mind. Using conjoint analysis, it is possible to determine the relative importance of each attribute, as well as the levels of each attributes which are the most preferred. Using the conjoint analysis in combination with the socio

demographic, attitudinal and socialization factors it is possible to identify and describe the preferences of segments within the company.

In order to investigate the respondents' intervention preferences to reduce the energy consumption in the office environment of Witteveen+Bos the people received two choices within the choice experiment from which to select one of these. The respondents had the choice to select one of the two profiles. If people have a choice based on the options it is a binary choice (Yoshimoto, 2008).

4.2.4 Data coding

To analyze the data of the survey containing the attributes, the initial data will be described according the dummy and effect coding. The dummy coding scheme will only be used for the interventions. The procedure of constructing dummy code is to first make the choice of code and then consider the interpretation of the problem from the choice of code. The coding is based on k groups. Therefore the vector k-1 will be created. If the factors in group 1 will be labeled "1", all other groups will be assigned "0" for the same vector (Sundström, 2010). This procedure will be applied to all vectors. The disadvantage of this method is the fact that the analysis does not involve interaction between terms. To be able to make statements about the outcome, the effect coding will be rotated. This is shown in Table 5 and Table 6

Table 6.

Table 5 Dummy coding scheme

Group	X_1	X_2	X_3
1	1	0	0
2	0	1	0
3	0	0	1
4	0	0	0

Table 6 Dummy coding scheme for the interventions

Intervention	PWS			GPW			SGP			WSG		
Presentation	1	0	0	0	1	0	0	0	1	0	0	0
Workshop	0	1	0	0	0	1	0	0	0	1	0	0
Screens	0	0	1	0	0	0	1	0	0	0	1	0
Game	0	0	0	1	0	0	0	1	0	0	0	1

Effect coding is similar to dummy coding, however the last group will be coded with a "-1". Therefore it is able to show the contrast between the factors (Sundström, 2010). The sum of the total coding will always be zero. The effect coding will be applied to the intervention, frequency, effort and interaction. These attributes will be split into the groups, daily and weekly, and monthly and quarterly for the frequency. For the attributes Effort and interaction the groups will be divided into low and normal, and normal and much. Because of the fact this contains two levels, the levels of -1 and 1 will be used. This is shown in Table 7.

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Table 7 Effect coding for variables intervention and effort

Frequency	-1	1	Effort	-1	1	Interaction	-1	1
daily/weekly	weekly	daily	low/normal	low	normal	less/normal	less	normal
monthly/quarterly	quarterly	monthly	normal/much	normal	much	normal/much	normal	much

Effect coding will also be used to investigate the influence of gender and age on the outcome. The following coding, shown in Table 8 will be used for this investigation.

Table 8 Effect coding for gender and age

Gender	Code	Age	Code

Female	-1	<40	-1
Male	1	>40	1

4.3 Data collection

4.3.1 Test

Before the questionnaire was send to the employees of the company, 15 persons, within and outside the company, tested the questionnaire. The purpose was to investigate if the questions were clear, to collect comments, and to calculate the average time for answering the questionnaire. After the adjustments of the questionnaire the questionnaire was tested once more.

4.3.2 Sample size

The discrete choice experiment is dependent on the number of variables of the experiment rather than the representation of the population size. By using the thumb rule or Orme (2014), the number of respondents can be determined. The calculation of the number of respondents is shown in equation 3 and 4.

$$n > \frac{500 \cdot c}{t \cdot a} \quad (3) \qquad\qquad n > \frac{500 \cdot 4}{16 \cdot 2} \quad (4)$$

n: number of respondents
c: number of analysis cells
t: number of choice sets
a: number of alternatives per task

During the experiment, the respondents received 16 choice sets, containing 2 levels of alternatives. The number of analysis cells is 3, this is equal to the largest number of levels for any attribute. The number 500 is based on the times an item of each level should minimally appear across all respondents. The preferably number is 1000 (Johnson & Orne, 2003). The outcome of this equation makes that the required number of respondents is 63.

The calculation of the number of respondents for the discrete choice experiment is relatively inefficient. Therefore the following formula calculates the sample size of respondents for the conjoint analysis:

$$n = \frac{z^2 \cdot p(1-p)}{a^2} \quad (5) \qquad\qquad n = \frac{1,96^2 \cdot 0,3(1-0,3)}{0,05^2} \quad (6)$$

n: number of respondents needed
z: standard deviation for the 95% interval of the mean (1.96 for a 95% confidence interval)
p: chance of responds
a: Margin error of 5%
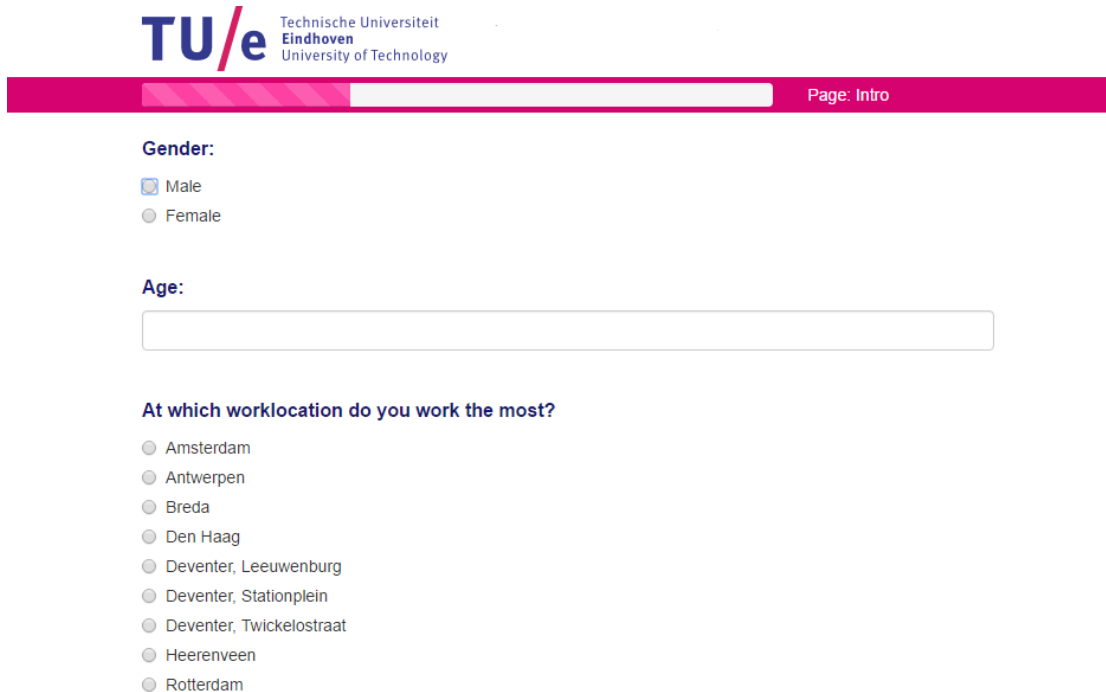
The outcome of the equation is a sample size of 323 respondents. This is a major difference compared to the outcome of equation 4. According to Orme (2010) the sample size for conjoint analysis generally range from 200 to 1.200 respondents. However, for quantitative research where one does not intend to compare sub-groups, Orme recommends at least 300 respondents (Orme, 2010).

However, due to the policy within the company, it is not allowed to conduct surveys among colleagues. An exception was made, whereby it was possible to conduct the questionnaire, with a restricted number of respondents which can be invited. It is made possible to invite 10% of the Dutch population within the company, which means it is possible to invite 97 persons.

4.3.3 Questionnaire platform

The questionnaire was online available via the Bergsystem of the university. People were invited to the questionnaire through the corporate email. The invitation is shown in appendix 5. The choice for sending the survey via mail is based on the policy regarding surveys. The company has 1350 employees, from which approximately 850 employees work in The Netherlands. The survey will invite employees of all the 8 offices in the Netherlands, and people across all the PMC's are among them. The invitation was send on the 20th of October and the reminder was send on the 31st of October. The survey was open from 20 October until 6 November 2016, where 97 employees were invited. An example of the questionnaire is shown in Figure 13 and an example of the choice set is shown in Figure 14. The received data was exported into a CSV file. The dataset is shown in Appendix 9.

Figure 13 Example questionnaire platform

Figure 14 Intervention choice

4.3.4 Response

The total response of the 97 invitees was 73, and 13 questionnaires were not completely filled out. Therefore, 60 datasets of the respondents were complete. Table 9 shows the respondents for the different part of the questionnaires. The first part of the questionnaire contains 22 questions about socio-demographic and other information which can help to create profiles. The second part of the survey was the choice experiment, the participants had to answer 16 choices in which they received two options, option 1 or option 2. The expected response rate was 30%. However, the response rate was 75,3%.

Table 9 Response of the questionnaire

	Total	%
Finished	60	61.9
Not-completed	13	13.4
Not-responded	25	25.7
Total response	73	75.3

4.4 Conclusion

Based on this chapter, the background of the questionnaire, the methods, and the respondents were introduced. These factors will help to determine the background and the choice behavior of the respondents regarding the interventions which could be used to reduce the energy consumption within the office environment of Witteveen+Bos. The questionnaire will only be conducted in the office environment of Witteveen+Bos in The Netherlands and was send to 10% of the Dutch Witteveen+Bos population. Almost 75% participated, whereby 61% completed the questionnaire. The first part of the questionnaire consisted of 22 multiple choice questions, regarding the socio-demographics, attitudinal and socialization factors. The second part of the survey was based on choice preferences consisting of 16 questions. The data will be analyzed using conjoint analysis.

Chapter 5

Results

After conducting the surveys, the data of the questionnaire can be analyzed. In chapter 5, the results of the questionnaire, containing the respondents, choice experiment and hypothesizes will be discussed. In paragraph 5.1, in information about the respondents is collected. In paragraph 5.2 the analysis of the choice experiment will be discussed. Followed by paragraph 5.3, in which the hypothesis are tested. The conclusions will be summarized in paragraph 5.4.

5.1 Respondents

The total respond of the questionnaire is 60. In Table 10 an overview of the respondents is shown. In the table the gender, age and education of the respondents is shown. Additional to the frequencies also different sociodemographic groups have been constructed and the corresponding percentages for every group are shown. From all the employees that were asked to fill in the questionnaire 62,5% responded, this is 7% of the total employees of Witteveen+Bos in the Netherlands. If the male and female respondents are compared to the deviation within the company, 77% is male and 23% is female (Witteveen+Bos, 2016), the ratio does not correspond to the ratio within the company. The same applies for the level of education, within the company 81% of the employees is higher educated, and in the questionnaire this is 89%. However, the age is comparable, 65% within the company is under 40 and in the questionnaire this is 62% (Witteveen+Bos, 2016).

Table 10 Respondents

	Total (n=60)	Percentage (%)	Sub-group	Total	%
Gender					
Male	35	58			
Female	25	42			
Age			**Group**		
20-29	16	27	<40	37	62%
30-39	21	35	>40	23	38%
40-49	12	20			
50-59	9	15			
>60	2	3			
Education			**Group**		
MBO	6	10	Low	6	10%
HBO	22	37	High	53	89%
WO	31	52			
Other	1	1			

Table 11 provides information about the base locations and work location of the respondents. The base location is the location were the employees are stationed. However, because of the concept of PLUSwerken it is possible that the numbers can diver. Before the collection of the data, it was expected that there would be a difference between the numbers of base location and work location. This expectation was based on the fact that many people are located at an certain base, mostly the one near the residence, however, the sectors of the company are spread over the Netherlands. This means that people work more at other locations than the location close to their residence, influenced by the fact that they need to work together with the other members of the team. The difference between the base location and the work location only appeared by four of the respondents. Therefore this event does not have a big influence on the results and the base location will be used for testing the hypothesizes.

Table 11 Outcome of base and work location

Base	Total (n=60)	%	Workplace	#	%
Amsterdam	8	13.3	Amsterdam	8	13.3
Breda	11	18.3	Breda	11	18.3
Den Haag	2	3.3	Den Haag	1	1.6
Deventer, LB	13	21.6	Deventer, LB	13	21.6

Deventer, SP	8	13.3	Deventer, SP	8	13.3
Deventer, TW	8	13.3	Deventer, TW	9	15.0
Heerenveen	5	8.3	Heerenveen	4	6.6
Rotterdam	5	8.3	Rotterdam	6	10.0

During the research and writing of the thesis, PLUSwerken was an important aspect. In the PLUS environment people, are not assigned to a certain desk which gives them the freedom to work wherever they please. This provides freedom for the employee. Because the PLUSwerken was a reoccurring topic within the research project also questions about the PLUS environment were added to the questionnaire in order to research the effect of the new way of working. In order to differentiate between the people working in the PLUS environment and the traditional environment people were asked whether they work regularly in the PLUSwerken environment (at least once a week). The outcome of this question is shown in Table 12. People were also questioned for which sector they work. The distribution of the answer set regarding the frequency of using the PLUS environment in relation to the sector they work in is shown in

Type of work	#	%
PLUSwerken	27	45
Traditional	46	55

Table 13. Due to an error two respondents did not correctly answer question 1 to 4 about the preferences of the interventions. Because of this error the answers of these two respondents are left out of the answer set for this question and thus only 58 results have been used to constructed Table 18. In general the respondents preferred the information screens the most, followed by the presentation. The third choice is the workshop, and the least preferred is the game intervention.

Table 12 ratio for type of work

Type of work	#	%
PLUSwerken	27	45
Traditional	46	55

Table 13 Distribution of the sectors

Sector	#	%
Built environment	12	20%
Water management	12	20%
Energy, water, environment	16	27%
Infrastructure and mobility	11	18%
Departments	9	15%

Table 14 Preferences of interventions

Intervention	First preference		Second preference		Third preference		Least preferred	
Presentation	10	17%	**20**	**33%**	16	27%	14	23%
Workshop	4	7%	18	30%	**29**	**48%**	9	15%
Screens	**35**	**58%**	13	23%	7	12%	5	8%
Game	11	18%	9	21%	8	15%	**32**	**54%**

Note: The highlighted numbers are the most chosen intervention.

Based on the response of question 13 it can be concluded that the people of Witteveen+Bos are conscious about saving energy in the private environment. The results of question 13 can be seen in Table 15. 85% of the respondents indicated that they are aware of their energy consumption in the private environment. The private environment in this case is the

residential environment. Furthermore 85% of the employees even talks about opportunities to reduce the energy consumption Table 16.

Table 15 Energy savings in the private environment (Q13)

Answer	#	%
Yes	51	85%
No	9	15%

Table 16 Frequency in which energy saving is discussed with other people (Q14)

Answer	#	%
Never	9	15%
Occasionally (every few months)	35	58%
Frequently (once a month)	12	20%
Very frequently (every week)	4	7%

One of the interventions mentioned as an opportunity for reducing the energy consumption was rewarding. Rewarding is a way of stimulating people instead of asking for an adjustment to reduce the energy consumption. In order to test whether rewarding would be a good stimulus respondents were asked about rewarding and competition. Question 16 asked the respondents if they are sensitive for the feeling of competition. In case the answer was "yes", the respondent was questioned if this would also apply in the working environment. The outcome is shown in Figure 15. Question 18 of the questionnaire was designed to receive an answer about the motivation of the employees in case they would be financially rewarded if they reduce the energy consumption. The outcome to this question is shown in Figure 16.
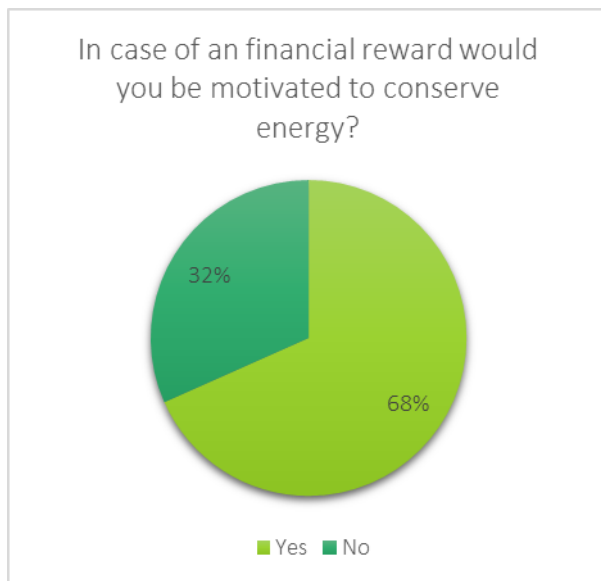
Figure 15 Outcome of question 18
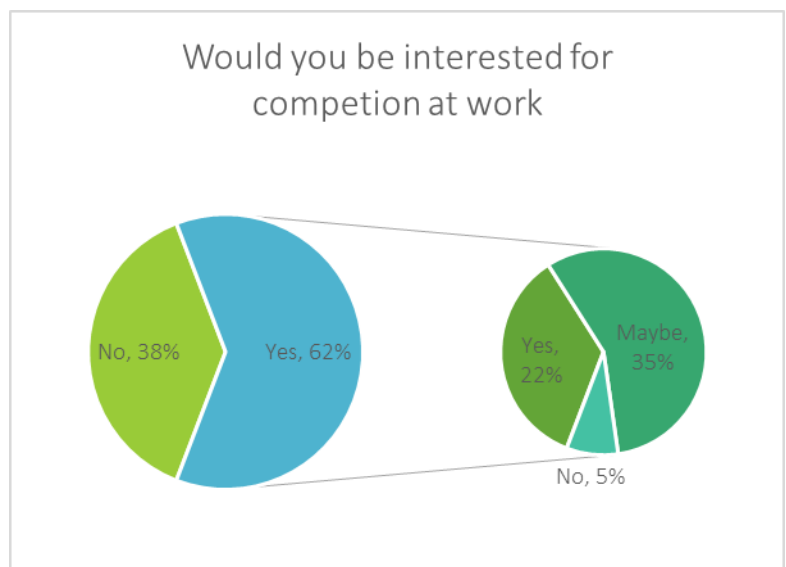
Figure 16 Outcome question 16 and 17

5.2 Preferences

As was mentioned in chapter 4, the choice experiment is based on the binary choice model. The results of the choice experiment will be used to calculate the most and least preferred profile for using as intervention to reduce the energy

consumption according to the respondents. The results have been analyzed by using the binomial probit model and the logit model. Both loops of the logit and probit model are shown in Figure 17. The loop of the probit model is more fitted compared to the logit model. During the analysis the result were analyzed using both models, however, the logit model fitted better according the R-square. The higher the R-square, the better the model fits. Besides this was not the only parameter which was better in this comparison. The log likelihood of the logit model was higher.
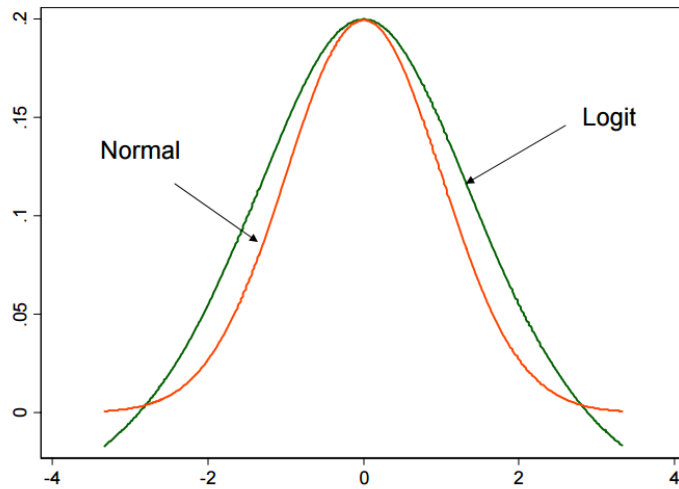
Figure 17 Difference between the Probit (normal) and Logit model adapted from (O'Halloran, 2016)

The outcome of the probit an logit model will be shown in Table 17 .

Table 17 R-square and loglikelihood of probit an logit model

	PWS		GPW		SGP		WSG	
	Logit	Probit	Logit	Probit	Logit	Probit	Logit	Probit
R-square	.1435	.1429	.1435	.1429	.1435	.1429	.1435	.1429
Log likelihood	-1330.842	-1140.557	-1330.842	-1140.557	-1330.842	-1140.557	-1139.814	-1140.557

The models are obtained using the Nlogit program, and the outcomes of the binary logit model are shown in appendix 11. Results of the interaction of the intervention and attributes (effort, frequency and interaction) will be explained and shown in the following paragraphs. These interactions are used in the formula which calculates the preference of the profiles according to the outcome of the choice experiment. To calculate the utility of an attribute or intervention, the coefficient of the attributes is used. The outcomes are only used when they are significant. Meaning, the significant of the values is 1%, 5% or 10% and therefore reliable. To calculate the utility (u) of a subject for a profile in the choices, the vector and the error should be included. The utility provides information about the respondents relative of each alternative (Rao, 2014). The formula to calculate the utility of attribute is as followed:

$$U_{nj} = V_{nj} + \varepsilon_{nj}$$

The vector can be calculated using the following equation:

$$V_{nj} = x_{nj}\beta$$

In this equation the coefficient of the outcome of Nlogit will be used as vector of parameters relating between the coding of the alternative and the alternative x_{nj} for the utility. The weighting of the attributes is defined as x, based on the coding.

The outcomes of the utilities will be shown in Figure 18-21. After these values are known, the profiles can be calculated to concluded the most and least preferred profile by the respondents of Witteveen+Bos. The highest value in the figure is preferred, in case the value is zero, there was no preference.

Intervention

Based on the analysis of the outcome of the interventions, the information screens received the highest values. the values were obtained during 4 analysis. This was due to the coding where, one of the interventions was used as a base scenario. This lead to the following outcome shown in Figure 18. The values are shown in table 18.
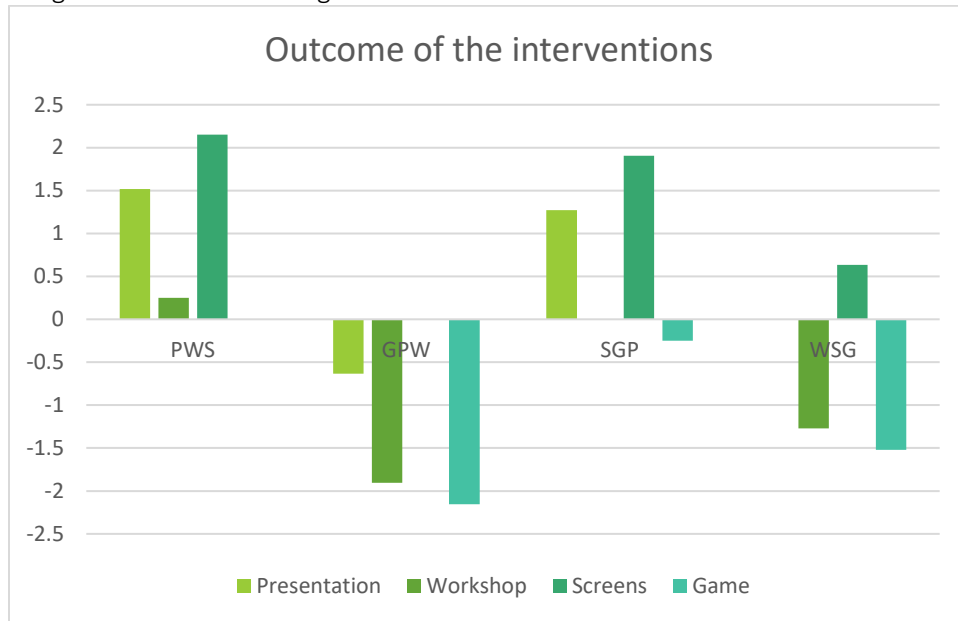
Figure 18 Outcome of the interventions

Table 18 Results supporting Figure 18

	PWS	GPW	SGP	WSG
Presentation	1.519	-0.634	1.270	0
Workshop	0.249	-1.904	0	-1.27
Screens	2.153	0	1.904	0.634
Game	0	-2.153	-0.249	-1.519

Frequency

The outcome of all logit models, show the same outcome for the frequency. This was expected, based on the fact that the attributes except for the interventions would be the same when comparing them. Table XX shows the frequency, when comparing daily with weekly, the weekly frequency is preferred. And when comparing the monthly frequency with quarterly, people prefer the quarterly interventions. This means that the frequency, with the most time between the interventions is preferred.

Table 19 Results Frequency

Frequency	PWS	GPW	SGP	WSG
Daily	-0.209	-0.209	-0.209	-0.209

Weekly	0.209	0.209	0.209	0.209
Monthly	-0.395	-0.395	-0.395	-0.395
Quarterly	0.395	0.395	0.395	0.395

Effort

The attribute of the effort was divided into two categories, low comparing normal, and normal to compare with much. Low was preferred over the normal effort. The normal and much comparison was not significant. This could be the result that the levels of normal and much are only used for one intervention, the game intervention.

Table 20 Results effort

Effort	PWS	GPW	SGP	WSG
Low	0.199	0.199	0.199	0.199
Normal	-0.199	-0.199	-0.199	-0.199
Normal	0	0	0	0
Much	0	0	0	0

Interaction

The levels or interaction are divide into two categories, low and normal, and the comparison of normal an much. The low interaction was preferred over the normal interaction. Even as the normal interaction compared with the much interaction. In this case, the lower level of the attributes was again preferred over the other.

Table 21 Results interaction

Interaction	PWS	GPW	SGP	WSG
Low	0.128	0.128	0.128	0.128
Normal	-0.128	-0.128	-0.128	-0.128
Normal	0.225	0.225	0.225	0.225
Much	-0.225	-0.225	-0.225	-0.225

Profiles

Based on the numbers in the previous figures, the utility for the profile is calculated using the following equation. This equation will also include an error value, this is the constant which is used to analysis.

$$
\begin{aligned}
\mu_{profile} =\ & x_{PWS\ intervention} + \beta_{effort} * x_{PWS\ effort} + \beta_{frequency} * x_{PWSfrequency} + \beta_{interaction} * x_{PWS\ interaction} \\
& + \varepsilon_{PWS} + x_{GPW\ intervention} + \beta_{effort} * x_{GPW\ effort} + \beta_{frequency} * x_{GPWfrequency} + \beta_{interaction} \\
& * x_{GPW\ interaction} + \varepsilon_{GPW} + x_{SGP\ intervention} + \beta_{effort} * x_{SGP\ effort} + \beta_{frequency} * x_{SGPfrequency} \\
& + \beta_{interaction} * x_{SGP\ interaction} + \varepsilon_{SGP} + x_{WSG\ intervention} + \beta_{effort} * x_{WSG\ effort} + \beta_{frequency} \\
& * x_{WSGfrequency} + \beta_{interaction} * x_{WSG\ interaction} + \varepsilon_{WSG}
\end{aligned}
$$

This is executed for all 32 profiles. The outcomes can be found in appendix 12. In these figures, the profiles which were the least preferred are marked red, the profiles which were the most preferred, are marked green. In all the cases profile 28 is the most preferred, which intervention exist of the information screens intervention, low effort, weekly frequency and a

low level of intervention. The profile which is the least preferred overall is the 32, with the game intervention, normal effort, daily frequency, and much interaction. However, overall profile 22 was the least preferred. Which is the workshop with the normal effort, monthly frequency, and much interaction.

A summary of the preference for the profiles is showed in table 22. In this table the three most preferred and three lest preferred interventions are shown table 23, with the outcome of the calculation.

Table 22 Most preferred profiles

Profile	Intervention	Effort	Frequency	Interaction	Value
28	Screens	Low	Weekly	Low	7.83635
26	Screens	Low	Weekly	Normal	6.80939
10	Screens	Normal	Weekly	Low	6.4346

Table 23 Least preferred profiles

Profile	Intervention	Effort	Frequency	Interaction	Value
22	Workshop	Normal	Monthly	Much	-4.5675
13	Game	Much	Daily	Normal	-4.25985
32	Game	Normal	Daily	Much	-4.25985

5.3 Results of hypothesis

In chapter 3 nine different hypothesis were presented. In this paragraph these hypotheses will be tested in order to get more information about the behavior and opinion of Witteveen+Bos employees regarding the environment, preferred intervention and the PLUS environment.

Hypothesis 1
Women are more considered about the impact of their actions

The aim of this hypothesis is to see if women are more considered about the impact of their actions than man. This hypothesis can be tested based on the outcomes of the questions about PCE (Question 8), ecological concern (Q 9) and energy savings (Q13). For the PCE and ecological concern question the answers "Totally disagree" and "disagree" were included in the answer options based on the idea that the if people disagree based on these statements they agree that there is a problem and people have influence to solve the problem. The third question is about energy savings in the private environment. This question has been added to verify the concern of the energy consumption. The outcomes show, that 56% of the women respondents agree to this questions, while 43 % of the man respondents agree to these questions.

Table 24 Hypothesis 1; Women consider the impact of their actions more

Gender	Yes	No	Yes %
female	14	11	56%
male	15	20	43%

Hypothesis 2
Women, older and well-educated are more engaged in energy issues

The outcome for this test was based upon the respondents which were grouped by gender, age and education. The age group (Q2) will be split up in two groups: under 40(young) and above 40(older) years old. The level of education (Q3) was also divided in well-educated and lower education. Well-educated relates to people with an HBO and WO education, lower

education relates to people with an MBO education. The outcomes of the questions about the PCE statements(Q8), ecological concern(Q9) and energy savings (Q13) are also involved for this hypothesis. The outcomes for this test is shown in Table 26, where the percentages are compared to the total amount of the same gender, age group and level of education. The outcome shows that women above 40 are all engaged in energy issues. It shows that the level of education is not important. Therefore, the hypothesis can be rejected. However, women in general are more engaged in energy issues, mainly the group above 40. Compared to man, women are more engaged in energy issues.

Table 25 Hypothesis 2; are well-educated older women more engaged in energy issues?

Age	Yes	No	Yes %	Education	Yes	No	Yes %	Total	Yes	No	Yes %
male <40	5	14	26%	male, low educated	0	2	0%	male <40, high	5	14	26%
male >40	4	12	25%	male, high educated	15	18	45%	male >40, high	4	10	28%
female <40	9	9	50%	female, low educated	2	3	40%	male <40, low	0	0	0%
female >40	4	3	57%	female, high educated	11	9	61%	male >40, low	0	2	0%
								female <40, high	3	12	20%
								female >40, high	5	0	100%
								female <40, low	2	1	66%
								Women >40, low	2	0	100%

Hypothesis 3

Younger people are more likely to be sensitive about environmental issues

The outcomes of hypothesis 3 is shown in Table 27. In Table 26 the outcome of the questions about PCE(Q8), ecological concern(Q9), energy savings(Q13) and the question about the frequency they talk about the options of energy savings(14) are shown. In this case the hypothesis can be rejected, the outcome shows that the group of people above (>40) is more sensitive about environmental actions. The percentages are based on total number of respondents in the same age group, which is shown in Table 10. This hypothesis can be rejected, the older population in the environment of Witteveen+Bos are more sensitive about environmental issues.

Table 26 Hypothesis 3; are younger people more likely to be sensitive about environmental issues

Age group	Yes	No	Percentage
<40	6	31	16%
>40	5	18	22%

Hypothesis 4

The higher the level of education, the bigger the concern of environmental actions

The testing of this hypothesis is done based on the same questions as hypothesis 2, however, the gender was left out of this comparison. The outcomes of this hypotheses show that the hypothesis can be rejected. The percentages are based on the total number of people in the same education group. Results are shown in Table 27. The level of MBO was 10% of the total, 6 persons. These people have no big concerns about environmental issues based on the answers in the questionnaire. The concern of HBO and WO employees is higher, however the relation it is not linear, which means that the outcome of the hypothesis does not apply to the employees of Witteveen+Bos. Meaning that the if a the people of Witteveen+Bos are higher educated, the concern of environmental issues increases.

Table 27 Hypothesis 4; the higher the level of education, the bigger the concern of environmental issues

Level of education	Yes	No	Percentage

MBO	0	6	0%
HBO	6	16	27%
WO	5	26	16%

Hypothesis 5

PLUSwerken improves the productivity

This hypothesis is based on the research of TNO (2011). TNO conducted a questionnaire in which people were asked about their productivity in the flexwerken environment. To test the hypothesis and results of TNO questions about this subject were also included in this questionnaire. People were asked if they are working at least one day a week in a PLUSwerken environment. If they answered with yes, they were asked if they are more productive in this environment (Q11). In case the respondent answered the question about PLUSwerken with no, the respondents were asked about their opinion if PLUSwerken would increase their productivity (Q12). The results in Table 28 show that a majority of the respondents, in the PLUSwerken environment, as well as the traditional work environment, agreed with this statement. This means that the hypothesis can be accepted, which means that PLUSwerken improves the productivity of the occupants in the environment of Witteveen+Bos.

Table 28 Hypothesis 5; does PLUSwerken increase productivity

PLUSwerken (n=25)	#	%	Traditional way of work (n=35)	#	%
PLUSwerken, totally disagree	3	12%	Traditional, totally disagree	0	0%
PLUSwerken, disagree	3	12%	Traditional, disagree	5	14%
PLUSwerken, neutral	3	12%	Traditional, neutral	13	37%
PLUSwerken, agree	15	60%	Traditional, agree	16	46%
PLUSwerken, totally agree	1	4%	Traditional, totally agree	1	3%

Hypothesis 6

PLUSwerkers are more sensitive for the behavior of their peers

The respondents were asked if the energy saving behavior of others people has a certain influence on them (Q15). The majority of the respondents are neutral about this statement. The people in the traditional environment disagree with this statement, while the proportion of the people working in the PLUSwerken environment is more neutral. Therefore the statement for this hypothesis can be rejected, an unambiguous statement impossible based on the outcomes shown in Table 29.

Table 29 Hypothesis 6; people in the PLUSwerken environment are influenced by their peers more

PLUSwerken (n=25)	#	%	Traditional way of work (n=35)	#	%
PLUSwerken, totally disagree	1	4%	Traditional, totally disagree	2	6%
PLUSwerken, disagree	6	24%	Traditional, disagree	9	26%
PLUSwerken, neutral	11	44%	Traditional, neutral	18	51%
PLUSwerken, agree	7	28%	Traditional, agree	4	11%
PLUSwerken, totally agree	0	0%	Traditional, totally agree	2	6%

Before the outcome of the following hypothesis will be discussed. First the characteristics of the following hypothesizes will be used to investigate the preferences of the respondents based on the gender, age and level of education.
This might help to provide an insight for the upcoming hypothesizes. Due to the small group of respondents the analysis is conducted using frequencies. Where the percentages is based on the total amount of group in which the respondents are

divided. First the gender and the outcome of question 19-22 will be show in tables 30-32. The outcome of the gender in combination with the interventions shows that the majority prefers the information screens as first intervention ant the game intervention is by the majority of men and women preferred as fourth intervention.

Table 30 Preference for intervention gender

Intervention	First choice				Second choice				Third choice				Fourth choice			
	Male		Female		Male		Female		Male		Female		Male		Female	
Presentation	7	20%	3	12%	12	34%	8	32%	13	37%	10	40%	10	29%	4	16%
Workshop	3	9%	1	4%	8	23%	10	40%	16	46%	9	36%	4	11%	5	20%
Screens	20	57%	15	60%	8	23%	5	20%	2	6%	1	4%	1	3%	4	16%
Game	5	14%	6	24%	7	20%	2	8%	6	17%	5	20%	20	57%	12	48%

When comparing the age groups to the outcome of the choice question. The statement again applies that the age groups prefer the information screens as first intervention and the game intervention for the fourth intervention. The second and third choice for the interventions to reduce the energy consumptions differ and the preferences are divided.

Table 31 Preference for intervention age

Intervention	First choice				Second choice				Third choice				Fourth choice			
	<40		>40		<40		>40		<40		>40		<40		>40	
Presentation	0	0%	5	22%	12	32%	8	35%	13	35%	3	13%	7	19%	7	30%
Workshop	4	11%	0	0%	12	32%	6	26%	16	43%	13	57%	5	14%	4	17%
Screens	21	57%	14	61%	9	24%	4	17%	2	5%	5	22%	5	14%	0	0%
Game	7	19%	4	17%	4	11%	5	22%	6	16%	2	9%	20	54%	12	52%

The following table, consists of the level of education combined with the four choices. The group of people with an MBO education is small, 6 respondents, and therefore, their choices differ not enough to make suitable conclusions. The preference of the HBO and WO responses are equal for the information screens as first choice and the game intervention as fourth choice. However, the second and third intervention choice is divided.

Table 32 Preference for intervention level of education

Intervention	First choice						Second choice						Third choice						Fourth choice					
	MBO		HBO		WO		MBO		HBO		WO		MBO		HBO		WO		MBO		HBO		WO	
Presentation	3	43%	3	14%	4	13%	1	14%	9	41%	10	32%	3	43%	3	14%	10	32%	0	0%	7	32%	7	23%
Workshop	0	0%	0	0%	4	13%	2	29%	3	14%	13	42%	3	43%	17	77%	9	29%	2	29%	2	9%	5	16%
Screens	3	43%	16	73%	16	52%	2	29%	5	23%	6	19%	1	14%	1	5%	5	16%	1	14%	0	0%	4	13%
Game	1	14%	3	14%	7	23%	2	29%	5	23%	2	6%	0	0%	1	5%	7	23%	4	57%	13	59%	15	48%

Hypothesis 7

There is no difference between the preferences of the PLUS environment and the traditional environment

This statement designed to research if there is a difference of preference between the PLUSwerkers and people in the traditional working environment. This hypothesis has been tested based on the question were people were asked which intervention they preferred the best followed by the levels for choice 2 up to choice 4. In Table 33 the outcomes are shown. There were two respondents, that not correctly answered the question, which means that the question has been analyzed using only the answers of 58 respondents. In both environments (traditional and PLUS environment) the first choice is the intervention in which the information screens are applied in the office, the third preference is the intervention with the workshops and the fourth choice is the game intervention. The second choice in the PLUS environment is the presentation, while in the traditional environment the workshop is preferred over the presentation for second and third choice.

Therefore, in the PLUS environment is the preference is more explicit in the PLUSwerken environment. However, the hypothesis can be rejected based on the difference of the preferences.

Table 33 Hypothesis 7; PLUSwerkers and traditional workers compared

Way of work and intervention		1st preference		2nd preference		3rd preference		Last preference	
PLUS	Presentation	5	20%	**10**	**40%**	4	16%	6	24%
(n=25)	Workshop	2	8%	5	20%	**14**	**56%**	4	16%
	Screens	**14**	**56%**	7	28%	3	12%	1	4%
	Game-intervention	4	16%	3	12%	4	16%	**14**	**56%**
TRAD.	Presentation	5	14%	10	28%	12	34%	8	22%
(n=35)	Workshop	2	6%	**13**	**38%**	15	44%	5	15%
	Screens	**21**	**60%**	6	17%	4	11%	4	11%
	Game-intervention	7	20%	6	17%	4	11%	**18**	**52%**

Note: The highlighted numbers are the most chosen intervention.

Hypothesis 8

There is a difference between the preferences for interventions and the base location

The analysis of this hypothesis are based on the base location of the respondents, and their preference. There are 8 locations in the Netherlands, two of those locations are PLUSwerken locations, Amsterdam and Breda. At the other locations, the traditional way of working is implemented. In Table 34, the locations and preferences are shown. The preferences that are highlighted are the most obvious choices for the level at this location. The percentages are based on the number of respondents at this location. The numbers for this location are shown in Table 11. As was mentioned earlier, there are two respondents which not filled out the question of the preferences correctly, these were located at the location SP and LB. Therefore, the number of respondents is mentioned under the location. The percentage are based on the number of respondents of the same location. There are 3 locations at which the preference is clear, Breda, Leeuwenburg, and Twickelostraat. In general at most of the locations the preference correspond to the previously mentioned outcome of Table 14. At 6 of the 8 locations the information screens are preferred above the other interventions. Based on this outcome, the hypothesis can be accepted. The base location causes a difference in the preferences of the interventions, even between the locations where PLUSwerken is implemented.

Table 34 Outcome Base location and the preference

Location	Intervention	1st preference		2nd preference		3rd preference		Last preference	
AS	Presentation	2	25%	1	13%			**5**	**63%**
(n=8)	Workshop			3	38%	**5**	**63%**		
	Screens	3	38%	3	38%	2	25%		
	Game	3	38%	1	13%	1	13%	3	38%
BR	Presentation	2	18%	**7**	**64%**	1	9%	1	9%
(n=11)	Workshop	2	18%	1	9%	**6**	**55%**	2	18%
	Screens	**7**	**64%**	2	18%	1	9%	1	9%
	Game			1	9%	3	27%	**7**	**64%**
DH	Presentation					**2**	**100%**		
(n=2)	Workshop			1	50%			1	50%
	Screens	1	50%	1	50%				
	Game	1	50%					1	50%

Sector	Intervention	Choice 1		Choice 2		Choice 3		Choice 4	
LB	Presentation	3	23%	**6**	**46%**	3	23%	1	8%
(n=13)	Workshop	1	8%	3	23%	**7**	**54%**	2	15%
	Screens	**7**	**54%**	3	23%	1	8%	2	15%
	Game	2	15%	1	8%	2	15%	**8**	**62%**
SP	Presentation			2	25%	4	50%	2	25%
(n=8)	Workshop	1	13%	1	13%	4	50%	2	25%
	Screens	**5**	**63%**	2	25%			1	13%
	Game	2	25%	**3**	**38%**			**3**	**38%**
TW	Presentation	1	13%	1	13%	**3**	**38%**	3	38%
(n=8)	Workshop			**4**	**50%**	2	25%	2	25%
	Screens	**5**	**63%**	1	13%	2	25%		
	Game	2	25%	2	25%	1	13%	**3**	**38%**
HV	Presentation	1	20%	2	40%	1	20%	1	20%
(n=5)	Workshop	0	0%	2	40%	**3**	**60%**	0	0%
	Screens	**4**	**80%**	0	0%	1	20%	0	0%
	Game	0	0%	1	20%	0	0%	**4**	**80%**
RT	Presentation	1	20%	1	20%	2	40%	1	20%
(n=5)	Workshop	0	0%	**3**	**60%**	2	40%	0	0%
	Screens	**3**	**60%**	1	20%	0	0%	1	20%
	Game	1	20%	0	0%	1	20%	**3**	**60%**

Note: The highlighted numbers are the most chosen intervention.

Hypothesis 9

There is a difference between the different sectors and their preferences

The company is divided into 4 sectors and a general supportive sector. In this hypothesis the sectors and the preferences are combined to determine if the preferences differ between the various departments. All the sectors, with the exception of PMC 3, have a distinct preference for one of the interventions. The first choice for all these sectors, except for PMC 3, is information screen, the other interventions are preferred in another order. This makes that the hypothesis can be accepted. The sectors, do all prefer the interventions in their own order. The results are shown in Table 35. On overview of the distribution of the respondents are shown in Table 13.

Table 35 Sectors and their preference

Sector		Choice 1		Choice 2		Choice 3		Choice 4	
Built environment	Presentation	1	8%	**6**	**50%**	2	17%	3	25%
(n=12)	Workshop	2	17%	2	17%	**6**	**50%**	2	17%
	Screens	**6**	**50%**	3	25%	2	17%	1	8%
	Game	3	25%	1	8%	2	17%	**6**	**50%**
Water management	Presentation	2	17%	3	25%	**6**	**50%**	1	8%
(n=12)	Workshop	1	8%	**7**	**58%**	4	34%		
	Screens	**7**	**58%**	2	17%	1	8%	2	17%
	Game	2	17%			1	8%	**9**	**75%**

		C1	%	C2	%	C3	%	C4	%
Energy, water, environment (n=16)	Presentation	2	13%	4	25%	3	19%	7	44%
	Workshop			4	25%	**10**	**63%**	2	13%
	Screens	**9**	**56%**	4	25%	3	19%		
	Game	5	31%	4	25%			7	44%
Infrastructure & mobility (n=11)	Presentation	3	27%	**4**	**36%**	2	18%	2	18%
	Workshop			2	18%	**7**	**64%**	2	18%
	Screens	**8**	**73%**	2	18%	1	9%		
	Game			3	27%	1	9%	**7**	**64%**
Departments (n=9)	Presentation	2	22%	**3**	**33%**	3	33%	1	11%
	Workshop	1	11%	3	33%	2	22%	3	33%
	Screens	**5**	**56%**	2	22%			2	22%
	Game	1	11%	1	11%	**4**	**44%**	3	33%

Note: The highlighted numbers are the most chosen intervention.

5.4 Conclusion

After analyzing the data, it is made clear that the most preferred intervention is the information screen. According to the choice experiment and the results of the hypothesizes. According to the choice experiment these are the most preferred profiles, shown in table 36. In this table the other interventions are also shown. The mentioned profiles show the most preferred for each intervention with the corresponding attributes. These interventions will be used to influence the human behavior in order to reduce the energy consumption in the of Witteveen+Bos.

Table 36 Most preferred profiles according to the choice experiment

Profile	Intervention	Effort	Frequency	Interaction
1	Presentation	Low	Quarterly	Low
5	Workshop	Low	Quarterly	Normal
28	Screen	Low	Quarterly	Normal
30	Game	Normal	Weekly	Low

Besides the choice experiment other information is received using the questionnaire about the people in the work environment of Witteveen+Bos. It is important to notice that this information is based on 7,5% of the Dutch population within the company. The respondents were randomly selected out of the complete Dutch employee database of Witteveen+Bos. 90% of the respondents are highly educated, meaning that they followed a HBO or WO study. The majority of the respondents, 62%, is below 40 years old, and 42%, almost half, is working frequently in the PLUS environment.

62% is competition sensitive, from which 22%, 13 respondents, are interested in an internal competition within the office. 21 respondents, 35%, would maybe join the competition. In case a financial reward would be granted when the energy consumption would be reduced in the work environment, 68% of the respondents would be interested to change their behavior in such a way that energy would be saved.

The hypothesis testing shows that women, compared to men, are more engaged in the energy issues. In particular the group of women above 40 are more engaged in the energy issue. This also applies to the group above 40 (both men and women), they are more sensitive about environmental issues, based on hypothesis 3. This showed, that the statement of hypothesis 3 was rejected which states that younger people are more sensitive about environmental issues.

Another hypothesis which was rejected was about the fact that a higher the level of education resulted in a bigger concern about environmental issues. In this case people with a MBO education showed no concern about the environment, and the respondents with the HBO and WO education showed concerns regarding the environment. However, the amount of respondents with HBO was higher than the WO.

The statement about the expected higher productivity in the PLUS environment compared to the traditional environment could be compared to the results of TNO(2011). The results show a higher productivity in the PLUS environment. Also the majority of the people in the traditional working environment expect that their productivity will improve when PLUSwerken would be implemented. The statement, that people in the PLUS environment, would be more sensitive for the behavior of their peers, was false. Here was expected that people who work in the same space/environment, in which everybody can see their peers, would be influenced through presence of their peers. This statement was rejected for the office environment of Witteveen+Bos.

Finally, 3 hypothesizes about the preference for a intervention to reduce the energy consumption in the office environment were tested. These were tested in relation to: their working environment, the base location, and sector. The first hypothesis stated that there would not be a difference between the preferences of the traditional environment and the PLUS environment. This hypothesis was false, differences for the second and third preference were observed. In both environments a majority preferred for the first preference the information screens, and as fourth preference the game intervention. The second and third intervention were not divided in the same clearance.

The hypothesizes for the base location and sectors was more divided. There was a bigger deviation between the preferences. Because the preferences were so different it was impossible to provide a clear list of the preferences of the interventions.

Chapter 6

Discussion, conclusion, recommendation and implementation

Chapter 6 discusses the report and results and provides the needed perspective. First the discussion of the research will be described in paragraph 6.1. This is followed by the conclusion, which will answer the research questions in paragraph 6.2. Paragraph 6.3 will describe the recommendation for Witteveen+Bos and for further research. Finally, paragraph 6.4 describes the implementation of how the human behavior can be influenced in order to reduce the energy consumption within the office environment of Witteveen+Bos.

6.1 Discussion

This case study is carried out to research how the human behavior could be influenced to reduce the energy consumption in the office environment of Witteveen+Bos. Research in other office environments than Witteveen+Bos are not conducted. Therefore, the outcome of this research can only be used in the office environment of Witteveen+Bos.

However, the results are based on a small part, 7,5% of the Dutch population of Witteveen+Bos. The respondents group deviates from the average of the Dutch population of Witteveen+Bos. Many women responded to the questionnaire, resulting in overrepresentation in the data. The same applies to the level of education, compared to the company's average, the respondents are higher educated.

The financial feasibility and implications are not included in this research, based on the fact that the study was focused on the behavior of people and how this could be influences. Financial goals are often an influence on the choices and behavior of people.

The energy consumption of the office environment of Witteveen+Bos is only 1% of the CO_2-emission, including the energy sources needed for heating and cooling makes total amount of 12%. This is only a small amount compared to the total amount of CO_2-emission and the bills of the company. However, Witteveen+Bos is a company which want to innovate, and an think about nature and climate, and being sustainable.

Another characteristic which is important for occupants is the comfort of the environment. This aspect was hard to included but might also be helpful for the preference of the occupants.

6.2 Conclusion

Answering the main research questions of this research:

How can the human behavior be influenced in the office environment of Witteveen+Bos to reduce the energy consumption?

To answer this question, the six sub questions need to be answered. During the literature review, observations, interviews and questionnaire within the office environment of Witteveen+Bos these questions were answered. In the following paragraphs the questions will be summarized and explained. After these conclusions, the main question will be answered.

6.2.1 Relation between human behavior and energy consumption
"What is the relation between the human behavior and the energy consumption?"

The human behavior is influenced by all experiences and education which the human receives. However, it needs time and effort before the human behavior can be changed or influenced. The relation between the human behavior and energy consumption is described as: actions and decisions which are taken by occupant of a building which impacts the energy consumption of the building. The human behavior can only influence the energy consumption by taking actions on the objects within their control, as well as the actions taken by the occupant itself. The lack of knowledge about how to behave within buildings is according to some statements (Herring, 2006; Janda, 2011), the main reason why the energy consumption within buildings increases. The effect of the human behavior on the energy consumption, is well accepted according to Lopes et al. (2012), because people spend the majority of their time within buildings.
The relation of the human behavior and the energy consumption, is based on actions made by the occupant within the building. Besides, the actions made are mostly about making it as comfortable as possible without keeping in mind the effect it has on the energy consumption, due to the lack of knowledge.

6.2.2 Methods and approaches can be used to investigating how the human behavior can be influenced
"Which methods and approaches are used to investigate how the human behavior can be influenced to reduce the energy consumption?"

To investigate the possibility to influence the human behavior in order to reduce the energy consumption different types of methods and approaches can be used. During the literature review the information is obtained. The following methods and approaches were studied:

Using simulations, will help and predict the possible reductions. The simulation is projected based on the real-life situation, and possible implantations can be tested. However, before making a model, lots of information is needed: the behavior of the people in the environment, the energy consumption, the use of the spaces, etc. This is a time consuming process, and the costs for making a simulation are high.

The use of social psychology has the aim to investigate the people in de office environment in relation to their behavior. Questionnaires can be used to investigate connections based on assumptions and predict possible outcomes for a situation on similar researches. By conduction this type of research it is important to obtain as many respondents as possible, to be able to make valid statements.

Another method is case study, where a certain environment can be explored. By observing and questioning all elements in the office environment, a clear view of the environment can be created. This is needed in order to reduce the energy consumption. The advantage of this method is a customize plan to reduce the energy consumption. However, it is hard to implanted the result in other environments, based on the customized advice.

Using a algorithmic formula will help to predict a certain relation of outcome based on parameters. The parameters, need to be based on information of a environment, where information is needed to set the parameters.

Using these methods or approaches, will help to predict a possible outcome, in order to reduce the energy consumption. The key aspect for the methods and approaches is to get familiar with the human behavior and the environment. The knowledge is important because the situation needs to be known even as how the human behavior is set in the environment in order to influence the situation.

6.2.3 Intervention strategies in the office environment
"What kind of intervention strategies can be applied in the office environment?"

To influence the human behavior, the literature review mentioned four possible interventions which can be used to reduce the energy consumption. All interventions mentioned achievements using these interventions. The goal of the interventions was providing people information about the energy consumption, to create awareness. During the interventions, feedback will be used to create awareness.

The first intervention is the information flow. Due to the lack of information about the energy consumption of a building, the information flow can be used. The research into the information flow existed of two types for sharing information: email and information screens. Using email, people received frequently information about the energy consumption based on personal or the buildings energy consumption. The information screens provided information at places within the building where occupants can be influenced, for example the elevator. The research showed that providing information to the occupants, people became more involved and aware about their contribution within the building.

Secondly, demonstrations showed that people can be influenced during meetings or workshops. Getting people together and talk about energy consumption creates awareness and people can involve if they want. By proving feedback about the total energy consumption and sharing experiences people become more aware about their contribution of the energy consumption. Resulting in the creation of awareness.

The third intervention was about rewarding people using social or monetary rewards. The monetary reward was expected to have a major influence on the human behavior. However, during the literature review this was proved otherwise. The

social results proved long term effect while the financial reward lasted short. During the social rewards, the feeling of competition was evoked. This resulted in social comparison and peer pressure leading to people become aware of others and feel the need to achieve goals. Due to the need to achieve goals people had to actually influence their behavior. This in order to conserve energy which therefore lasted longer.

The fourth intervention was game-intervention. During this intervention people participated in a online game which was connected to the results of their energy consumption. In case people use less energy than the company average, people received advantages for the game, in case of the more energy use than the company average, people received disadvantages. The participants could receive feedback by accessing the dashboard of the game, where information was shown about their own energy consumption, compared with the company's total energy consumption.

Using feedback during interventions, awareness will be created. This provides the human behavior information about their contribution to the energy consumption. Awareness is the key aspect to influence the behavior. The interventions are only a element to achieve the desired human behavior.

6.2.4. The influence of the attributes based on the preference of the intervention
"Does the levels of the attributes have influence on the preference for the intervention?"

Using the choice experiment, the preference of four different interventions was analyzed. The interventions exist of: presentation, workshop, information screens and game intervention. The most preferred intervention is information screens and the least preferred intervention is the game intervention. The attributes: effort, frequency and interaction, consisted of different levels. The difference between two levels was analyzed: low and normal, and normal and high, for effort and interaction. And for the levels of frequency, daily compared to the weekly, and monthly compared to quarterly. The results show that the respondent prefer interventions which needs the least effort, and the lowest level of interaction. For the frequency, people preferred the longest time between the repeated intervention.

6.2.5. The influence of characteristics on the preferences for interventions
"Do the way of gender, age, level of education, working, location and sector have influence the preferences for interventions to reduce the energy consumption?"

Due to the small group of respondents, the deviation based on characteristics such as: gender, age, level of education are used to analyze hypothesizes using frequencies. Using the outcome of the questionnaire, the characteristics of gender, ages and level of education is used separately but also combined to investigate hypothesizes. First general hypothesizes were tested to investigate if the respondents of Witteveen+Bos fit a certain green behavior profile. The analysis shows that women are more considered about environmental issues. Also the higher educated respondents are more concerned about the environmental issues. However, the expected outcome of hypothesis , that younger people are more likelihood to be sensitive about the environmental issues, was rejected, the responds above 40 were tested to be more sensitive about the environmental issues. Based on the way of working , it was proved that PLUSwerken increase the productivity based on the frequencies, 64% agreed to this. Besides, according to people in the traditional environment expect that PLUSwerken will improve the productivity (49%).

The characteristics, gender, age, level of education way of working, base location and sectors were used to test hypothesis concerning the intervention preferences. For the general characteristics, gender, age and level of education, the outcome shows that the information screens is the most preferred, while the game intervention is in all the cases the least preferred. This does also apply to the comparison of the results between the PLUS and traditional environment, the first preference, information screen, and fourth preference, game intervention. There are differences between the second and third choice, in some cases these choices are close, which makes it not suitable to make conclusions based on the outcomes. The outcome of the base location and sectors is more various. With exception of the information screens,

which received at all base locations and sectors a majority of the choices form the respondents. However, the rest of the choices is more divided. Also the groups are smaller, which makes the deviation between the groups harder to analyze.

6.2.6 Answering the main question

The behavior of people in the work environment of Witteveen+Bos can be influenced by making them more aware about the energy consumption within the office environment. Hereby proving information about their contribution to the energy consumption need be shared. This can be achieved by a combination of interventions, providing feedback and education about this topic. The awareness provide the human behavior with information, where people start reacting on this information, consciously or unconsciously. Based on the choice experiment conducted in the office environment of Witteveen+Bos, people prefer the information screens. This was also concluded based on the results of the questionnaire, where the majority of the people also chose the information screen as first preference for reducing the energy consumption. To create an actively involved support for this plan by the people of Witteveen+Bos, the use of public and private feedback might be helpful in combination with an internal. The combination of the interventions, feedback and rewards, will result based on the separate researches in the best outcome for the office environment. For achieving energy reductions in the office environment, people need to receive information.

6.3 Recommendation

6.3.1 Recommendation Witteveen+Bos

Based on the observations, Witteveen+Bos is working on a sustainable environment. The PLUS environment is an improvement based on a smarter environment in which the employees work productive and feel comfortable. The implementation in Breda, has sensors which is therefore more smarter than Amsterdam and might suggest is less energy use. During the observations and interviews the topic of introducing a system in which floors will only be used if the floor is filled, is a smart solution. However, besides the fact that PLUSwerken has no assigned places for people, the experience shows, that people are attached to a certain area on a floor. Or being in the same area of direct colleagues. Therefore, it might be interesting how people react at such implementations. However, assigning people to a certain area offers potential for providing feedback of a certain area.

Based on the outcome of the research the information screens were most preferred. This is a simple adjustment within the office environments. Thereby, there are already ideas placing for information screens within the office environment to share information about projects, activities. The information about the energy consumption within the building, could be an aspect which can help to make people aware about certain energy consumptions within the building. However, the place where the screens will be placed is important. This should be implemented at locations, where people will be observe the information, but also have the opportunity to receive the information they needed. An example of a good location might be by the elevators. People receiving information about the use of the elevator, might stimulate more to take the stairs instead. Another option can be a place where people the take their break, wait, enter the building or print. This creates awareness.

Using presentations, is based on the outcome of the choice experiment, preferred as second intervention. Within the office environment there are already presentations during the lunch break, once in a while. Therefore, this intervention could be used to share information about the energy consumption. This is a forum which can easily be used to share information. However, the information which will be provided during the presentation need to be interesting otherwise no one will join.

By simulation people in the office environment to reduce the energy consumption the use of social connections is a powerful tool. Based on the results of the questionnaire, the majority of the people often discusses the possibilities to reduce energy. Using social rewards might help to create a community. Nowadays, there are many initiatives including

communities. The community will take the lead for a certain goal, and together they try to achieve this, by involving other people. This initiative could be a success, however, it is important the a certain group starts and try to stay active.

6.3.2 Recommendations for further research

The research which is conducted is based on theoretical and previously conducted researchers. However, a combination of previous mentioned solutions is not been tested. Therefor the first recommendation is to test effectiveness of the combination of the solution, and measure the behavioral change and effects on the energy consumption.

The intervention strategies where based on the literature review, however, there might be other effective interventions which were not mentioned and the offer of energy saving devices is growing.

Further is the research only conducted in the environment of Witteveen+Bos, it might be the case, that other companies have other preferences and needs.

And other point of attention is the personal comfort of people in the office environment was not involved, this might have influence on the behavior and preference of the occupants in the working environment, therefore a recommendation might be to involve this aspect in further research an test if this have influence on the choices of people.

6.4 Implementation
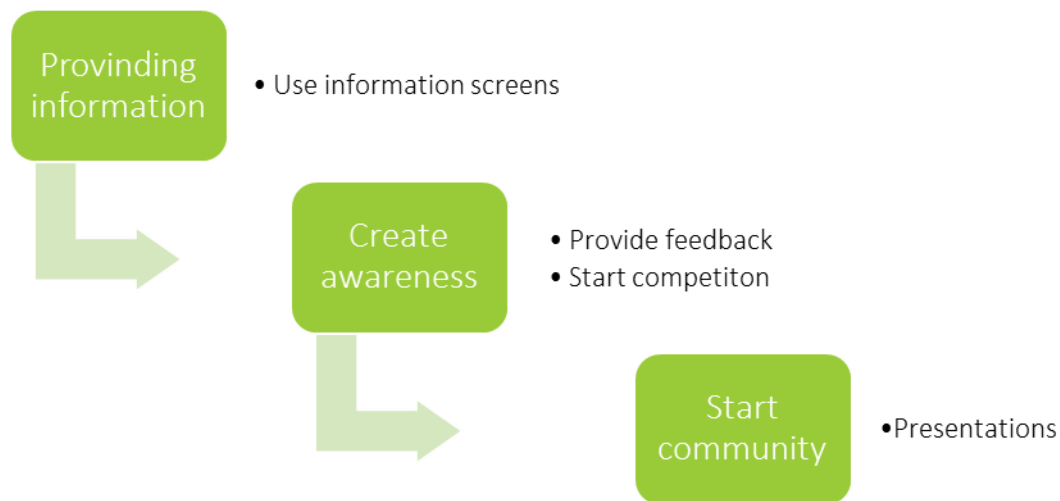
Figure 19 Implementation

The first step in achieving energy conservation in the office environment of Witteveen+Bos is providing information to the users. Based on the outcome of the choice experiment and the ranking of the interventions, information screens are suggested as method. The information on the information screens needs to be interesting, which means the attention needs to be attracted to the screens. This can be done by showing relevant news items, or by attracting them in an interactive way e.g. contest. People, according to the questionnaire mainly men, are sensitive for competition. Using the contest, people will be triggered into reading the information on the screen. The contest also provides information about which people are involved already. In this way the contest works in two ways; to get people to look at the screens and to see which people are involved. Suggested locations of screens are: the entrance of the building and the coffee corner.

People need to be able to read the information, and have the possibility to discuss the information. Therefore placing the screens at a main route would be discouraged based on the fact that it might lead to obstacles for people walking by.

The second step in the process is creating awareness. After providing information, people need to receive feedback. The information screens show the current energy consumption, compared to the energy over periods of time. The screens provide insight in what is happening. People might react on this information, and want to learn about it. To create more awareness, the start of a competition within the office environment would be suggested Starting a competition will evoke people to involve. The participants will push boundaries to become the best, which means they will change their behavior in order to win.

The third step is starting a community. This means people will come together to share experiences and think about solutions to achieve reductions of the energy consumption in the office environment. People will come together and talk about strategies with the aim to actively get people involved and also to motivate other people. Presentations will help during this step. Based on the outcome of the choice experiment a quarterly frequency is suggested, based on the most preferred profile of presentation. By creating a community, people in it share the same goals and there are more people who can join and take initiative in new ideas.

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J.H.E. van Eeden

Appendix

Table of content appendix

J.H.E. van Eeden

1. List of findings in observations

Observations Amsterdam:

- 150 work places
- More interaction when people walk by compared than the situation in Breda
- All types of workplaces are frequently are used
- The possibility to walk around within the office
- They environment is experienced positively and improves the productivity
- Open environment
- Lights are controlled manually
- During the lunch there is a big groups gathering together in the canteen for lunch
- The focus room is only be used for phone calls, the phone boots are never used

Observations Antwerp:

- 30 workplaces
- Everyone has their own desk which is personalist with personal items
- People experience their own work desk as convenient, based on the fact that they are not used to het nieuwe werken.
- People lunch together in the canteen
- The lights are controlled manually

Observations Breda:

- 40 workplaces
- They environment is experienced positively and improves the productivity
- Open environment
- Lights are controlled manually
- The focus room is only be used for phone calls, the phone boots are never used
- The lights are controlled with sensors, with the exception of the toilets, they are controlled manually
- During the lunch there is only a couple of people (max. 6) gathering together in the canteen for lunch
- People would prefer more personal space for looking up previous projects

2. Map of observations of Amsterdam
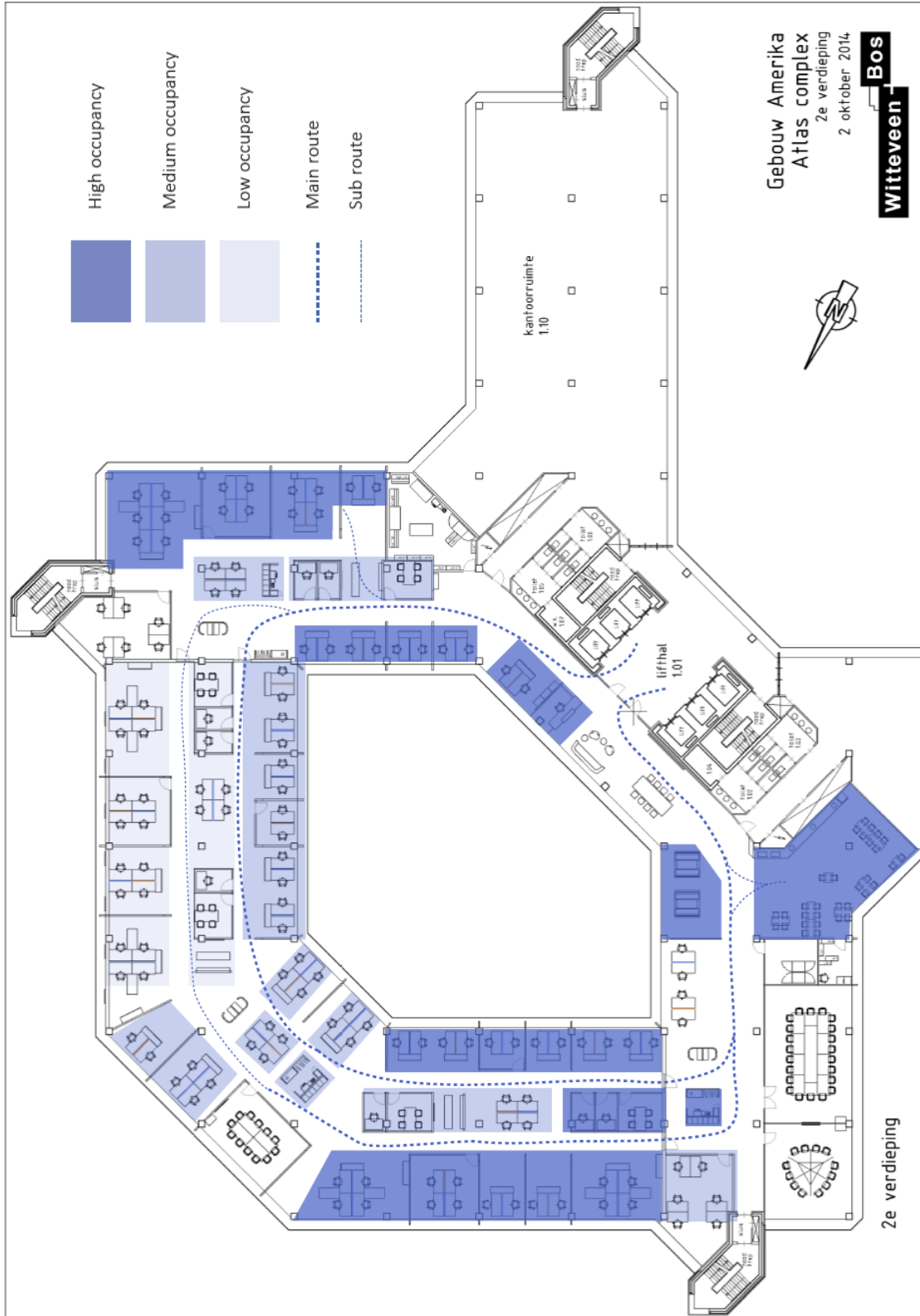
3. Map of observations of Breda

Stationsweg
2e verdieping
15 januari 2016

Witteveen+Bos

SCHAAL 1:250

High occupancy

Medium occupancy

Low occupancy

Main route

Sub route

4. Semi-structured interview

Information needed

➔ Based on the conclusion of the literature review what do you expect to be implemented within the company?
➔ What will stimulate the employees of Witteveen+Bos cooperate to reduce the energy consumption?
➔ How can the employees be encouraged to engage?
➔ Do you have ideas to stimulate employees?

- Conceptual: Are people concerned about energy issues?
- Diagnostic: What stimulate people to involve in reducing the energy consumption, or not?
- Evaluate: How can the you make sure goals can be achieved?
- Strategic: Can you think of implementations which can be used to reduce the energy consumption?

5. Inviting letter

Beste collega van Witteveen+Bos,

Graag wil ik u uitnodigen om deel te nemen aan een enquête die ik verspreid onder een kleine groep medewerkers bij Witteveen+Bos. Mijn naam is Anne van Eeden, ik ben afstudeerder bij Witteveen+Bos in de PMC van Rinus Pelgrum (212). Tijdens mijn afstuderen onderzoek ik het vraagstuk, hoe mensen in de werkomgeving energie kunnen besparen. Het doel van mijn onderzoek is om inzicht te krijgen in de voorkeuren van de medewerkers van Witteveen+Bos in de werkomgeving om informatie te ontvangen over het energiegebruik. Hierbij hoop ik ook graag te kunnen beantwoorden wie de Witteveen+bos-er is.

Door middel van de uitkomsten uit deze enquête wil ik graag uitspraak doen over de voorkeur voor een interventie methode van de medewerkers bij Witteveen+Bos in relatie tot het inzichtelijk maken van mogelijke energiebesparingen in de werkomgeving.

Witteveen+Bos heeft duurzaamheid hoog in het vaandel en steunt de uitvoering van mijn onderzoek. Om te voorkomen dat een te grote groep medewerkers wordt belast met het invullen van de vragenlijst, nodig ik een kleine groep (85 personen, 10 % van de Nederlandse populatie) uit om deel te nemen. U bent (aselect) geselecteerd en ik hoop van harte dat u aan dit onderzoek wilt meewerken.

Het onderzoek zal ongeveer 6 minuten van uw tijd in beslag nemen. De gegevens zullen geheel anoniem en betrouwbaar behandeld worden. Onderstaande link verwijst u naar de vragenlijst.

http://vragen9.ddss.nl/q/Energiebesparing_kort

Indien gewenst kunt u aangeven de resultaten te willen ontvangen als het onderzoek is afgerond. Hiervoor kunt u op de laatste pagina uw emailadres achterlaten. Mocht u nog vragen of opmerkingen hebben, dan kunt u deze ook op de laatste pagina noteren.

Bedankt voor uw aandacht en tijd.

Met vriendelijke groet,

Anne van Eeden
06 18706211
anne.van.eeden@witteveenbos.com

6. Invitee

Table 37 Investees

ID.	Sex	Loc.	Department	ID.	Sex	Loc.	Department
1	Male	DH	BUILT ENVIRONMENT	50	Male	SP	ENERGY, WATER, ENVIRONMENT
2	Female	DH	BUILT ENVIRONMENT	51	Male	SP	ENERGY, WATER, ENVIRONMENT
3	Female	HV	BUILT ENVIRONMENT	52	Male	AS	INFRASTRUCTURE & MOBILITY
4	Male	SP	BUILT ENVIRONMENT	53	Male	AS	INFRASTRUCTURE & MOBILITY
5	Male	SP	BUILT ENVIRONMENT	54	Male	AS	INFRASTRUCTURE & MOBILITY
6	Male	SP	BUILT ENVIRONMENT	55	Female	AS	INFRASTRUCTURE & MOBILITY
7	Male	BR	BUILT ENVIRONMENT	56	Male	HV	INFRASTRUCTURE & MOBILITY
8	Male	BR	BUILT ENVIRONMENT	57	Male	SP	INFRASTRUCTURE & MOBILITY
9	Male	LB	BUILT ENVIRONMENT	58	Female	AS	INFRASTRUCTURE & MOBILITY
10	Male	LB	BUILT ENVIRONMENT	59	Male	HV	INFRASTRUCTURE & MOBILITY
11	Male	AS	BUILT ENVIRONMENT	60	Female	LB	INFRASTRUCTURE & MOBILITY
12	Female	LB	BUILT ENVIRONMENT	61	Female	SP	INFRASTRUCTURE & MOBILITY
13	Male	LB	BUILT ENVIRONMENT	62	Male	SP	INFRASTRUCTURE & MOBILITY
14	Male	AS	BUILT ENVIRONMENT	63	Male	AS	INFRASTRUCTURE & MOBILITY
15	Male	BR	BUILT ENVIRONMENT	64	Male	BR	INFRASTRUCTURE & MOBILITY
16	Female	RT	WATER MANAGEMENT	65	Male	LB	INFRASTRUCTURE & MOBILITY
17	Male	RT	WATER MANAGEMENT	66	Female	AS	INFRASTRUCTURE & MOBILITY
18	Male	RT	WATER MANAGEMENT	67	Male	AS	INFRASTRUCTURE & MOBILITY
19	Male	LB	WATER MANAGEMENT	68	Male	AS	INFRASTRUCTURE & MOBILITY
20	Male	RT	WATER MANAGEMENT	69	Female	AS	INFRASTRUCTURE & MOBILITY
21	Male	LB	WATER MANAGEMENT	70	Female	LB	DEPARTMENTS
22	Male	LB	WATER MANAGEMENT	71	Female	TW	DEPARTMENTS
23	Male	RT	WATER MANAGEMENT	72	Female	LB	DEPARTMENTS
24	Female	HV	WATER MANAGEMENT	73	Male	SP	DEPARTMENTS
25	Male	SP	WATER MANAGEMENT	74	Female	TW	DEPARTMENTS
26	Male	RT	WATER MANAGEMENT	75	Female	TW	DEPARTMENTS
27	Female	DH	WATER MANAGEMENT	76	Female	LB	DEPARTMENTS
28	Male	SP	WATER MANAGEMENT	77	Male	LB	DEPARTMENTS
29	Male	SP	WATER MANAGEMENT	78	Female	LB	DEPARTMENTS
30	Male	SP	WATER MANAGEMENT	79	Female	TW	DEPARTMENTS
31	Male	RT	WATER MANAGEMENT	80	Female	TW	DEPARTMENTS
32	Male	BR	WATER MANAGEMENT	81	Male	TW	DEPARTMENTS
33	Female	TW	WATER MANAGEMENT	82	Female	SP	INFRASTRUCTURE & MOBILITY
34	Male	TW	ENERGY, WATER, ENVIRONMENT	83	Female	BR	INFRASTRUCTURE & MOBILITY
35	Male	TW	ENERGY, WATER, ENVIRONMENT	84	Female	DH	ENERGY, WATER, ENVIRONMENT
36	Male	TW	ENERGY, WATER, ENVIRONMENT	85	Female	AS	ENERGY, WATER, ENVIRONMENT
37	Male	TW	ENERGY, WATER, ENVIRONMENT	86	Female	DH	ENERGY, WATER, ENVIRONMENT
38	Male	TW	ENERGY, WATER, ENVIRONMENT	87	Female	RT	WATER MANAGEMENT
39	Male	TW	ENERGY, WATER, ENVIRONMENT	88	Female	SP	WATER MANAGEMENT
40	Male	AS	ENERGY, WATER, ENVIRONMENT	89	Female	BR	WATER MANAGEMENT
41	Male	BR	ENERGY, WATER, ENVIRONMENT	90	Female	SP	WATER MANAGEMENT
42	Female	TW	ENERGY, WATER, ENVIRONMENT	91	Female	DH	BUILT ENVIRONMENT
43	Male	DH	ENERGY, WATER, ENVIRONMENT	92	Female	BR	BUILT ENVIRONMENT
44	Male	TW	ENERGY, WATER, ENVIRONMENT	93	Female	RT	ENERGY, WATER, ENVIRONMENT
45	Male	TW	ENERGY, WATER, ENVIRONMENT	94	Female	RT	ENERGY, WATER, ENVIRONMENT
46	Male	BR	ENERGY, WATER, ENVIRONMENT	95	Female	RT	ENERGY, WATER, ENVIRONMENT
47	Male	RT	ENERGY, WATER, ENVIRONMENT	96	Female	HV	DEPARTMENTS
48	Male	LB	ENERGY, WATER, ENVIRONMENT	97	Female	BR	DEPARTMENTS
49	Male	HV	ENERGY, WATER, ENVIRONMENT	98	Male	BR	WATER MANAGEMENT

7. Survey

1. Wat is uw geslacht?

O Man   O Vrouw

2. Wat is uw leeftijdscategorie?

<20 jaar
20-29 jaar
30-39 jaar
40-49 jaar
50-59 jaar
>60 jaar

3. Wat is uw opleidingsniveau?

O MBO
O HBO
O WO
O Anders

4. Wat is uw standplaats?

O Amsterdam
O Breda
O Den Haag
O Deventer, Leeuwenburg
O Deventer, Stationsplein
O Deventer, Twickelostraat
O Heerenveen
O Rotterdam

5. Op welke locatie werkt u het meeste?

O Amsterdam
O Breda
O Den Haag
O Deventer, Leeuwenburg
O Deventer, Stationsplein
O Deventer, Twickelostraat
O Heerenveen
O Rotterdam

6. Bij welke sector bent u werkzaam?

O Gebouwde omgeving (PMC 1)
O Delta's, kusten en rivieren(PMC 2)
O Energie, water en milieu(PMC 3)
O Infrastructuur en mobiliteit(PMC 4)
O Departments

7. In welke PMC bent u werkzaam?

Built environment	Water management	Energy, water, envir.	Infrastructure & mob.	Departments
226-Gebiedsontwikkeling	113-Kusten, rivieren en landaanwinngen	321-Afvalwater	214-Kunstwerken en railinfra	Financiën
212-Gebouwen	325-Ecologie	324-Drinkwater	211-Infra constructies	Algemene zaken
331-Omgevingsrecht en vergunningen	111-Hoogwaterbescherming en landbescherming	322-Informatietechnologie	221-Geïntrigeerde contracten	Personeel en Organisatie
227-Planstudies en Procesmanagement	114-Waterbouwkun-dige constructies en geotechniek	332-Industrie en energie	215-Smart Infra Systems	Juridische zaken

225-Stedelijke ontwikkeling	414-International technical assistance	333-Bodemgebruik, ondergrond en reststoffen	222-Verkeer en wegen	Kwaliteitszaken
	112-Havens en scheepvaartwegen	326-Assetmanagement	216-Ondergrondse infrastructuur	Overig
	323-Watermanagement			

8. **"Als iedereen probeert energie te sparen op kantoren, zal dit geen verschil maken voor de totale energie consumptie van Nederland."**
O Helemaal oneens   O Oneens   O Neutraal   O Eens   O Helemaal eens

9. **"De ernst van milieuproblemen wordt overdreven door milieuactivisten."**
O Helemaal oneens   O Oneens   O Neutraal   O Eens   O Helemaal eens

10. **"Ik werk regelmatig (minimaal 1x per week) op een locatie met het Pluswerken concept."**
O Ja   O Nee

11. **"Door het Pluswerken gaat mijn productiviteit omhoog."**
O Helemaal oneens   O Oneens   O Neutraal   O Eens   O Helemaal eens

12. **"Door het Pluswerken zal mijn productiviteit omhoog gaan."**
O Helemaal oneens   O Oneens   O Neutraal   O Eens   O Helemaal eens

13. **Bent u in de privé-omgeving bewust bezig met het besparen van energie?**
O Ja   O Nee

14. **Bespreekt u regelmatig met anderen mogelijkheden om energie te besparen?**
O Nooit   O Af en toe   O Regelmatig   O Vaak

15. **"Het energiebesparende gedrag van andere beïnvloed mijn gedrag."**
O Helemaal oneens   O Oneens   O Neutraal   O Eens   O Helemaal eens

16. **Bent u competitief aangelegd?**
O Ja   O Nee

17. **Ook als dit een competitie is in en met betrekking tot de werkomgeving?**
O Ja   O Misschien   O Nee

18. **Indien een financiële beloning uitgekeerd wordt als een bepaalde energiebesparing behaald wordt, zou dit u motiveren?**
O Ja   O Nee

19. **Als u zou mogen kiezen, naar welke interventie gaat uw voorkeur uit?**
O Prestentatie   O Workshop   O Informatieschermen   O Game-interventie

20. **Welke interventie zou u als tweede kiezen?**
O Prestentatie   O Workshop   O Informatieschermen   O Game-interventie

J.H.E. van Eeden

21. **Welke interventie zou u als derde kiezen?**
  O Prestentatie   O Workshop   O Informatieschermen   O Game-interventie

22. **Welke interventie zou u als laatste kiezen?**
  O Prestentatie   O Workshop   O Informatieschermen   O Game-interventie

8. Experiment design

Table 38 Choice sets experiment designs

Question	Profile	Intervention	Effort	Repeat	Inter-action
1	19	1	1	3	1
1	31	4	3	2	2
2	12	3	2	2	2
2	17	1	2	3	2
3	3	1	1	3	2
3	15	4	3	2	1
4	9	3	1	1	1
4	6	2	2	3	2
5	5	2	1	4	2
5	32	4	2	1	2
6	28	3	1	2	1
6	7	2	1	3	3
7	16	4	2	1	1
7	18	1	1	4	2
8	27	3	2	1	1
8	8	2	2	4	3
9	2	1	2	3	1
9	30	4	2	2	1
10	26	3	1	2	2
10	13	4	3	1	2
11	4	1	2	4	2
11	22	2	2	3	3
12	10	3	2	2	1
12	14	4	2	2	2
13	20	1	2	4	1
13	23	2	1	3	2
14	11	3	1	1	2
14	21	2	1	4	3
15	24	2	2	4	2
15	25	3	2	1	2
16	29	4	3	1	1
16	1	1	1	4	1

9. Dataset

Q6	Q7	Q7	Q7	Q7	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18
Group	BUILT	WATER	ENERGY	INFRAS	dep	PCE	ECO	PLUS	PLUSstat	PLUSwaar	EnergySavings	COM	energie	COMP	INTCOMP	Re
4				6		2	2	1	4			2	1	4	1	2
4				1		2	2	1	2			1	2	4	2	
2		4				2	3	2			3	1	2	4	1	3
2		6				2	3	2			1	1	3	3	2	
1	5					2	3	2			3	1	2	4	2	
3			3			1	2	1	3			2	2	4	1	2
4				3		1	3	2			1	1	2	4	1	2
2		3				1	1	2			2	1	3	3	1	1
1	2					1	4	1	3			1	2	4	2	
3			4			2	2	1	4			1	4	4	1	2
4				1		2	3	1	3			1	2	2	2	
2		3				2	3	2			2	2	1	2	2	
4				6		2	3	1	2			2	2	1	1	1
2		4				2	4	2			3	1	2	4	1	1
1	5					1	2	1	2			1	2	1	2	
3			3			3	2	2			3	2	2	2	1	2
4				1		2	3	1	2			1	3	4	1	1
5					1	2	2	2			2	1	2	3	1	2
3			1			2	5	2			3	1	2	3	1	2
2		1				4	2	1	4			1	2	3	1	2
5					3	2	4	2			2	2	1	3	1	2
4				4		2	3	2			5	1	2	4	1	1
3			5			4	2	1	1			1	2	2	1	3
4				5		2	3	1	3			1	2	4	1	2
2		5				1	1	2			5	1	3	4	2	
4				3		2	2	2			2	1	2	3	2	
5					3	2	4	2			2	1	2	2	1	1
5					6	5	3	1	3			1	3	4	2	
1	2					1	1	2			3	1	3	4	2	
1	4					4	1	1	4			1	3	4	1	1
3			4			4	1	2			2	1	2	4	1	2
3			6			2	3	2			3	1	2	4	1	2
3			2			2	3	2			3	1	3	4	1	2
3			1			1	1	2			4	1	3	4	1	2
3			3			2	2	1	3			2	2	4	2	
1	4					1	2	1	3			1	2	4	2	
2		2				2	1	2			3	1	2	3	2	
3			3			2	2	2			2	1	2	3	1	1
3			5			2	2	2			3	1	3	4	1	1
1	3					2	1	1	2			1	2	3	1	2
1	4					4	2	1	3			2	2	3	2	

2		4				2	2	2		3	1	2	2	1	2
5					1	3	3	2		3	1	1	3	1	2
3			2			1	1	2		2	1	4	3	1	1
5					6	4	3	2		3	1	2	2	1	2
2		7				2	2	1	4		1	1	4	1	1
1	3					2	1	1	4		1	1	2	2	
5					4	2	2	2		4	1	2	4	1	2
3			6			3	3	2		3	1	2	4	1	3
5					4	2	2	2		3	1	2	3	2	
4				6		1	1	1	3		1	4	4	1	1
3			5			2	2	1	4		1	1	4	2	
2		3				2	2	2		3	1	1	4	2	
5					6	2	2	2		4	1	3	4	2	
4				7		4	3	2		3	2	1	3	2	
1	1					1	1	2		4	1	4	5	2	
1	3					3	2	1	2		1	2	1	1	2
2		1				1	2	2		3	1	2	3	2	
3			6			1	1	1	3		1	2	4	1	2
1	5					2	2	1	3		1	3	5	1	1

10. Results

Question 1			Question 2			Question 6			Question 4			Question 5		
Gender			Age			Departments			Base			Worklocation		
Male	35	58%	<20	0	0%	BE	19	32%	AS	0	0%	AS	0	0%
Female	25	42%	20-29	16	27%	WM	0	0%	BR	0	0%	BR	0	0%
			30-39	21	35%	EWE	0	0%	DH	0	0%	DH	0	0%
Question 3			40-49	12	20%	IM	0	0%	LB	0	0%	LB	0	0%
Education			50-59	9	15%	DEP	0	0%	SP	0	0%	SP	0	0%
MBO	9	15%	>60	2	3%				TW	0	0%	TW	0	0%
HBO	0	0%							HV	0	0%	HV	0	0%
WO	0	0%							RT	0	0%	RT	0	0%
Other	0	0%												

Question 7			Question 7			Question 7			Question 7			Question 7		
Built environment			Water management			Energy, water, environment			Infrastructure & mobility			Departments		
226	1	2%	113	2	3%	321	2	3%	214	3	5%	Finance	2	3%
212	2	3%	325	1	2%	324	2	3%	211	0	0%	General aff	0	0%
331	3	5%	111	3	5%	322	4	7%	221	2	3%	Legal aff	2	3%
227	3	5%	114	3	5%	332	2	3%	215	1	2%	P&O	2	3%
225	3	5%	414	1	2%	333	3	5%	222	1	2%	Properties	0	0%
Other	0	0%	112	1	2%	326	3	5%	216	3	5%	Other	3	5%
			323	1	2%	Other	0	0%	Other	1	2%			
			Other	0	0%									

Question 8			Question 9			Question 10			Question 11			Question 12		
PCE			ECO			Pluswerken			Productivity in PLUS environ.			Expectation productivity in PLUS		
TD	14	23%	TD	13	22%	Y	25	42%	TD	1	2%	TD	2	3%
D	34	57%	D	25	42%	N	35	58%	D	6	10%	D	9	15%
N	4	7%	N	17	28%				N	11	18%	N	18	30%
A	7	12%	A	4	7%				A	7	12%	A	4	7%
TA	1	2%	TA	1	2%				TA	0	0%	TA	2	3%

Question 13			Question 14			Question 15			Question 16			Question 17		
Energy savings			Communication			Energy behavior			Competition			Competition at work		
Y	51	85%	N	9	15%	TD	3	5%	Yes	37	62%	Yes	13	22%
N	9	15%	S	35	58%	D	8	13%	No	23	38%	Maybe	21	35%
			F	12	20%	N	16	27%				No	3	5%
			M	4	7%	A	31	52%	Question 18					
						TA	2	3%	Reward					
									Yes	41	68%			
									No	19	32%			

Question 19			Question 20		
Choice 1			Choice 2		
Presentation	31	52%	**Presentation**	**25**	42%
Workshop	0	0%	Workshop	35	58%
Info	**0**	0%	Info	0	0%
Game	0	0%	Game	0	0%

Question 21			Question 22		
Choice 3			Choice 4		
Presentation	1	2%	Presentation	2	3%
Workshop	**6**	10%	Workshop	9	15%
Info	11	18%	Info	18	30%
Game	7	12%	**Game**	**4**	7%

Input sex and age			Input sex &education		
Gender and Age			Gender and education		
Male <40	19	32%	Male, high	33	55%
Male >40	16	27%	Male, low	2	3%
Female<40	18	30%	Female, high	20	33%
Female >40	7	12%	Female, low	5	8%

11. Nlogit outcome

PWS

```
|-> LOGIT;Lhs=CHOICE;Rhs=ONE,INTERV1,INTERV2,INTERV3,QM,WD,EFFORTLM,EFFORTMH
    ,INTERLM,INTERMH$
Normal exit:   5 iterations. Status=0, F=     1139.815


-----------------------------------------------------------------------------
Binary Logit Model for Binary Choice
Dependent variable                 CHOICE
Log likelihood function     -1139.81473
Restricted log likelihood   -1330.84259
Chi squared [   9 d.f.]        382.05572
Significance level                .00000
McFadden Pseudo R-squared      .1435390
Estimation based on N =   1920, K =  10
Inf.Cr.AIC  =   2299.6 AIC/N =    1.198
Model estimated: Dec 07, 2016, 13:21:46
Hosmer-Lemeshow chi-squared =  43.63477
P-value=  .00000 with deg.fr. =       8
--------+--------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
  CHOICE|  Coefficient      Error       z     |z|>Z*         Interval
--------+--------------------------------------------------------------------
Constant|    -.97261***      .10291     -9.45   .0000    -1.17431    -.77092
 INTERV1|    1.51905***      .14146     10.74   .0000     1.24180    1.79630
 INTERV2|     .24904*        .14346      1.74   .0826     -.03214     .53023
 INTERV3|    2.15342***      .14996     14.36   .0000     1.85952    2.44733
      QM|    -.39555***      .06976     -5.67   .0000     -.53229    -.25881
      WD|    -.20963***      .07473     -2.81   .0050     -.35611    -.06316
EFFORTLM|    -.19970***      .05846     -3.42   .0006     -.31428    -.08512
EFFORTMH|     .03158         .10262      .31   .7583     -.16954     .23271
 INTERLM|    -.12837**       .05902     -2.17   .0296     -.24405    -.01269
 INTERMH|    -.22538**       .09952     -2.26   .0235     -.42043    -.03032
--------+--------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
-----------------------------------------------------------------------------
```

GPW

```
|-> LOGIT;Lhs=CHOICE;Rhs=ONE,INTERV1,INTERV2,INTERV3,QM,WD,EFFORTLM,EFFORTMH
    ,INTERLM,INTERMH$
Normal exit:   5 iterations. Status=0, F=     1139.815


-----------------------------------------------------------------------------
Binary Logit Model for Binary Choice
Dependent variable                 CHOICE
Log likelihood function     -1139.81473
Restricted log likelihood   -1330.84259
Chi squared [   9 d.f.]        382.05572
Significance level                .00000
McFadden Pseudo R-squared      .1435390
Estimation based on N =   1920, K =  10
Inf.Cr.AIC  =   2299.6 AIC/N =    1.198
Model estimated: Dec 07, 2016, 13:22:34
Hosmer-Lemeshow chi-squared =  43.63477
P-value=  .00000 with deg.fr. =       8
--------+--------------------------------------------------------------------
        |                  Standard            Prob.       95% Confidence
  CHOICE|  Coefficient      Error       z     |z|>Z*         Interval
--------+--------------------------------------------------------------------
Constant|    1.18081***      .10844     10.89   .0000      .96828    1.39334
 INTERV1|   -2.15342***      .14996    -14.36   .0000    -2.44733   -1.85952
 INTERV2|    -.63437***      .14531     -4.37   .0000     -.91918    -.34957
```

```
 INTERV3|    -1.90438***          .14765    -12.90   .0000      -2.19376   -1.61500
      QM|     -.39555***          .06976     -5.67   .0000       -.53229    -.25881
      WD|     -.20963***          .07473     -2.81   .0050       -.35611    -.06316
EFFORTLM|     -.19970***          .05846     -3.42   .0006       -.31428    -.08512
EFFORTMH|      .03158             .10262       .31   .7583       -.16954     .23271
 INTERLM|     -.12837**           .05902     -2.17   .0296       -.24405    -.01269
 INTERMH|     -.22538**           .09952     -2.26   .0235       -.42043    -.03032
--------+-------------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
---------------------------------------------------------------------------------
```

SGP

```
|-> LOGIT;Lhs=CHOICE;Rhs=ONE,INTERV1,INTERV2,INTERV3,QM,WD,EFFORTLM,EFFORTMH
    ,INTERLM,INTERMH$
Normal exit:   5 iterations. Status=0, F=     1139.815


---------------------------------------------------------------------------------
Binary Logit Model for Binary Choice
Dependent variable              CHOICE
Log likelihood function     -1139.81473
Restricted log likelihood   -1330.84259
Chi squared [   9 d.f.]        382.05572
Significance level                .00000
McFadden Pseudo R-squared       .1435390
Estimation based on N =    1920, K =   10
Inf.Cr.AIC   =    2299.6 AIC/N =    1.198
Model estimated: Dec 08, 2016, 10:51:39
Hosmer-Lemeshow chi-squared =   43.63477
P-value=   .00000 with deg.fr. =        8
--------+-------------------------------------------------------------------------
        |                     Standard              Prob.      95% Confidence
  CHOICE|  Coefficient        Error        z      |z|>Z*         Interval
--------+-------------------------------------------------------------------------
Constant|     -.72357***          .09997     -7.24   .0000       -.91950    -.52764
 INTERV1|     1.90438***          .14765     12.90   .0000      1.61500    2.19376
 INTERV2|     -.24904*            .14346     -1.74   .0826       -.53023     .03214
 INTERV3|     1.27001***          .13982      9.08   .0000       .99596    1.54405
      QM|     -.39555***          .06976     -5.67   .0000       -.53229    -.25881
      WD|     -.20963***          .07473     -2.81   .0050       -.35611    -.06316
EFFORTLM|     -.19970***          .05846     -3.42   .0006       -.31428    -.08512
EFFORTMH|      .03158             .10262       .31   .7583       -.16954     .23271
 INTERLM|     -.12837**           .05902     -2.17   .0296       -.24405    -.01269
 INTERMH|     -.22538**           .09952     -2.26   .0235       -.42043    -.03032
--------+-------------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
---------------------------------------------------------------------------------
```

WSG

```
|-> LOGIT;Lhs=CHOICE;Rhs=ONE,INTERV1,INTERV2,INTERV3,QM,WD,EFFORTL,EFFORTM
    ,INTERLM,INTERMH$
Normal exit:   5 iterations. Status=0, F=     1133.458


---------------------------------------------------------------------------------
Binary Logit Model for Binary Choice
Dependent variable              CHOICE
Log likelihood function     -1133.45784
Restricted log likelihood   -1330.84259
Chi squared [   9 d.f.]        394.76950
Significance level                .00000
McFadden Pseudo R-squared       .1483156
Estimation based on N =    1920, K =   10
Inf.Cr.AIC   =    2286.9 AIC/N =    1.191
Model estimated: Dec 07, 2016, 13:29:28
Hosmer-Lemeshow chi-squared =   34.69012
```

```
P-value=  .00003 with deg.fr. =        8
--------+------------------------------------------------------------------
        |                    Standard              Prob.      95% Confidence
  CHOICE|  Coefficient        Error       z      |z|>Z*          Interval
--------+------------------------------------------------------------------
Constant|    -.77810***       .10211     -7.62    .0000      -.97823    -.57798
 INTERV1|    2.02893***       .15116     13.42    .0000      1.73266    2.32520
 INTERV2|    -.14100          .14624      -.96    .3349      -.42762     .14562
 INTERV3|    1.31427***       .14191      9.26    .0000      1.03614    1.59240
     QM|     -.43800***       .07114     -6.16    .0000      -.57744    -.29856
     WD|     -.17870**        .07515     -2.38    .0174      -.32599    -.03141
 EFFORTL|    -.20378***       .06025     -3.38    .0007      -.32186    -.08569
 EFFORTM|     .01508          .09601       .16    .8752      -.17309     .20325
 INTERLM|    -.15691***       .06025     -2.60    .0092      -.27500    -.03882
 INTERMH|    -.22481**        .09570     -2.35    .0188      -.41238    -.03724
--------+------------------------------------------------------------------
Note: ***, **, * ==>  Significance at 1%, 5%, 10% level.
--------------------------------------------------------------------------
```

12. Profile preference

PWS

#	INTERVENTIE	FREQ	EFFORT	INTERA	Constant	Presentat	Worksh	Screens	Game	Daily	Weekly	Monthly	Quarterly	Low	Normal	Normal	Much	Low	Normal	Normal	Much	SUM
1	Presentation	Quarterly	Low	Low	-0.9726	1.51905							0.39555	0.1997				0.12837				1.27006
2	Presentation	Monthly	Normal	Low	-0.9726	1.51905						-0.3956			-0.1997			0.12837				0.07956
3	Presentation	Monthly	Low	Normal	-0.9726	1.51905						-0.3956		0.1997					-0.12837			0.22222
4	Presentation	Quarterly	Normal	Normal	-0.9726	1.51905							0.39555		-0.1997				-0.12837			0.61392
5	Workshop	Quarterly	Low	Normal	-0.9726		0.249						0.39555	0.1997						0.22538		0.09706
6	Workshop	Monthly	Normal	Normal	-0.9726		0.249					-0.3956			-0.1997					0.22538		-1.09344
7	Workshop	Monthly	Low	Much	-0.9726		0.249					-0.3956		0.1997							-0.22538	-1.1448
8	Workshop	Quarterly	Normal	Much	-0.9726		0.249						0.39555		-0.1997						-0.22538	-0.7531
9	Screens	Daily	Low	Low	-0.9726			2.1534		-0.20963				0.1997				0.12837				1.29925
10	Screens	Weekly	Normal	Low	-0.9726			2.1534			0.2096				-0.1997			0.12837				1.31911
11	Screens	Daily	Low	Normal	-0.9726			2.1534		-0.20963				0.1997					-0.12837			1.04251
12	Screens	Weekly	Normal	Normal	-0.9726			2.1534			0.2096				-0.1997				-0.12837			1.06237
13	Game	Daily	Much	Normal	-0.9726				0	-0.20963							0		-0.12837			-1.31061
14	Game	Weekly	Normal	Normal	-0.9726				0		0.2096						0		-0.12837			-0.89135
15	Game	Weekly	Much	Low	-0.9726				0		0.2096						0	0.12837				-0.63461
16	Game	Daily	Normal	Low	-0.9726				0	-0.20963							0	0.12837				-1.05387
17	Presentation	Monthly	Normal	Normaal	-0.9726	1.51905						-0.3956			-0.1997				-0.12837			-0.17718
18	Presentation	Quarterly	Low	Normaal	-0.9726	1.51905							0.39555	0.1997					-0.12837			1.01332
19	Presentation	Monthly	Low	Low	-0.9726	1.51905						-0.3956		0.1997				0.12837				0.47896
20	Presentation	Quarterly	Normal	Low	-0.9726	1.51905							0.39555		-0.1997			0.12837				0.87066
21	Workshop	Quarterly	Low	Much	-0.9726		0.249						0.39555	0.1997							-0.22538	-0.3537
22	Workshop	Monthly	Normal	Much	-0.9726		0.249					-0.3956			-0.1997						-0.22538	-1.5442
23	Workshop	Monthly	Low	Normal	-0.9726		0.249					-0.3956		0.1997						0.22538		-0.69404
24	Workshop	Quarterly	Normal	Normal	-0.9726		0.249						0.39555		-0.1997					0.22538		-0.30234
25	Screens	Daily	Normal	Normal	-0.9726			2.1534		-0.20963					-0.1997				-0.12837			0.64311
26	Screens	Weekly	Low	Normal	-0.9726			2.1534			0.2096			0.1997					-0.12837			1.46177
27	Screens	Daily	Normal	Low	-0.9726			2.1534		-0.20963					-0.1997			0.12837				0.89985
28	Screens	Weekly	Low	Low	-0.9726			2.1534			0.2096			0.1997				0.12837				1.71851
29	Game	Daily	Much	Low	-0.9726				0	-0.20963							0	0.12837				-1.05387
30	Game	Weekly	Normaal	Low	-0.9726				0		0.2096						0	0.12837				-0.63461
31	Game	Weekly	Much	Normal	-0.9726				0		0.2096						0		-0.12837			-0.89135
32	Game	Daily	Normal	Normal	-0.9726				0	-0.20963							0		-0.12837			-1.31061

GPW

#	INTERVENTIE	FREQ	EFFORT	INTERA	Constant	Presentat	Worksh	Screens	Game	Daily	Weekly	Monthly	Quarterly	Low	Normal	Normal	Much	Low	Normal	Normal	Much	SUM
1	Presentation	Quarterly	Low	Low	1.18081	-0.6344							0.39555	0.1997				0.12837				1.27006
2	Presentation	Monthly	Normal	Low	1.18081	-0.6344						-0.3956			-0.1997			0.12837				0.07956
3	Presentation	Monthly	Low	Normal	1.18081	-0.6344						-0.3956		0.1997					-0.12837			0.22222
4	Presentation	Quarterly	Normal	Normal	1.18081	-0.6344							0.39555		-0.1997				-0.12837			0.61392
5	Workshop	Quarterly	Low	Normal	1.18081		-1.904						0.39555	0.1997						0.22538		0.09706
6	Workshop	Monthly	Normal	Normal	1.18081		-1.904					-0.3956			-0.1997					0.22538		-1.09344
7	Workshop	Monthly	Low	Much	1.18081		-1.904					-0.3956		0.1997							-0.22538	-1.1448
8	Workshop	Quarterly	Normal	Much	1.18081		-1.904						0.39555		-0.1997						-0.22538	-0.7531
9	Screens	Daily	Low	Low	1.18081			0		-0.20963				0.1997				0.12837				1.29925
10	Screens	Weekly	Normal	Low	1.18081			0			0.2096				-0.1997			0.12837				1.31911
11	Screens	Daily	Low	Normal	1.18081			0		-0.20963				0.1997					-0.12837			1.04251
12	Screens	Weekly	Normal	Normal	1.18081			0			0.2096				-0.1997				-0.12837			1.06237
13	Game	Daily	Much	Normal	1.18081				-2.15	-0.20963							0		-0.12837			-1.31061
14	Game	Weekly	Normal	Normal	1.18081				-2.15		0.2096						0		-0.12837			-0.89135
15	Game	Weekly	Much	Low	1.18081				-2.15		0.2096						0	0.12837				-0.63461
16	Game	Daily	Normal	Low	1.18081				-2.15	-0.20963							0	0.12837				-1.05387
17	Presentation	Monthly	Normal	Normaal	1.18081	-0.6344						-0.3956			-0.1997				-0.12837			-0.17718
18	Presentation	Quarterly	Low	Normaal	1.18081	0							0.39555	0.1997					-0.12837			1.64769
19	Presentation	Monthly	Low	Low	1.18081	-0.6344						-0.3956		0.1997				0.12837				0.47896
20	Presentation	Quarterly	Normal	Low	1.18081	-0.6344							0.39555		-0.1997			0.12837				0.87066
21	Workshop	Quarterly	Low	Much	1.18081		-1.904						0.39555	0.1997							-0.22538	-0.3537
22	Workshop	Monthly	Normal	Much	1.18081		-1.904					-0.3956			-0.1997						-0.22538	-1.5442
23	Workshop	Monthly	Low	Normal	1.18081		-1.904					-0.3956		0.1997						0.22538		-0.69404
24	Workshop	Quarterly	Normal	Normal	1.18081		-1.904						0.39555		-0.1997					0.22538		-0.30234
25	Screens	Daily	Normal	Normal	1.18081			0		-0.20963					-0.1997				-0.12837			0.64311
26	Screens	Weekly	Low	Normal	1.18081			0			0.2096			0.1997					-0.12837			1.46177
27	Screens	Daily	Normal	Low	1.18081			0		-0.20963					-0.1997			0.12837				0.89985
28	Screens	Weekly	Low	Low	1.18081			0			0.2096			0.1997				0.12837				1.71851
29	Game	Daily	Much	Low	1.18081				-2.15	-0.20963							0	0.12837				-1.05387
30	Game	Weekly	Normaal	Low	1.18081				-2.15		0.2096						0	0.12837				-0.63461
31	Game	Week	Much	Normal	1.18081				-2.15		0.2096						0		-0.12837			-0.89135
32	Game	Daily	Normal	Normal	1.18081				-2.15	-0.20963							0		-0.12837			-1.31061

SGP

Column groups: Intervention (Presentat, Worksh, Screens, Game) · Frequency (Daily, Weekly, Monthly, Quarterly) · Effort (Low, Normal, Normal, Much) · Interaction (Low, Normal, Normal, Much)

#	INTERVENTIE	FREQ	EFFORT	INTERA	Constant	Presentat	Worksh	Screens	Game	Daily	Weekly	Monthly	Quarterly	Low	Normal	Normal	Much	Low	Normal	Normal	Much	SUM
1	Presentation	Quarterly	Low	Low	-0.7236	1.27001							0.39555	0.1997				0.12837				1.27006
2	Presentation	Monthly	Normal	Low	-0.7236	1.27001						-0.3956			-0.1997			0.12837				0.07956
3	Presentation	Monthly	Low	Normal	-0.7236	1.27001						-0.3956		0.1997					-0.12837			0.22222
4	Presentation	Quarterly	Normal	Normal	-0.7236	1.27001							0.39555		-0.1997				-0.12837			0.61392
5	Workshop	Quarterly	Low	Normal	-0.7236		0						0.39555	0.1997						0.22538		0.09706
6	Workshop	Monthly	Normal	Normal	-0.7236		0					-0.3956			-0.1997					0.22538		-1.09344
7	Workshop	Monthly	Low	Much	-0.7236		0					-0.3956		0.1997							-0.22538	-1.1448
8	Workshop	Quarterly	Normal	Much	-0.7236		0						0.39555		-0.1997						-0.22538	-0.7531
9	Screens	Daily	Low	Low	-0.7236			1.9044		-0.20963				0.1997				0.12837				1.29925
10	Screens	Weekly	Normal	Low	-0.7236			1.9044			0.2096				-0.1997			0.12837				1.31911
11	Screens	Daily	Low	Normal	-0.7236			1.9044		-0.20963				0.1997					-0.12837			1.04251
12	Screens	Weekly	Normal	Normal	-0.7236			1.9044			0.2096				-0.1997				-0.12837			1.06237
13	Game	Daily	Much	Normal	-0.7236				-0.25	-0.20963							0		-0.12837			-1.31061
14	Game	Weekly	Normal	Normal	-0.7236				-0.25		0.2096					0			-0.12837			-0.89135
15	Game	Weekly	Much	Low	-0.7236				-0.25		0.2096						0	0.12837				-0.63461
16	Game	Daily	Normal	Low	-0.7236				-0.25	-0.20963						0		0.12837				-1.05387
17	Presentation	Monthly	Normal	Normaal	-0.7236	1.27001						-0.3956			-0.1997				-0.12837			-0.17718
18	Presentation	Quarterly	Low	Normaal	-0.7236	1.27001							0.39555	0.1997					-0.12837			1.01332
19	Presentation	Monthly	Low	Low	-0.7236	1.27001						-0.3956		0.1997				0.12837				0.47896
20	Presentation	Quarterly	Normal	Low	-0.7236	1.27001							0.39555		-0.1997			0.12837				0.87066
21	Workshop	Quarterly	Low	Much	-0.7236		0						0.39555	0.1997							-0.22538	-0.3537
22	Workshop	Monthly	Normal	Much	-0.7236		0					-0.3956			-0.1997						-0.22538	-1.5442
23	Workshop	Monthly	Low	Normal	-0.7236		0					-0.3956		0.1997						0.22538		-0.69404
24	Workshop	Quarterly	Normal	Normal	-0.7236		0						0.39555		-0.1997					0.22538		-0.30234
25	Screens	Daily	Normal	Normal	-0.7236			1.9044		-0.20963					-0.1997				-0.12837			0.64311
26	Screens	Weekly	Low	Normal	-0.7236			1.9044			0.2096			0.1997					-0.12837			1.46177
27	Screens	Daily	Normal	Low	-0.7236			1.9044		-0.20963					-0.1997			0.12837				0.89985
28	Screens	Weekly	Low	Low	-0.7236			1.9044			0.2096			0.1997				0.12837				1.71851
29	Game	Daily	Much	Low	-0.7236				-0.25	-0.20963							0	0.12837				-1.05387
30	Game	Weekly	Normaal	Low	-0.7236				-0.25		0.2096					0		0.12837				-0.63461
31	Game	Week	Much	Normal	-0.7236				-0.25		0.2096						0		-0.12837			-0.89135
32	Game	Daily	Normal	Normal	-0.7236				-0.25	-0.20963						0			-0.12837			-1.31061

WSG

Column groups: Intervention (Presentation, Workshop, Screens, Game) · Frequency (Daily, Weekly, Monthly, Quarterly) · Effort (Low, Normal, Normal, Much) · Interaction (Low, Normal, Normal, Much)

#	INTERVENTIE	FREQ	EFFORT	INTERA	Constant	Presentation	Workshop	Screens	Game	Daily	Weekly	Monthly	Quarterly	Low	Normal	Normal	Much	Low	Normal	Normal	Much	SUM
1	Presentation	Quarterly	Low	Low	0.54644	0							0.20963	0.2				0.13				1.084
2	Presentation	Monthly	Normal	Low	0.54644	0						-0.21			-0.2			0.13				0.265
3	Presentation	Monthly	Low	Normal	0.54644	0						-0.21		0.2					-0.128			0.408
4	Presentation	Quarterly	Normal	Normal	0.54644	0							0.20963		-0.2				-0.128			0.428
5	Workshop	Quarterly	Low	Normal	0.54644		-1.27						0.20963	0.2						0.225		-0.09
6	Workshop	Monthly	Normal	Normal	0.54644		-1.27					-0.21			-0.2					0.225		-0.91
7	Workshop	Monthly	Low	Much	0.54644		-1.27					-0.21		0.2							0.23	-0.51
8	Workshop	Quarterly	Normal	Much	0.54644		-1.27						0.20963		-0.2						0.23	-0.49
9	Screens	Daily	Low	Low	0.54644			0.634		-0.21				0.2				0.13				1.299
10	Screens	Weekly	Normal	Low	0.54644			0.634			0.396				-0.2			0.13				1.505
11	Screens	Daily	Low	Normal	0.54644			0.634		-0.2				0.2					-0.128			1.052
12	Screens	Weekly	Normal	Normal	0.54644			0.634			0.2				-0.2				-0.128			1.052
13	Game	Daily	Much	Normal	0.54644				-1.52	-0.2							0		-0.128			-1.3
14	Game	Weekly	Normal	Normal	0.54644				-1.52		0.2					0			-0.128			-0.9
15	Game	Weekly	Much	Low	0.54644				-1.52		0.2						0	0.13				-0.64
16	Game	Daily	Normal	Low	0.54644				-1.52	-0.2						0		0.13				-1.04
17	Presentation	Monthly	Normal	Normaal	0.54644	0						-0.21			-0.2				-0.128			0.009
18	Presentation	Quarterly	Low	Normaal	0.54644	0							0.20963	0.2					-0.128			0.827
19	Presentation	Monthly	Low	Low	0.54644	0						-0.21		0.2				0.13				0.665
20	Presentation	Quarterly	Normal	Low	0.54644	0							0.20963		-0.2			0.13				0.685
21	Workshop	Quarterly	Low	Much	0.54644		-1.27						0.20963	0.2							0.23	-0.09
22	Workshop	Monthly	Normal	Much	0.54644		-1.27					-0.21			-0.2						0.23	-0.91
23	Workshop	Monthly	Low	Normal	0.54644		-1.270					-0.210		0.200						0.225		-0.508
24	Workshop	Quarterly	Normal	Normal	0.54644		-1.270						0.210		-0.200					0.225		-0.488
25	Screens	Daily	Normal	Normal	0.54644			0.634		-0.200					-0.200				-0.128			0.653
26	Screens	Weekly	Low	Normal	0.54644			0.634			0.200			0.200					-0.128			1.451
27	Screens	Daily	Normal	Low	0.54644			0.634		-0.200					-0.200			0.128				0.909
28	Screens	Weekly	Low	Low	0.54644			0.634			0.200			0.200				0.128				1.708
29	Game	Daily	Much	Low	0.54644				-1.519	-0.200							0.000	0.128				-1.044
30	Game	Weekly	Normaal	Low	0.54644				-1.519		0.200					0.000		0.128				-0.644
31	Game	Week	Much	Normal	0.54644				-1.519		0.200						0.000		-0.128			-0.901
32	Game	Daily	Normal	Normal	0.54644				-1.519	-0.200						0.000			-0.128			-1.301

Total sum

	INTERV	FREQ	EFFORT	INTERA	SUM PWS	SUM GPW	SUM SGP	SUM WSG	TOTAL SU ▾
1	Presentatior	Quarterly	Low	Low	2.24267	1.27006	1.27006	1.08414	5.86693
2	Presentatior	Monthly	Normal	Low	1.05217	0.07956	0.07956	0.26548	1.47677
3	Presentatior	Monthly	Low	Normal	1.19483	0.22222	0.22222	0.40814	2.04741
4	Presentatior	Quarterly	Normal	Normal	1.58653	0.61392	0.61392	0.428	3.24237
5	Workshop	Quarterly	Low	Normal	1.06967	0.09706	0.09706	-0.08885	1.17494
6	Workshop	Monthly	Normal	Normal	-0.12083	-1.09344	-1.09344	-0.90751	-3.21522
7	Workshop	Monthly	Low	Much	-0.17219	-1.1448	-1.1448	-0.50811	-2.9699
8	Workshop	Quarterly	Normal	Much	0.21951	-0.7531	-0.7531	-0.48825	-1.77494
9	Screens	Daily	Low	Low	2.27186	1.29925	1.29925	1.29888	6.16924
10	Screens	Weekly	Normal	Low	2.29172	1.31911	1.31911	1.50466	6.4346
11	Screens	Daily	Low	Normal	2.01512	1.04251	1.04251	1.05207	5.15221
12	Screens	Weekly	Normal	Normal	2.03498	1.06237	1.06237	1.05207	5.21179
13	Game	Daily	Much	Normal	-0.338	-1.31061	-1.31061	-1.30063	-4.25985
14	Game	Weekly	Normal	Normal	0.08126	-0.89135	-0.89135	-0.90123	-2.60267
15	Game	Weekly	Much	Low	0.338	-0.63461	-0.63461	-0.64449	-1.57571
16	Game	Daily	Normal	Low	-0.08126	-1.05387	-1.05387	-1.04389	-3.23289
17	Presentatior	Monthly	Normal	Normaal	0.79543	-0.17718	-0.17718	0.00874	0.44981
18	Presentatior	Quarterly	Low	Normaal	1.98593	1.64769	1.01332	0.8274	5.47434
19	Presentatior	Monthly	Low	Low	1.45157	0.47896	0.47896	0.66488	3.07437
20	Presentatior	Quarterly	Normal	Low	1.84327	0.87066	0.87066	0.68474	4.26933
21	Workshop	Quarterly	Low	Much	0.61891	-0.3537	-0.3537	-0.08885	-0.17734
22	Workshop	Monthly	Normal	Much	-0.57159	-1.5442	-1.5442	-0.90751	-4.5675
23	Workshop	Monthly	Low	Normal	0.27857	-0.69404	-0.69404	-0.50811	-1.61762
24	Workshop	Quarterly	Normal	Normal	0.67027	-0.30234	-0.30234	-0.48825	-0.42266
25	Screens	Daily	Normal	Normal	1.61572	0.64311	0.64311	0.65267	3.55461
26	Screens	Weekly	Low	Normal	2.43438	1.46177	1.46177	1.45147	6.80939
27	Screens	Daily	Normal	Low	1.87246	0.89985	0.89985	0.90941	4.58157
28	Screens	Weekly	Low	Low	2.69112	1.71851	1.71851	1.70821	7.83635
29	Game	Daily	Much	Low	-0.08126	-1.05387	-1.05387	-1.04389	-3.23289
30	Game	Weekly	Normaal	Low	0.338	-0.63461	-0.63461	-0.64449	-1.57571
31	Game	Week	Much	Normal	0.08126	-0.89135	-0.89135	-0.90123	-2.60267
32	Game	Daily	Normal	Normal	-0.338	-1.31061	-1.31061	-1.30063	-4.25985