

THE AS-TOOL:

A DECISION SUPPORTING TOOL FOR CHOOSING AN
ACCOMMODATION PLAN, IN ORDER TO IMPLEMENT
THE NEW WAYS OF WORKING.

Using computer modelling to simultaneously take into account feasibility and desirability

MASTER THESIS.

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FOREWORD.

This report contains the documentation of my graduation project for the study Real Estate & Housing, at Delft University of technology. Real Estate & Housing is part of the faculty of architecture, and mainly focuses on the financial and management aspects of the built environment. Within my graduation project, a computer tool (the Accommodation Support Tool) is developed that can support the decision making process of organizations regarding how they will implement the new ways of working in their real estate. Therefore, it is mainly a management focussed tool, but financial variables are also taken into account.

I would like to thank my mentors, Ruud Binnekamp, Theo van der Voordt and Monique Arkesteijn, for their assistance during my research project. Furthermore, I would like to thank all the stakeholders of the case of the municipality of Rotterdam, which was subject for the study for their cooperation. A special thanks goes out to Marijke Drost, for arranging all appointments, and to John Smeets, for providing much valuable information and thoughts for my project.

Furthermore, I want to point out that the models developed by the Centre for People and Buildings in Delft, inspired me to develop a model to deliver something new. The study of their existing work was very beneficial for my own project.

I wish you much pleasure in reading my report, and for more information or questions about the subject you can contact me via e-mail, stated on the front page of this report.

Bart Pols

INTRODUCTION.

Since a couple of years, the phenomenon called the new ways of working (Dutch: Het Nieuwe Werken) is becoming an increasingly important topic for many organizations. However, not all of them are prepared for these changes, and research on the topic is still ongoing. This graduation thesis contributes to this research field.

In a broader perspective, this study will try to tackle the potential problems, related to the accommodation of an organization, that are created by the new ways of working (in a Dutch perspective). Specifically, this will be done by use of a model which takes in consideration (new) demands of the stakeholders, and the properties of the real estate object. The study performed here applies to a specific case, but the model is developed inductively, meaning that with only little change to the structure, the model can be applied to other cases.

All new stakeholder demands, and the properties of the real estate object can be translated into mathematical constraints. The model that will be created will then take these constraints into account, which means that only feasible solutions are generated.

GOALS AND MOTIVATION

I was motivated to research this topic by personal experiences as well as that of relatives with the new ways of working. What is interesting to me is that there are many different views on how the new ways of working should be implemented. This has to do with the mindsets of different individuals, but also with the methods that the company used to change their work culture. It is my belief that a changing company culture requires a changing real estate setup in order to accommodate the new demands of the stakeholders. Additionally, changing the real estate could also help to change the mindset of people in terms of performance and execution of their work.

My study goals for this project are to develop a thorough understanding of the demands and criteria of stakeholders, and the way that these demand can be physically implemented in real estate with the given constraints. Moreover, I aim to understand the relevant factors in decisions made from the organizational point of view and the (possible) differences from the choices that would fit user demands. Finally, I wish to gain more insight in computer modeling and the logic behind it.



SUMMARY.

The topic for the study is the *New Ways of Working*. Various authors have done research on this subject, but an overall accepted definition does not exist. The main reason is that the new ways of working is a concept that differs for each organization. Bijl (2007) states that the main aspects of this concept consist in updating:

1. *the physical working environment,*
2. *the organizational structure and culture,*
3. *the management style, and*
4. *the mentality of both employee and employer.*

Organizations may have multiple reasons for implementing the new ways of working. The main idea behind this implementation relates to the desires and demands of the employee, which organizations have become increasingly willing to listen and adjust to (Van Dinteren, 2010). Besides the benefits for the employee, another important advantage for employers is the potential reduction of accommodation costs.

This research is aimed at providing the optimal solution for the New Ways of Working in real estate. The problem this study addresses is: the tools available for organizations to support choosing an accommodation plan for implementing the new ways of working, fail to simultaneously take into account feasibility and desirability. The tools that do exist do not fully take into account:

1. *the feasibility of a project, which means that they are not defining a solution space containing all possible feasible solutions, or*
2. *the desirability of a project, which means that that the solution is not optimized for the stakeholders objectives.*

A project leader now has to make decisions based on the unprocessed qualitative requests or wishes of stakeholders (Baan, 2014). Based on the problem, the research question is formulated as follows: How can a tool be developed to support organizations in choosing an accommodation plan to implement the new ways of working, while simultaneously taking into account feasibility and desirability? To answer this question, a computer model will be developed that serves as such a decision supporting tool.

The study design includes 4 main steps to be taken. These steps are the following:

1. *Literature study for a better understanding of the subject.*
2. *Construction of a first model.*
3. *A cyclic process containing technical and social cycles, in which the model will be improved.*
4. *Documenting the model.*

In order to better understand the new real estate demands related to the new ways of working, a client statement will include objectives, constraints and functions which are required by the client (Dym, Little & Orwin, 2014). Objectives describe what the end product should be like. Constraints are requirements that describe what the end product at least must include. Functions describe what the end product should be doing, meaning what variables will be used.

SUMMARY.

In scientific terms, this project is an operations research (OR) project. In OR, a model is structured by equations, where the following formula is leading: $U = f(X_i, Y_j)$, where

- *U is the optimal solution,*
- *f is the formula and*
- *X_i and Y_j are variables and constraints.*

The OR model fits this research, because the model constructed for the research question also includes the search for an optimal solution within certain constraints.

The search for an optimal solution relates to the domain of decision making systems, but also to the domain of real estate management. Within decision making systems, all variables are translated into a (computer) model in order to define an objective function to be optimized.

Real estate management provides and describes theories about added value. The added value is provided by the alignment of real estate with the demands and objectives of the stakeholders, and U is a optimized solution that relates to these demands and objectives. Added value of real estate is key for both scientific domains (real estate management & design and decision making systems), and connects them together.

As part of real estate management, the DAS-frame (De Jonge et al., 2009) can be related to this research project. The DAS-frame has 4 main steering events, being:

1. *Determine the match or mismatch between current demand and current supply.*
2. *Determine the match of mismatch between future demand and current supply.*
3. *Generate alternative solutions for the mismatches.*
4. *Step-by-step plan to implement the chosen alternative.*

The model created for the study will be able to generate alternative solutions for mismatches, as the third step states. With the correct input, which is a result of the first 2 steps, these alternatives are a solid bases for the fourth step, in which the architect determines how the chosen alternative can be implemented.

In order to determine which alternative will be chosen, stakeholders need to use criteria based on their general interests. The research of Riratanathong (2014) shows a solid way to translate these interests to goals, which in turn can be used to define the ways to add value to these goals which are called the performance measures. Based on these performance measures, criteria for the computer model can be proposed.

The research question of this study states that there is no tool available for organizations that simultaneously takes into account feasibility and desirability. However, other tools do exist to supporting organizations in choosing an accommodation plan. For this research, two important tools are studied more in detail, to be able to compare them to the final product. The tools are called the HK model and the PACT model.

The HK model (Huisvestingskeuzemodel) is a process oriented model which returns the best possible conceptual choices based on the goals of an organization (Ikiz-Koppejan, van der Voordt, & Hartjes-Gosselink, 2009). The model takes a qualitative approach, and fails to take into account the feasibility of the accommodation plan.

SUMMARY.

The PACT model (Plekken en ACTiviteiten) is used as a calculation tool to return the optimized implementation of workstations, regarding number, types and orientation (De Bruyne & Gosselink, 2011). This model takes a quantitative approach, and requires input about the organization (like f.t.e., activities, flex factor).

The main focus of the PACT model is to create a solution of office interior elements, for the specified activity profile. Just like the HK model, it fails to determine the feasibility within the real estate object. Furthermore, the PACT model does not include any form of preference measurement, and can only be used as a calculation tool for the optimal workstation composition. The methods used for this research project are part of the second scientific domain, which is design and decision making systems. 2 main methods are used, being:

1. *Linear programming, in order to solve the feasibility aspect of the constructed model, and*
2. *Preference measurement, in order to solve the desirability aspect of the constructed model.*

Linear programming is a technique used to determine whether an accommodation plan is feasible, given the constraints of the stakeholders and the real estate object properties (Binnekamp et al., 2006). If feasible, the method is also able to generate a solution optimized for a specific objective. The method can be executed in a spreadsheet and contains four main elements:

1. *Constraints: they define the solution space.*
2. *Solution space: defined by constraints, it contains all possible solutions*
3. *Objective function: used to find the optimal solution within the solution space.*
4. *Solution: a point within the solution space, which can be optimized for the objective function.*

For an operations research project, empiric notions must be connected to these elements of a mathematical system. These empiric notions are based on the problem statement and research question, and are the following:

1. *Constraints: building properties and demands of the stakeholders for the design, quantified to object variables.*
2. *Solutions space: the design space, defined by the constraints.*
3. *Objective function: the dominant design criterion.*
4. *Solution: a design.*

Because linear programming only generates solutions using one objective function, the solutions will only be optimized for one stakeholder, or multiple stakeholders who share the same objective. This introduces preference measurement. Preference measurement, the second main method for this research project, is a technique to determine the most desirable solution for all stakeholders. The following procedure is used for this method (Binnekamp, 2010):

1. *Specify the alternatives.*
2. *Specify the decision maker's criteria tree.*
3. *Rate the decision maker's preferences for each alternative against each criterion.*
4. *To each leaf criterion assign the decision maker's weight.*
5. *Use an algorithm to yield an overall preference scale.*

At the end, the most desirable solution is the alternative with the highest overall preference rating.

SUMMARY.

The model that is constructed during the study applies to a specific business case. The chosen case belongs to the municipality of Rotterdam and was carried out between 2011 and 2015 (Municipality of Rotterdam, 2012), in which the municipal office employees moved from 26 different buildings to 4 large office buildings.

In defining the desired elements, the municipality of Rotterdam has taken the underlying ideas of the New Ways of Working and adjusted them to fit the organization. With these adjustments, the developed vision on the New Ways of Working has been given the name “HNW010” (Bouman - Vermeulen, 2013; Municipality of Rotterdam, 2013). Within HNW010, six main statements are defined which describe the focus of the municipality:

1. *Work where the city needs you*
2. *Control your own development and results*
3. *Be reachable, i.e. open for communication*
4. *Have (access to) information and knowledge required for the job*
5. *Take responsibility*
6. *Talent determines value*

Furthermore, as for gathering data such as spatial measures and materials, the municipality of Rotterdam has made a document already, containing standard office interior elements. Since every organization is different, including other municipalities, these elements will also differ slightly per case. The various “building blocks” of which a Rotterdam municipal office building must consist (Gosselink & Smeets, 2011) have been used for the initial model.

The process of the construction of the model in this specific case can be divided into three technical and social cycles.

The first technical cycle starts off with a basic model based on the literature of the case. The interior building blocks were implemented, as well as objectives related to the stakeholders. Furthermore, in this phase the model took into account multiple floors of a building, providing a detailed design in the output sheet.

With the initial model finished, interviews were conducted with the stakeholders of the case which was the first social cycle of the process. These stakeholders had different areas of expertise, namely: IT services, asset manager, facility management, project controller, new ways of working, real estate developer and design concept manager.

The interview (and all additional documentation provided here) revealed more accurate constraints and objectives. In the second technical cycle, all of these constraints were implemented in the model until the model sufficiently represented the reality of the case. The model was then used to create 4 alternative strategies, one of which being the actual chosen design in the real case.

With the generated alternatives, the second social cycle included a workshop with the stakeholders, to discuss the differences of the theoretical strategies, the accuracy of the constraints and the preferences of each area of expertise. The preferences, based on criteria stated by the stakeholders themselves, were the input for determining the desirability.

During the workshop, it became apparent that the stakeholders did not agree that all constraints were implemented in the model at that point. Therefore, a third and final technical cycle was entered to update the model, aiming to include all data that the stakeholders would need for a total overview, allowing them to use the result in the negotiation process of choosing an accommodation plan.

SUMMARY.

After the third technical cycle, a third social cycle included an evaluation of the model with the stakeholders, in order to validate the model's simulation of the case, and to discuss the utilization potential of the final product.

The final product of this study is a computer model to support organizations in choosing an accommodation plan, called the Accommodation Support tool (or AS-Tool). The model requires a set of variables as input, such as the activity profile, the size of the building and different floors, the minimum and maximum number of office elements, facilities and specials to be implemented and financial constraints. When all of the input is entered, the model could either conclude that there is no feasible solution, or return an optimized solution for the set objective. The solution takes the form of an accommodation plan, specifying which elements have to be implemented for each floor of the building.

For the result of the field test, the workshop of the second social cycle is examined. Within this workshop, the result of the preference measurement showed that the overall most preferred solution was not the same strategy, and the actual implemented solution for the case. This meant that the current accommodation plan is not optimized for the stakeholder objectives. The two reasons for this were that:

1. *the chosen solution and the most preferred solution both score very high, and a tool was not yet available to show the difference in preference, and that*
2. *the stakeholders believe that the organization is not yet fit to support the most preferred strategy.*

The result of the project as a whole is a product which answers the initial research question, which was: How can a tool be developed to support organizations in choosing an accommodation plan to implement the new ways of working, while simultaneously taking into account feasibility and desirability?

Feasibility is taken into account by quantifying both the demands of the stakeholders and the physical building properties and regulations. The AS-Tool uses all of these constraints to validate the existence of a solution space, which contains all solutions that are allowed within the constraints. If a solution space does not exist, then the constraints are too strict and are mutually exclusive. Within a process of choosing an accommodation plan, this means that the stakeholders should (re)negotiate their demands.

Within an existing solution space, the objectives of the stakeholders are used to find optimized solutions for different objective functions. Each optimized solution will fit at least one stakeholder the best, since it is based on their objective.

In order to find the overall most preferred solution which relates to the desirability, preference measurement is used. All stakeholders define criteria which they use to rate the alternative solutions. A algorithm is then used to find the overall most preferred solution, which is still a feasible outcome of the computer model.

To reflect back of the research project, the completeness of data, validity of the results, scientific relevance and utilization potential are discussed.

SUMMARY.

First of all, in order for the AS-Tool to generate a realistic accommodation plan, the input data should be accurate. For this project this was not always the case, because:

1. *not all stakeholders constraints and objectives were quantified to begin with and the stakeholders had difficulties expressing some of their demands in numbers, and*
2. *Some of the data was never provided because of the sensitivity of the numbers.*

As a result, many assumptions had to be made regarding the constraints of the model. A incomplete data set therefore leads to an inaccurate result for the AS-Tool.

The result of the research was that the municipality did not implement an optimal most preferred solution. The validity of this result is however affected by the completeness of data described above, and also by the choice of not implementing certain aspects in the model, because of the limited time frame of the project. While incomplete however, the results can still be used as leverage and clarity within the negotiation process.

As for the scientific relevance, this project adds value to both domains (real estate management and design and decision modeling) by relating them together. Furthermore, for real estate management, it offers a method to clearly execute the third step of the DAS-frame. For design and decision modeling, it combines 2 modeling methods, in order provide a new method of problem solving.

The utilization potential of the end product is not limited to the chosen case of Rotterdam only, since the model is constructed inductively. The structure allows for easy changes in constraints, objectives and decision variables (functions), meaning that it has much utilization potential. The use of the constructed model can save organization time and money in the decisions making process, and also provides clarity in stakeholder demands.

CONCISE SUMMARY IN DUTCH.

Het onderwerp van dit onderzoek is Het Nieuwe Werken. Omdat hiervan geen algemene definitie bestaat, is ook de toepassing ervan in vastgoed van organisaties ongedefinieerd. Het werk van Bijl (2007) noemt 4 hoofdaspecten van het nieuwe werken, deze zijn het updaten van:

1. *de fysieke werkomgeving,*
2. *de organisatie structuur en cultuur,*
3. *de management stijl, en*
4. *de mentaliteit van werkgever en werknemer.*

Dit project doelt op het maken van een tool voor het definiëren van een optimale huisvestingsoplossing om het nieuwe werken in vastgoed te kunnen implementeren. De probleemstelling die hierbij van toepassing is, is: Er bestaat geen tool voor organisaties voor het ondersteunen van het keuzeproces voor een huisvestingsplan om het nieuwe werken te implementeren, die tegelijkertijd de haalbaarheid en wenselijkheid van het plan in acht neemt. De tools die wel bestaan, zoals het HK model en het PACT model, zijn niet ontwikkeld om zowel de haalbaarheid als wenselijkheid mee te nemen in het beslissingsmodel.

Gebaseerd op de probleemstelling is de onderzoeksvraag als volgt geformuleerd: Hoe kan er een tool worden ontwikkeld dat organisaties kan ondersteunen in het keuzeproces voor een huisvestingsplan om het nieuwe werken te implementeren, die tegelijkertijd de haalbaarheid en wenselijkheid van het plan in acht neemt? Het antwoord op deze vraag zal in de vorm van een computer model zijn.

Dit onderzoek neemt de vorm aan van een handelingsvraagstuk (Operations Research). Binnen OR nemen modellen de vorm aan van een wiskundige vergelijking, waarbij de vergelijking $U = f(X_i, Y_j)$ centraal staat. Hierin wordt de U geoptimaliseerd, en zijn X en Y beslissingsvariabelen. Deze formule past goed bij het gehele onderzoek, omdat daar ook gezocht wordt naar een optimale oplossing.

De methodes die worden gebruikt voor het modeleren zijn lineair programmeren en voorkeursmeting. Lineair programmeren kan worden gebruikt om te bepalen of de oplossingsruimte wel of niet leeg is, en zo dus ook de haalbaarheid van het project te onderzoeken. Voorkeursmeting is een methode om de meeste wenselijke oplossing te vinden, uit een reeks toegestane oplossingen.

Het model dat gemaakt wordt voor dit onderzoek wordt toegepast op een case van de gemeente Rotterdam dat is uitgevoerd in 2011 - 2015. De gemeente heeft een eigen vorm van het nieuwe werken opgesteld dat is ingevoerd in het nieuwe vastgoed van het project.

Verder heeft de gemeente documenten opgesteld waar de invulling van het vastgoed voor een deel gedefinieerd wordt, wat overeenkomt met de eisen van de stakeholders. Deze documenten beschrijven onder andere de elementen die toegepast moeten voor het ondersteunen van de werkzaamheden, wat in een computermodel omgezet wordt in beslissingsvariabelen.

Het proces van het creëren van het uiteindelijke computermodel kent een cyclisch karakter, waarbij 3 technische en 3 sociale fases zijn doorlopen. Tijdens de technische fases is het model geconstrueerd, en worden wijzigingen toegepast. De sociale fases zijn de test momenten van het model met de stakeholders, waar voorkeursmeting kan worden toegepast en de volledigheid van het model kan worden gecontroleerd.

Het eindproduct van dit afstuderen is een computermodel, genaamd het de AS-Tool, dat de eisen van de stakeholders en de eigenschappen van een vastgoedobject in acht neemt voor het bepalen van de haalbaarheid. Voor de wenselijkheid geven de stakeholders een score aan de hand van zelf gedefinieerde criteria aan de gegenereerde alternatieven, om zo de meest wenselijke oplossing te kunnen vinden. De alternatieve oplossingen hebben de vorm van een ontwerpplan, waarbij per verdieping gespecificeerd is welke elementen moeten worden toegepast, hoe veel ruimte dit kost en wat de financiële consequenties zijn.

Het eindproduct voldoet aan de onderzoeksvraag, waarbij tegelijkertijd de haalbaarheid en wenselijkheid van de mogelijke plannen in acht worden genomen. Als reflectie op het onderzoeksproject wordt gekeken naar de volledigheid van de data, de validiteit van de resultaten, de wetenschappelijke relevantie en het gebruikspotentieel.

Voor het genereren van een nauwkeurig huisvestingsplan is het noodzakelijk dat de input data volledig en gedetailleerd is. Voor dit project is dat niet zo geweest, omdat de stakeholders niet al hun eisen konden vertalen in object variabelen, en omdat sommige informatie te gevoelig was en daarom niet gedeeld. Dit had als resultaat dat er veel aannames moesten worden gemaakt, waardoor de modeluitkomsten minder nauwkeurig werden.

De validiteit van de resultaten heeft hierdoor ook geleden, en daarnaast is er gekozen om sommige aspecten niet mee te nemen in het computermodel, vanwege het tijdsbestek van het onderzoek. De resultaten zijn echter goed bruikbaar tijdens de onderhandelingen tussen de stakeholders over de huisvesting, en ook bieden de resultaten meer transparantie in het proces.

Betreft de wetenschappelijk relevantie biedt dit onderzoek toegevoegde waarde voor beide wetenschappelijke domeinen, "real estate management" en "design and decision modeling". Voor real estate management heeft het model raakvlakken met een bestaande methode genaamd het DAS-frame. Deze methode wordt gebruikt om het vastgoed van organisaties te kunnen aanpassen op een veranderende vraag in de toekomst. Het model is een goede methode om specifiek de derde stap van het DAS-frame uit te voeren. Voor design and decision modeling biedt dit onderzoek een unieke combinatie van de methodes lineair programmeren en voorkeursmetingen in een vastgoed vraagstuk.

Omdat de AS-Tool niet gelimiteerd is voor de case van de gemeente Rotterdam, is het gebruikspotentieel groot. De structuur staat gemakkelijke veranderingen toe aan de eisen, doelstellingen en beslissingsvariabelen en zou daardoor voor iedere organisatie kunnen worden opgesteld. Het gebruik van het model kan organisaties tijd en geld besparen in het beslissingsproces, en biedt ook transparantie voor de stakeholders.

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Within the research, information regarding stakeholders demands will be gathered. This information is then used as input for a computer model, which is able to generate design solutions for the accommodation of an organization. This is done using linear programming, which takes into account the demands as mathematical constraints, to only generate feasible solutions. The goal is to provide an easy way to determine feasibility of a project, and to be able to compare solutions regarding preference. The description of the relevance of this model is split up in three different subjects, being the scientific relevance, the societal relevance and the utilization potential of the final product.

SCIENTIFIC RELEVANCE

The research is related to other scientific disciplines in the field of real estate management and design and decision modeling. First of all, Riratanaphong (2014) has created a theory that is followed in this study, about the added value of real estate, based on the demands of stakeholders, which is fundamental for this study. Furthermore, various studies done by the Center for people and buildings concerning physical elements of office real estate are included. This research will combine the real estate management topics with methods of decision modeling, which include linear programming and preference measurement (Binnekamp, van Gunsteren, & van Loon, 2006). These methods allow for a concise and structured way of modeling, because of its quantitative approach. The added value of this particular research is that it translates the demands of the stakeholders to the physical adjustments that have to be made in real estate, by means of computer-based decision modeling.

UTILIZATION POTENTIAL

The main topic for this research is the implementation of the new ways of working in office based organizations. Because of the changes in organizations caused by the new ways of working, the real estate is subject to changing demands. This research is aimed at the solutions that can be created for the problems that organizations encounter when existing real estate do not longer support the changes caused by the new ways of working.

The outcome of this research will be in the form of a computer model. This computer model will be capable of translating real estate demands by stakeholders to a list of required physical components. For organizations, the computer model can be used as a decision making model, where goals can be defined. Without clear goals, the model can also be used as a feasibility study, in order to confirm the existence of a solution space with the given constraints. The outcome of this study can directly be used by the organization where the study takes place, which in this case is the municipality of Rotterdam. The model should however be inductive, meaning that little adjustments have to be made to make it applicable to other organizations. Reason for this is that the structure of the model remains the same.

The added value for organizations of using a computer model is that it provides a tool for the multi-criteria decision making process that has to be done by an assigned project manager. A computer model can make the decision making process more objective and concise, and can more easily be used to explain choices and to provide transparency of stakeholder constraints and objectives within a project. Because of this, the model has the potential to save time within the negotiation and design processes.

READER'S GUIDE.

In this chapter, the structure of the document is summarized in order to provide a guide for the first-time readers. The report exists of various main parts, as described below.

At the start of the study, the research topic, proposal and over structure have to be clarified. This is the purpose of part 1 of the report. This part will introduce research proposal, which includes the problem analysis, research questions, product description and structure. The second chapter states the client statement of the research, which can be seen as a program of requirements or the aims and objectives. After this, the scientific context is clarified.

The second part of the report contains the theory related to real estate management, which is used for the research project. The chapters in part 2 elaborate on the DAS-framework, the new ways of working, stakeholder criteria and existing models.

Besides real estate management, this study also used the theoretical framework of operations research. Part 3 of the report therefore contains the theoretical elaboration of linear programming and preference measurement.

Part 4 of the report is the description of the case, with which the model that has been created can be validated. The case description contains an overall description, definition of the used office elements and qualitative demands of the stakeholders.

Part 5 of the report describes the process of the construction of the final model, the Accommodation Support Tool. The process contains three technical cycles in which adjustments to the actual computer model are made, and three social cycles in which the model is presented to the stakeholders for validation. This leads to the final product described after, in part 6.

The sixth part of the report describes the final model, which is the AS-Tool, in detail. The 3 different sheets are the input sheet, model sheet and output sheet, each containing different elements, but more importantly, a different structure. A description on the required input, preference measurement technique and limitations of the model are also stated here.

The conclusion will include a discussion about the results of the social cycles, and an overall conclusion and reflection on the research project, as well as a personal reflection. Following the conclusion, are the sources used for the research, and the appendixes.



PART 1

RESEARCH STRUCTURE.

- 1.1 - Introduction
- 1.2 - Research proposal
- 1.3 - Client statement
- 1.4 - Scientific context
- 1.5 - Research organizations

1.1 INTRODUCTION

As stated in the introduction of the report itself, the subject for the study includes the New Ways of Working. Various authors have done research on this subject, but an overall accepted definition does not exist. This is because the New Ways of Working is a concept that will differ for each organization. Bijl (2007) states that the main aspects of this concept are the updating of the physical working environment, the organization structure and culture, the management style and the mentality of both employee and employer.

Organizations may have multiple reasons for implementing the New Ways of Working. The main idea behind implementing the new ways of working relates to the desires and demands of the employee, which has become an important aspect organizations want to listen to (Van Dinteren, 2010). Besides the benefits for the employee, another important advantage for employers is the potential reduction of accommodation costs.

To support the implementation of the new ways of working in an accommodation plan, various tools exist, like the HK model or the PACT model. These models however have different limitations, where the HK model focuses mainly on qualitative desirability and the PACT model mainly on optimal workspace division.

1.2 RESEARCH PROPOSAL

The research proposal will include a problem analysis where the current shortcomings are described. Based on this, the research question is formed. The sub-questions for the research indicate steps of the process. After the description of the question, the aimed end-product and study design are briefly described.

PROBLEM ANALYSIS

This section will start off with a short introduction to the main problem created by the new ways of working, after which a client statement is formulated to further describe the problem. The new ways of working creates new demands for the real estate of an organization. Flexibility is the keyword for these demands (Duurzaam vastgoed, 2014). This means that the employee has more choice when to work, and also where (Van Dinteren, 2010). New ways of working includes flexible office spaces without employees having their own desk, but also working from home. Moreover, the ways in which people have meetings are changing to a less formal setting.

The combination of employees working at home or at different times, and the working and meeting environments becoming less formal, is the basis for the problem statement for this report. For the real estate, the New Ways of Working brings along new demands for various subjects, like working stations and meeting rooms (Baan, 2014). The actual problem that is being created here is: The tools available for organizations to support choosing an accommodation plan for implementing the new ways of working, fail to simultaneously take into account feasibility* and desirability**.

* Feasibility within stakeholder constraints and the real estate object limitations.

** Desirability of the involved stakeholders calculated by preference measurement.

PART 1: RESEARCH STRUCTURE.

The tools that do exist do not fully take into account the feasibility of a project, which means that it is not defining a clear solution space, or the desirability, which means that that the solution is not optimized for a stakeholder. Currently, a project leader has to make decisions himself based on the unprocessed qualitative requests or wishes of stakeholders (Baan, 2014).

In relation to the scientific context, which is described more in detail in a later chapter, the problem relates to both decision making systems and real estate management. With the domain of decision making systems, the adjustment part of the problem can be solved by creating a (computer) model, providing an optimized solution to create the highest possible value. Real estate management theories describe the new ways of working, and the added value of real estate adjustment for various stakeholders. The added value of real estate is the key word that brings the two scientific domains together.

RESEARCH QUESTION

Based on the previous section, the research question is formulated as follows: How can a tool be developed to support organizations in choosing an accommodation plan to implement the new ways of working, while simultaneously taking into account feasibility and desirability? The answer for the question will be in the form of a decision making computer model. Furthermore, sub-questions for the research, in order to guide the process, include:

- *What are the demands of the stakeholders created by the new ways of working, quantified for the model? **
- *What are the constraints of the real estate object, quantified for the model? **
- *What are the criteria of the stakeholders, quantified for the model? ***

* Used to determine the feasibility of the accommodation plan

** Used to determine the desirability of the accommodation plan

PRODUCT

The final product of the research is the computer model itself, a tool to support the decision making process of an accommodation plan. The outcome of the model could be a recommendation or suggestion for the organizations involved, but this is different in every other setting. The research is inductive, meaning that while conducted with a certain case, the model should be generally applicable for similar cases. Furthermore, the model is capable of delivering more than one solution. The most interesting therefore is the structure of the model.

STUDY DESIGN

Multiple methods are used during this research to gather information and data. This section of the report describes these methods in a chronological way, which as a whole represents the process of the research, or study design.

1. *The first step is to study relevant literature on the new ways of working, and modeling methods. Information about previous implementations and the consequences of this is used in the research. This provides a theory-based description of the new ways of working. Also information about the case for the study is gathered.*

PART 1: RESEARCH STRUCTURE.

2. *The next step is to design a first version of the model, based on the information gathered. This step can be seen as the first technical cycle of the model. Because of the generic information, the first model is very standard. Therefore it is not applicable in a real life situation. The goal of this step however, is to gain insight in the way the model works, and to find out what additional information is needed.*
3. *Following step 2 comes the moment to field test the early version of the model, which is the first social cycle of the model. With the gathered data, the model should come up with possible solutions for the problem. These solutions will be presented to the case stakeholders in order to find out if they fit their demands. Presenting the model and the outcomes leads to usable feedback on either the mechanics or the values used. This feedback will be used to improve the model in a next technical cycle, after which a second social cycle will follow, and so on. This research project contains 3 technical and 3 social cycles (part 5 of the report).*
4. *The repeating phase of step 3 (technical and social cycles) continues until the point is reached where the model is accurate enough to provide a useful solution. When this is found out during the feedback phase (social cycle), the documentation of the whole model is started (part 6 of the report). Another result of the research could have been that a solution cannot be found with the current demands of the stakeholders.*

CONCEPTUAL MODEL OF THE PROCESS

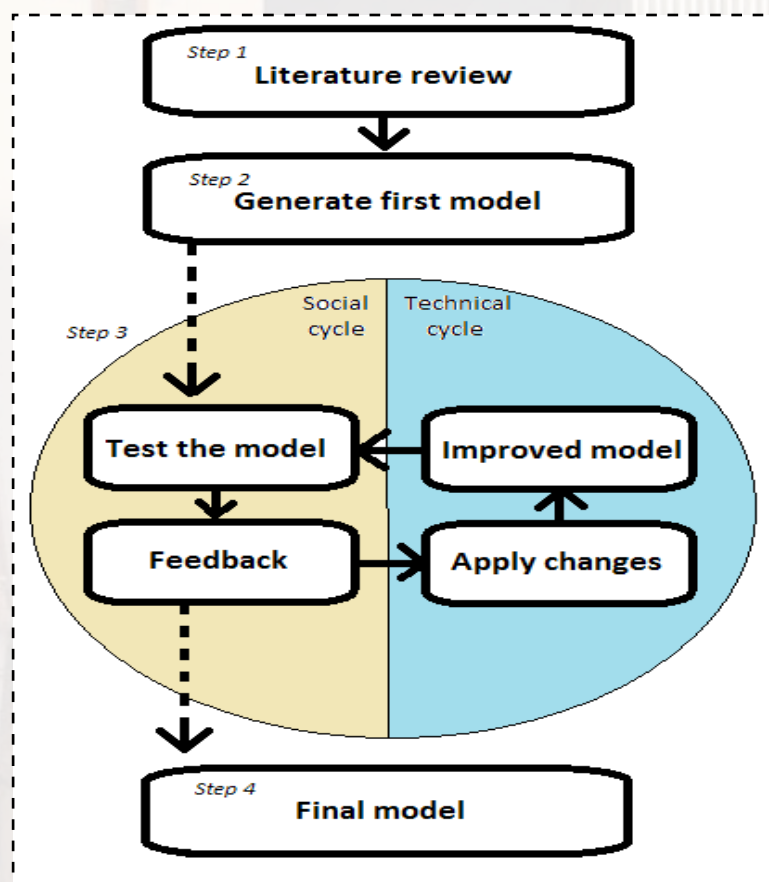


Figure 1.1: conceptual model of the research project process

1.3 CLIENT STATEMENT

To make the real estate demands related to the new ways of working more clear, a client statement will include objectives, constraints and functions which are requested by the clients. These are the clients' requirements. In this case, the clients are all the involved stakeholders in an organization related to the new accommodation plan. The method of defining the client statement in this way is based on Dym, Little & Orwin (2014).

Objectives, constraints and functions stated here are based on theoretical studies and results of a few cases, and are aimed at the outcome of this particular research. When the client for a specific project is clearly defined, the statement can change because the implementation of the new ways of working will be different for every organization. The objectives, constraints and functions are partly based on Skinner (2011) and FNV Bondgenoten (2014).

OBJECTIVES

The objectives within a client statement describe what the end product should be like. They are goals which should be achieved to the greatest extent possible. Related to these goals, are variables which therefore must be either maximized or minimized. Examples of goals are:

1. *The first objective is to create an efficient working environment. This means that the amount of workstations within the building should be maximized, resulting into more places for employees to work.*
2. *The second objective is to create an optimal working environment experience. Various psychological variables like openness, personal preference or quality should be maximized.*
3. *The third objective is to minimize the costs of real estate. This means that several costs variables should be minimized, like realization or operating costs.*

CONSTRAINTS

For solving the stated problem, constraints also exist. Constraints have to be taken serious because they do have a major influence on possible solutions. They are requirement that describe what the end product at least must be. Related to constraints are values of variables which may not be violated. Examples of constraints are:

1. *The first constraint is to comply to the minimal demands of the building regulations and health and safety regulations. If this is not the case, then they model as a whole cannot be considered feasible.*
2. *The second constraint is availability of resources for changing an office location. This means that the variables related to resources have a maximum (limit) which is fixed.*
3. *The third constraint relates to the current fixed aspects of the office building. Certain variables, like size, location and fixed construction elements like elevators, cannot be changed and therefore also a constraint.*

FUNCTIONS

This section will describe some of the functionality fitting the problem statement. In other words, what must be the functions of the real estate within an organization. Functions and objective are sometimes mistaken for each other, but functions specifically tries to describe the requirements which are needed to work towards some of the objectives (Dym et al., 2014). The functions in a client statement describe what the end product should be doing. Examples of functions are:

1. *The first function within the (new) office of an organization is to support the general working activities, and provide facilities related to office life (like toilets, coffee machines etc.)*
2. *The second function within the new office is to support a certain level of variance in working desks, where the employee has more choice about his direct environment.*
3. *The third function within the new office is to support varying occupation situations, where the office can still be efficient when many employees are present and when many employees are working from other locations.*
4. *The fourth function within the new office is to support the increasing demand of digital facilities, because the new ways of working make use of many web-based services.*
5. *The fifth function within the office is to provide sufficient parking space, interior climate, internal accessibility and so on.*

1.4 SCIENTIFIC CONTEXT

In this chapter, the scientific domains of the study are described and linked together. These are Design and Decision Systems and Real Estate Management. Before this, the research structure of the project itself will be elaborated.

To place the research project itself into a more scientific context, this study takes the form of an operations research project. In an empirical research project, the main question is based on studying an existing situation and concluding the findings, while in an operations research project, new models are created in order to provide new solutions for existing problems.

The method of operations research includes controlling 'organized systems' to achieve best possible solutions. The systems mean in this case various (managerial) approaches and choices within an organization (Churchman, Ackoff, & Arnoff, 1967). The five stages of operations research, which are also present in the study design, are:

- *Formulating the problem (study design step 1)*
- *Constructing the model (study design step 2)*
- *Deriving a solution (study design step 2)*
- *Testing the model and evaluating the solution (study design step 3)*
- *Implementing and maintaining the solution (study design step 4)*

For operations research, a simulation is essential. However, these simulations can often not be performed on the total system of an organization, due to for example risk failure. Therefore, a representation of these systems and its operations have to be made, which is the essence of a model. In operations research, a model take the form of equations, where the following is leading: $U = f(X_i, Y_j)$

PART 1: RESEARCH STRUCTURE.

In a research, U stands for the utility or the systems performance. X and Y are both the variables which influence U, where X variables can be controlled, and Y variables cannot be controlled. The function f is the relationship between U, X and Y, and can consist of computational or mathematical rules. The model allows for searching for the best solutions (highest U), by changing X variables (which could in turn influence Y variables). In essence, solving the research problem of an operations research is done by using mathematics to find the best values of the controlled variables. This is called the optimal solution.

The reason that OR fits this research project the best, is because in the project, also the search exists for the optimal solution. In this case, U should be the “best adjustment” from the research question. As said before, this outcome will be a combination of provided main objectives, making it a multi-criteria problem. X and Y are in this case the various variables related to all objectives, constraints and functions. At the end, the solution of the problem U will therefore be a function of the values of all variables involved, which can also influence each other. The main formula can be connected to the client statement:

U = Solution optimized for client objectives

X_i = Client functions

Y_i = Client constraints

The search for an optimal solution relates to the domain of decision making systems, but also to the domain of real estate management. Within decision making systems, all variables are translated into a (computer) model in order to set an objective function to be optimized. This objective function is the same as the optimization of U, and the variables are based on utility theory, where utility means value in relation to U.

Real estate management provides and describes theories about added value. The alignment of real estate with the demands of the stakeholders, in which the U is a goal that relates to these demands, should provide this added value. Added value of real estate is key for both scientific domains, and therefore connects them together. In the literature study on real estate management of part 2 of the report, the demands of the main stakeholders are described more in detail, and are translated into criteria for the operations research model.

1.5 RESEARCH ORGANIZATION

This chapter states some organizational information about the research process, including a short definition of the scientific domains and mentors, and a rough planning. The scientific domains that relate to the study are:

1. *Design and Decision Systems: a computer model will support the decision making process of the research problem.*
2. *Real Estate Management: the problem concerns the reorganization of an organizations real estate*

It is also of importance to choose the mentors who are able to assist on the matter of changing real estate demands and using computer modeling to find solutions. For this study the following mentors have been chosen:

1. *Dr. Ir. Ruud Binnekamp*
2. *Dr. Ir. Theo van der Voordt*



PART 2

REAL ESTATE MANAGEMENT.

- 2.1 - Introduction
- 2.2 - Designing an accommodation strategy
- 2.3 - Background of new ways of working
- 2.4 - Origins of the demands
- 2.5 - Stakeholders and criteria
- 2.6 - Existing models

2.1 INTRODUCTION

The domain of real estate management relates to the added value that real estate has. With the new ways of working, new client objectives and constraints came to existence. In order for real estate to be able to add value to an organization, supporting the new ways of working have to be implemented in the real estate objects itself.

The DAS-framework provides a method for changing real estate of an organization, to support future demand. For the tool to be created with this research, it is also important to determine the future demand, as input to create an accommodation plan.

To further understand the future demand, a closer examination of the new ways of working and origins of stakeholder demands is required. More specific, the real estate related concepts of the new ways of working must be studied to determine the constraints and elements for the model to work with.

Another part of the study of real estate management, is the examination of existing models. Both the HK and PACT model are studied to validate the problem statement and research question.

2.2 DESIGNING AN ACCOMMODATION STRATEGY

In order to guide the process of adjusting the supply for the new real estate demands, a framework can be used which has been prepared for the accommodation strategy design process (De Jonge et al., 2009). This framework is called the DAS framework, and is based on a matrix where demand and supply, and current and future are set out against each other.

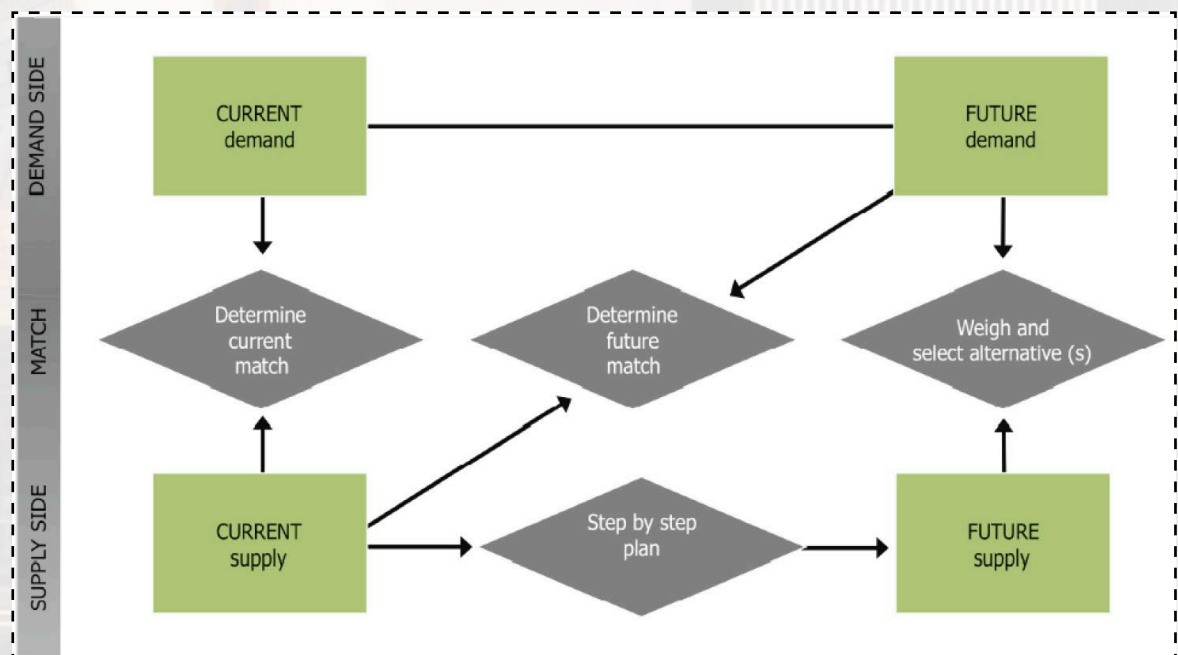


Figure 2.1: DAS-frame (source: De Jonge et al. (2009))

PART 2: REAL ESTATE MANAGEMENT.

Within this framework, there are four main steering events which can guide the process. De Jonge et. al. (2009) summarize these events as follows:

- *“What we need now” vs. “what we have now”*: This is the step where the match or mismatch between the current demand and the current supply is determined.
- *“What we need in the future” vs. “what we have now”*: This is the step where the match and mismatch between the future demand and the current supply is determined.
- *“Alternatives of what we could have”*: This is the step where solutions for both mismatches are designed, evaluated and selected.
- *“Step-by-step plan”*: This is the step where an implementation plan of the chosen solution is designed.

The first two steps are primarily the result of literature study, while the field tests of the model later on will reveal more and better detailed demands. The third step, which is to generate alternatives, can be executed using the model, where the input comes from the previous two steps. Finally, the step-by-step plan of implementing the solution is the next step within the process, and the results of the model can be used as input to construct that plan. This means that the constructed model offers a method to clearly execute the third step of the DAS-frame

2.3 BACKGROUND OF NEW WAYS OF WORKING

In order to address the potential problems created by the new ways of working, first a better understanding on the subject itself is required. This chapter will take into account different sources which try to explain or describe the contents and processes concerning the new ways of working, and brings them together as a background overview.

WHAT IS ‘THE NEW WAYS OF WORKING’?

One way to describe the elements of the new ways of working, is to look at the work of Bijl (2007), who is one of the authors in the Netherlands that did research on the subject. Bijl states that the main aspect of the new ways of working are renewal (or updating) of the physical working environment, the organization structure and culture, the management style and the mentality of both employee and employer. Being more specific, this includes the usage of new technology, experimenting with new ways of working together, less hierarchical leadership, more personal responsibility and more room for creativity.

According to Bentvelzen (2012), the new ways of working is a collection of many initiatives concerning the office environment. As a key factor, these initiatives are aimed at innovating the way work is organized, to fully make use of talents. The general result of these initiatives on real estate is the need of less office space than was needed for traditional ways of working, and the demands for office space that is needed are changing.



PART 2: REAL ESTATE MANAGEMENT.

One of the reasons that less office space is needed, is because employees are getting more freedom in choosing their work environment (Van Dinteren, 2010), which has resulted in many people working at home. Van Dinteren (2011) states that in 2010, 32% of employees was working from home, for either long-term or short-term. The freedom to be able to do this is created by the increase in digital connectivity facilities (Van Dinteren: "telewerkfaciliteiten").

Many aspects stated by Bijl (2007) however, remain rather vague. What this means is that there are no definitions for, for example, the most suitable office floor plan layout, the most fitting management set up or the most desired organization culture. Because of the lack of definition, there also is no standard of implementation of the (new) office elements. New ways of working will differ for each company and only the underlying abstract idea remains the same.

WHY IMPLEMENT 'THE NEW WAYS OF WORKING'?

Following the broad description of the new ways of working that was is given, the question that rises is: why do we want to implement this? Multiple answers exist for this question, relating to both the employee and employer.

The most promoted idea behind implementing the new ways of working relates to the desires and demands of the employee, which has become an important aspect organizations wants to listen to. Reason for this is that the pressure on the labor market had caused a shift from the employee to the employer being the 'asking' party in the previous years (Van der Krabben & Van Dinteren, 2011). While this might or might not be the case anymore, still organizations consider it beneficial to listen to their employees. Combined with a changing culture this means employees will (want to) have more to say about organizational subjects, like working time and location. For many people, working at home is a fitting solution for saving traveling time and combining work with their personal lives.

Besides the benefits for the employee, the new ways of working also offer advantages for the employers. The most important one is that costs can greatly be reduced (Baane, Houtkamp, & Knotter, 2011). Because employees are less present, electricity and other operating costs will also drop. Besides that, the new demand for less space in general could lead to a relocation where less office space is taken in the contract. Also other costs related to having employees present are decreased (e.g. coffee machines). Some of these additional costs however now are for the account of the employees themselves.



2.4 ORIGINS OF THE DEMANDS

The constraints for the model to be created, are based on the demands set by the involved stakeholders. It is important to gain a better knowledge concerning how the demands have been created or altered by the New Ways of Working, in order to understand the reason for implementation, or to think of alternative implementations. Although it is not possible to state detailed demands based on literature, since this is situation dependent, there are authors who wrote about the demands in general.

Van Dinteren (2010) states “flexibility” as keyword for the important new demands. Flexibility relates to the working time, working location and working organization. In current times it is made possible to change these aspects because of the increasing possibilities of information and communication services (Van Dinteren, 2010). While employers benefit from employees altering their working location, due to savings in housing costs, also employees want it because of the created “freedom”.

New ways of working	Old ways of working
- <i>Independant</i>	- <i>Assignments from “higher up”</i>
- <i>Freedom</i>	- <i>Monitoring presence</i>
- <i>Responsibility for employee</i>	- <i>Responsibility for employer</i>
- <i>Trust in employee</i>	- <i>No trust, leading to rules / prescriptions</i>
- <i>Output focussed</i>	- <i>Input focussed</i>
- <i>Working where wanted</i>	- <i>Working in an office building</i>
- <i>Working when wanted</i>	- <i>Working for 9 to 5</i>
- <i>Separation work / private life fades</i>	- <i>Strict separation work / private life</i>

Figure 2.2: Difference new and old ways of working, translation of Van Dinteren (2010)

Flexibility also includes increasing the efficiency of the real estate by combining functions (Willemsen & Bruins, 2013). Besides combining functions, the New Ways of Working is also causing a shift in the use of the office building, and thus the actual required functions. Offices have to be set up more as a meeting location, where meetings, working together, receiving guests and being able to use specific facilities are the most important functions (Pomp, Klapwijk, Haverkamp, & Smit, 2012). This indicates that the ratio between basic workstations and meeting and conference facilities is changing. Since the New Ways of Working includes working from home and other locations, the total footprint demand of office buildings is decreasing, while the specific area demand of meeting and conference facilities is not, which proves the above changing ratio (De Bruyne & Gosselink, 2011).

As for the interior of offices, an important demand is the change towards uniformity (Willemsen & Bruins, 2013). This also includes changing the structure of long hallways with closed office on both sides toward open spaces, which will benefit collaboration greatly (Pomp et al., 2012). Greater collaboration will lead to an increased productivity and creativity, which in turn will lead to better company results (Van Dinteren, 2007).

2.5 STAKEHOLDERS AND CRITERIA

Criteria are used by stakeholders to determine their preference for a solution. Since this research project also contains this preference measurement, it is important to understand how criteria are formed for stakeholders. Before criteria themselves can be stated, a division of important stakeholders is needed in order to relate the criteria to a main objective. The division of stakeholders is based on the research of Den Heijer & De Vries (2004), who have defined four major types. These stakeholders have their own general interests, which will be linked to goals originating from the six perspectives defined by Bradley (2002) in figure 2.3.

Stakeholder	General interest	Goals (Bradley, 2002)
Policy maker	Achiving the goals of the company	- Organizational development - Environmental responsibility
Controller	Increasing the value of real estate and reducing costs	- Financial health - Cost efficiency
User	Increasing flexibility, functioning and satisfaction.	- Stakeholder perception
Technical manager	Increasing non-core service and productivity.	- Productivity

Figure 2.3: Relating stakholder interests to goals (source: Riratanaphong (2014))

In Riratanaphong (2014) a number of KPIs (key performance indicators) originating from various sources, are also clustered in the six main perspectives defined by Bradley (2002). Within the perspectives, Riratanaphong (2014) describes ways to add value based on a large literature review. These added values are linked to performance measures or operating decisions, describing the methods to reach the added value.

Since the computer model will need measurable variables, a list of proposed criteria based on the performance measures is added. These proposed criteria can be implemented as constraints, or preference measurement rating criteria, and it is there important to note that they also define the solution space. The tables below provides a theoretical view based on the KPIs of Riratanaphong (2014).

Stakeholder: Policy maker			
Main goal	Added value	Performance measure	Proposed criteria
Organizational development	Quality of facilities	- physical condition of facilities - Suitability of premises and functional environment - Building quality audits	1. Physical condition rank 2. Suitability rating 3. Functionality rating 4. Number of quality audits
	Accomodation usage	- Square meters per employee (accupancy) - Effective utilization of space	1. Amount of m2 / empl. 2. Vacancy rates 3. Functionality rating
	CRE unit quality	- Over time in projects - Over budget in projects	1. % of exceeding of time 2. % of exceeding of budget
Environmental responsibility	Resource use	- Energy consumption	1. Total energy consumption per year
	Waste	- Amount of garbage	1. Total m3 garbage per year

PART 2: REAL ESTATE MANAGEMENT.

Stakeholder: Controller			
Main goal	Added value	Performance measure	Proposed criteria
Financial health	Value of property, plant and equipment	<ul style="list-style-type: none"> - Business return on RE assets - RE return on investment - RE return on equity - Revenue per square meter - Space per unit of revenue - Return on prop. management 	<ol style="list-style-type: none"> 1. Return on RE 2. Return on investment 3. Return on equity 4. Revenue per m2 5. m2 per revenue 6. Return on management
Cost efficiency	Occupancy costs	<ul style="list-style-type: none"> - Occupancy costs / employee - OC as % of total operate costs - OC as % of operating revenue 	<ol style="list-style-type: none"> 1. Occupancy costs / empl. 2. % Occupancy costs of total cost and income
	Operating costs	<ul style="list-style-type: none"> - Total Op. costs vs budget - Facility management costs 	<ol style="list-style-type: none"> 1. Exceeding of budget 2. % FM of total costs

Stakeholder: User			
Main goal	Added value	Performance measure	Proposed criteria
Stakeholder perception	Employee satisfaction with work and environment	<ul style="list-style-type: none"> - Quality of indoor environment - Safe environment - Location success factors - Ratio common space vs office - Amenities - Workplace reforming 	<ol style="list-style-type: none"> 1. Indoor env quality rating 2. Env safety rating 3. # of success factors 4. Ratio common / office 5. Number of amenities 6. Number of reforms
	Employee satisfaction with CRE services	<ul style="list-style-type: none"> - Allow employees to develop professional skills - Information sharing system 	<ol style="list-style-type: none"> 1. Number of professional employees 2. Rating information sys.
	Customer satisfaction with facilities	<ul style="list-style-type: none"> - Perform surveys - Listening to complaints - Minimize call freqs - Add location success factors 	<ol style="list-style-type: none"> 1. Rating of surveys 2. Number of complaints 3. Costs of help desk 4. # of success factors
	Community and well-being	<ul style="list-style-type: none"> - Contribute to society 	<ol style="list-style-type: none"> 1. Rating of contribution

Stakeholder: Technical manager			
Main goal	Added value	Performance measure	Proposed criteria
Productivity	Employee productivity	<ul style="list-style-type: none"> - Productivity - Absentee rates 	<ol style="list-style-type: none"> 1. Time to complete project 2. Cost to complete project 3. Rates of absentee
	Strategic involvement	<ul style="list-style-type: none"> - CRE involved in strategic plan - CRE involved in HR - CRE involved in initiatives 	<ol style="list-style-type: none"> 1. % involvement in SP 2. % involvement in HR 3. % involvement in initi.

Figure 2.4: Relating stakeholder goals to KPI and criteria, based on Riratanaphong (2014))

2.6 EXISTING MODELS

The research question of this study states that there is no tool available for organizations that simultaneously takes into account feasibility and desirability. However, other tools do exist to supporting organizations in choosing an accommodation plan. For this research, two important tools are studied more in detail, to be able to compare them to the final product in a later phase. The tools are called the HK model and the PACT model.

HK - MODEL

The HK model (Huisvestingskeuzemodel) is a process oriented model which returns the best possible conceptual choices based on the goals of an organization (Ikiz-Koppejan et al., 2009). The model takes a qualitative approach, but is placed within a cyclic process, meaning that goals or intentions are also subject for change.

The main focus of the HK model is the desirability of the solutions for the involved stakeholders, which is similar to the goal of the model that is created for this research. However, since the model only has a qualitative approach, it fails to determine the feasibility of the solutions, for both stakeholder constraints and real estate object constraints.

The way in which the HK model used (qualitative) empiric data of an organization, and is places within a cyclic process, can be of great value for the model to be created.

PACT - MODEL

The PACT model (Plekken en ACTiviteiten) is used as a calculation tool to return the optimized implementation of workstations, regarding number, types and orientation (De Bruyne & Gosselink, 2011). This model takes a quantitative approach, and requires input about the organization (like f.t.e., activities, flex factor).

The main focus of the PACT model is to create a solution of office interior elements, for the specified activity profile. Just like the HK model, it fails to determine the feasibility within the real estate object. Furthermore, the PACT model does not include any form of preference measurement, and can only be used as a calculation tool for the optimal workstation composition.

What the PACT model can do as a calculation tool, however, is valuable for this research project, since the model to be created also has to include the translation of an activity profile to a workstation composition.

PART 3

OPERATIONS RESEARCH.

- 3.1 - Introduction
- 3.2 - Linear programming
- 3.3 - Desirability

3.1 INTRODUCTION

Methods of operations research are used for the construction of the model. The model to be created has to fulfill 2 tasks: 1) the determination of the feasibility, and 2) the determination of the desirability. Therefore, also 2 modeling techniques are used.

Linear programming can be used to determine whether an accommodation plan is feasible, given the constraints of the stakeholders and the real estate object properties. Within a feasible solution space, optimized solutions for specified objective functions are generated, where the objective functions represent the stakeholder goals (1 goal for each objective function).

To determine the desirability of the alternative optimized solutions, the technique of preference measurement is used. This technique requires stakeholders to define criteria and attach weights to them, and to rate the alternatives for those criteria in order to find the overall most preferred solution.

3.2 LINEAR PROGRAMMING

More formally, linear programming is a method to achieve the best outcome in a mathematical model, whose requirements are represented by linear relationships between decision variables. In more detail, LP is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. For the description of the general mathematical model of LP, the following form is used based on Binnekamp et al. (2006):

$$\text{Maximize } Z = c_1x_1 + c_2x_2 + \dots + c_nx_n$$

Subject to the restrictions:

$$\begin{aligned} a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n &\leq b_1 \\ a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n &\leq b_2 \text{ etc.} \end{aligned}$$

and

$$x_1 \geq 0, x_2 \geq 0, \dots, x_n \geq 0$$

Linear programming is a method which contains four main elements (Barendse, Binnekamp, De Graaf, Van Gunsteren, & van Loon, 2012). If executed within a spreadsheet, the elements can easily be identified, as seen in the figures (3.1 & 3.3) below. Furthermore, the elements have a relation with each other, and this can best be shown in a graph, since its mathematical characteristics. The elements are:

- Constraints: they define the solution space
- Solution space: defined by the constraints, it contains all possible solutions and thereby defines feasibility
- Objective function: used to find the optimal solution within the solution space
- Solution: a point within the solution space, optimized for the objective function

	A	B	C	D	E	F	G
1	Endogenous variables	var1	var2	...	varn		
2	Outcome	x_1	x_2	...	x_n		
3							
4	Objective Function	c_1	c_2	...	c_n		Z
5							
6	Constraint 1	a_{11}	a_{12}	...	a_{1n}	\leq	b_1
7	Constraint 2	a_{21}	a_{22}	...	a_{2n}	\leq	b_2
8	
9	Constraint m	a_{m1}	a_{m2}	...	a_{mn}	\leq	b_m

Figure 3.1: Framework of LP
(Source: Binnekamp et al. (2006))

PART 3: OPERATIONS RESEARCH.

To illustrate more clearly, within the graph of figure 3.2, the constraints are related to the decision variables represented on the X- and Y-axis. The solution space, if non-empty, is defined by the constraints. This means that all solutions within the solution space are feasible given the constraints. The objective function in this example is related to variable 1, and can move to either minimize (left) or maximize (right) the value of that variable. In the graph, some optimal solutions are shown, based on the minimum or maximum value that the variables can meet. Note that all other point within the solution space (blue shaded area in figure 3.2) also represents a solution, but they are not optimized for the variables 1 or 2.

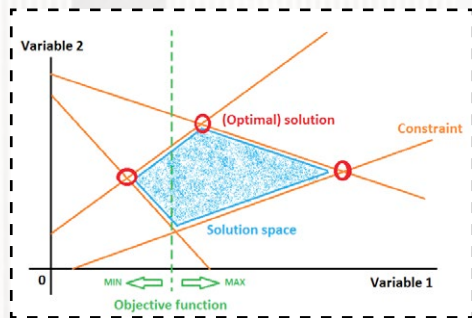


Figure 3.2: Graphical demonstration of linear programming

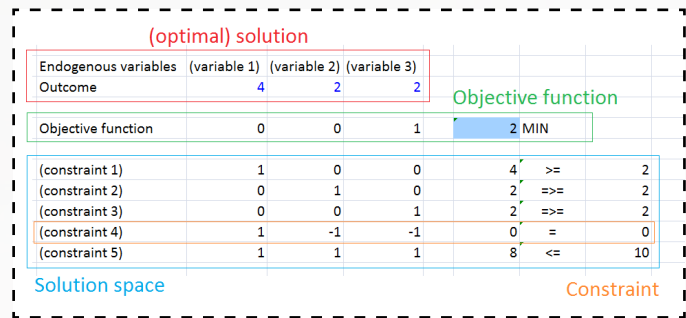


Figure 3.3: Linear programming in a spreadsheet

An effective way to utilize linear programming modeling, is using the What's Best! add-in for Microsoft Excel, created by Lindo Systems (Binnekamp et al., 2006). What's Best! requires the set up shown in figure 3.3, after which Adjustable cells and the Best cell must be defined (corresponding with the X cells and the Z cell in figure 3.1). Furthermore using the inequalities, the relation between the A variables and the B variables can be defined. This structure will form the basis of the research study.

EMPIRICAL INTEGRATION

An important step when doing an operations research project, is the construction of a model. Different kinds of models exist, but in this case a mathematical model is meant. Mathematical modeling is the representation of an empiric system (the real world) into a mathematical system. The following steps are carried out during the OR project:

1. Formulating the problem.
2. Constructing the model.
3. Deriving a solution.
4. Testing the model and evaluating the solution.
5. Implementing and maintaining the solution.

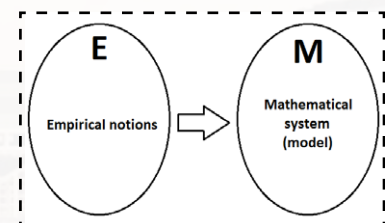


Figure 3.4: Relating empirical notions to a system

The first four steps require empiric notions to be connected to a model or mathematical system (figure 3.4). This gives meaning to the mathematical elements that are used within a model, and defines the functionality of the model as a whole.

Based on the background information of the problem statement, and the research question, the following notions are connected to this theoretical framework:

- Constraints: building properties (example: size of floors in m²) and the demands of the stakeholders (example: minimum amount of workstations on a floor) for the design, these must first be quantified to be object variables.
- Solution space: the design space, defined by the constraints.
- Objective function: the dominant design criterion (example: lowest realization costs).
- Solution: a design.

Based on these notions, the difference between the input and output of the model should be clarified. Where the input is defined by the demands of the stakeholders, also known as a program of requirements, the output will be a feasible and optimized design. Because it might be difficult to understand how a spreadsheet calculation model delivers a design, an example is given to showcase the method. In this example, a very basic set-up is chosen which does not represent any value of the actual research project. See appendix II for the example. Furthermore, the structure of LP can be related to the client statement, similar to the way that the main formula of OR is related (see chapter scientific context in part 1 of the report).

Client statement	OR ($U = f (X_i, Y_j)$)	LP structure
Objectives	Optimization of U	Objective function
Constraints	Y_j	Constraints
Functions	X_i	Endogenous variables

Figure 3.5: Relating client statement to operations research and linear programming

3.3 DESIRABILITY

An important feature of LP models is that there can be only one objective function, which means it is only suited for single criterion optimization. For multi-criteria optimization, the constraint method can be used within a LP model (Binnekamp et al., 2006). With the constraint method, the optimized value of a model outcome is implemented as a constraint for that model, when changing the objective function. This method helps to find feasible solutions while optimized for multiple criteria, but fails to help selecting the most preferred solution. This introduces preference measurement.

By use of preference measurement, the designs generated with different dominant design criteria will be tested and rated by the stakeholders who have other goals. By doing this, the most desirable design can be determined, because it was given the highest overall preference rating. The following procedure is used for the method of preference measurement (Binnekamp, 2010):

1. Specify the alternatives
2. Specify the decision maker's criteria tree
3. Rate the decision maker's preferences for each alternative against each leaf criterion
4. To each leaf criterion assign the decision maker's weight
5. Use an algorithm to yield an overall preference scale

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In this case, the alternatives are the different solutions that have been generated. Since each stakeholder has different objectives, also the criteria for rating these alternatives differ per stakeholder. When all stakeholders have rated all alternatives, the alternative with the highest overall preference rating can be found, which is the most desirable solution.

The stakeholders rating the designs means that the scale first need to be determined. Determining a scale can only be done by connecting at least 2 numbers to empirical notions. For this preference measurement method, this means connecting the number 0 to the design which fits the stakeholder goals the least, and the number 100 to the design which fits the stakeholder goals the most. The number 100 will therefore always be given to the design which has been optimized for the dominant design criterion of that specific stakeholder. For a clear illustration of this method, the example of appendix II is elaborated upon. It is important to realize that a design that receives a 0, is still an allowed design. This technique is based on the former research of Barzilai (2010) and Binnekamp (2010).

PROCESS ORIENTATION

The previous steps show how the LP model combined with preference measurement can be a decision making tool for the design as a product. However, the model will also be process orientated and to understand this, the 5 mains steps of operations research, stated in the chapter of the scientific context, have been put in a cyclic figure as shown in figure 3.6.

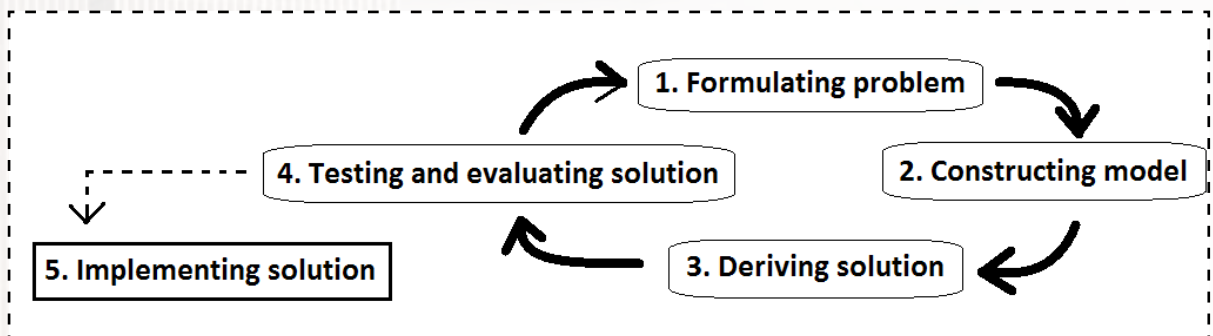


Figure 3.6: Cyclic nature of the model, based on the 5 operations research steps

What this figure illustrates is that after step 4, when the testing and evaluating of the solution results into a solution that is not what the organization or stakeholders want, the model will return to step 1. From here, the problem might be formulated differently, or the model (containing the constraints) might be constructed differently. The process orientation exists because if step 4 results into reformulating the problem, this might also influence the goals and criteria of the stakeholders themselves.



PART 4

CASE DESCRIPTION.

- 4.1 - Introduction
- 4.2 - Impressions
- 4.3 - HNW 010
- 4.4 - Office interior elements
- 4.5 - Demands of the stakeholders
- 4.6 - Case design documents

4.1 INTRODUCTION

The model that will be created during the study will be validated by using a case for the input and evaluating the output. The case that has been chosen, belongs to the municipality of Rotterdam and was carried out over the years 2011 - 2015 (Municipality of Rotterdam, 2012). The execution of the business case led to the rehousing of office based public servants of the city from 27 different locations, to 4 locations, while at the same time implementing the New Ways of Working at those 4 locations.

Implementing the new ways of working for the municipality meant that workplaces had to be standardized, to enable flexible working locations. Several standard interior elements were chosen, support the various profiles of the employee.

The main goal of the business case was to cut accommodation costs by $\square 25,000,000$ each year, which will be realized starting from year 2018 (this is the year where the costs for the actual case have been recovered by the initial savings as a result of the project). This main goal is no part of the goal of this study, since the rehousing itself has accomplished this. Instead, the goal of this study is to create an optimal accommodation plan for the stakeholders to support the business case. The 4 buildings that were chosen to house all office based public servants of the city, are called:

- Het Stadhuis
- Het kantoor aan de Librijesteeg
- De Rotterdam
- Het Stadskantoor

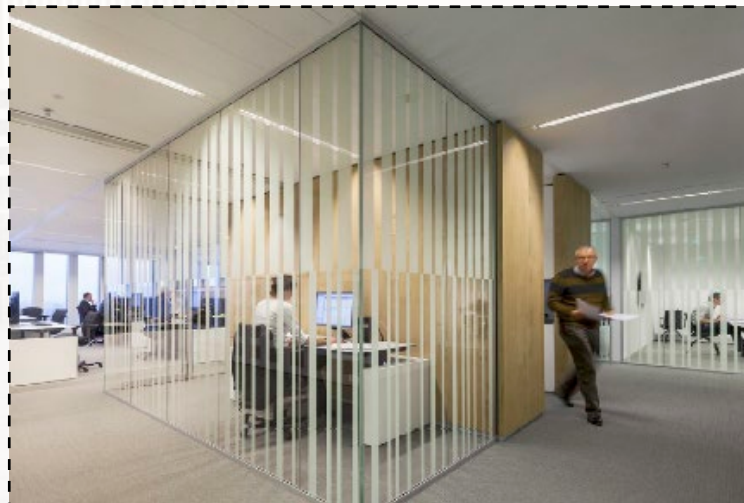
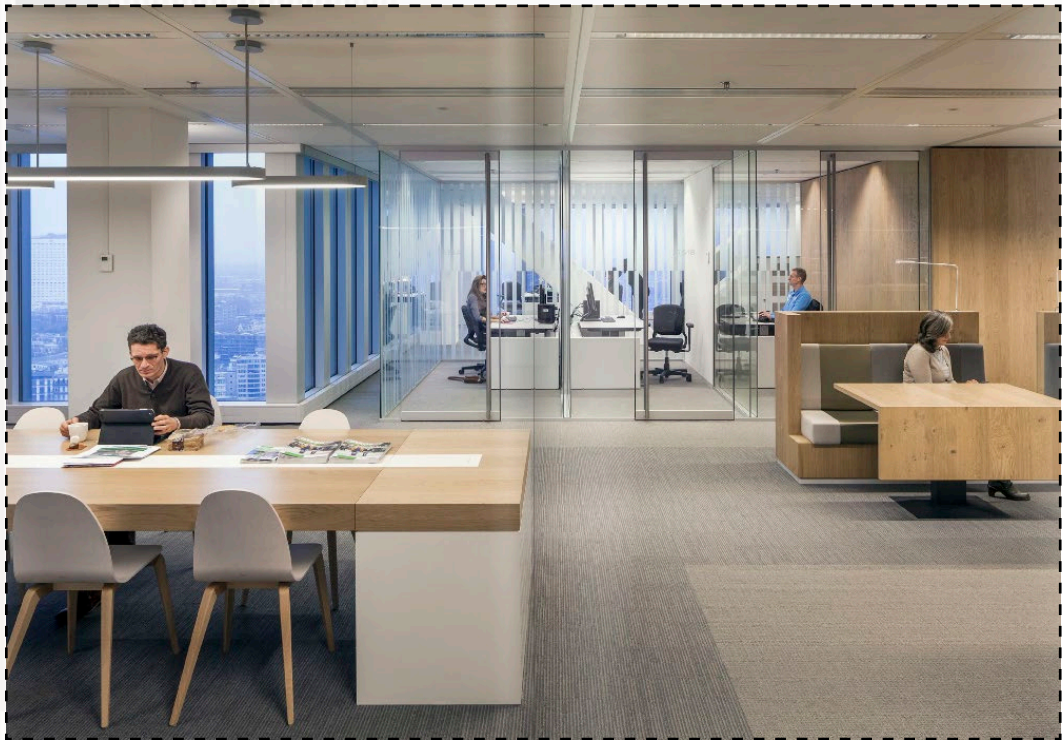
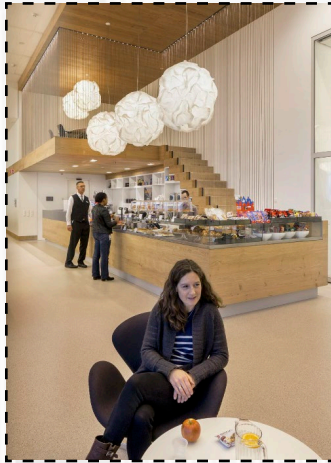
This research only focuses on the case of the building “De Rotterdam”, seen on the top image below. Before the project, the municipality did not own this building, meaning that it is both a rehousing project, and an implementation of new ways of working. By using the same constraints and objectives of the municipality as they did in the real situation, the choices regarding the interior of “De Rotterdam” can be evaluated.

The building consists of 34 floors, starting at floor 7 to floor 40 (Municipality of Rotterdam, 2014). Each floor is approximately 1.300 m², and some elements are already fixed. Besides those elements, the floor plan is very flexible. In total, the office space rented by the municipality is around 41.000m², and the number of workstations implemented at this location is 2.300.



PART 4: CASE DESCRIPTION.

4.2 IMPRESSIONS



4.3 HNW 010

The municipality of Rotterdam has taken the underlying ideas of the New Ways of Working, and adjusted them to fit the organization. These adjustments have been given the name “HNW010” (Bouman - Vermeulen, 2013; Municipality of Rotterdam, 2013). Within HNW010, six main statements are defined which state the focus of the municipality.

1. The first statement is that the public servant will work on the location where the city needs them. This means that not all work can be done at home, or at the same office building all the time. Within the city, the municipality has various office locations. In order to support this statement, all locations are accessible, and available to perform office work for all public servants.
2. The second statement is that the public servant has the control over their own development, accomplishments and results. What this means is that the control by the management will be minimized, and the work will be evaluated based on the results, and not on the presence at the office. The municipality promotes addressing promises which are not kept, in order to create a sense of responsibility. The statement also includes that notable increased efficiency and effectively by the employee should be rewarded, which could be done financially.
3. The third statement is that the public servant should always be attainable. The reason that this is important relates to the first statement, where the public servant can choose to work at various locations. Attainable means that the knowledge and networks of each public servant can be easily shared with colleagues. The municipality also states the importance of update social media profiles, with the emphasis on LinkedIn.
4. The fourth statement is that the public servant always has the knowledge, or access to the information which is needed for his own job. The challenge here is the search for the most effective and efficient way to realize this accessibility of information. Thinking “out-of-the-box” should be stimulated, and evaluating choices of the structure of the work is promoted.
5. The fifth statement is that the public servant should take responsibility for his own actions, and for this will be rewarded with trust. It is believed that trust will stimulate collaboration, which in turn increases the efficiency of the whole organization.
6. The final statement is that the talent of the individual, meaning the value of their accomplishes work, will be reflected in the value of the individual employee. What this means is that the employee should be rewarded based on their accomplishments within the organization.

Besides these six statements, HNW010 also defines the five different profiles of employees of the municipality. These are: (service based) front office, back office, “knowledge worker”, manager and executive staff (Bouman - Vermeulen, 2013). For a study focussed on the real estate of the organization, not all above information will be useful. However, the fact that all employees have the choice of working at each office location, means that each building must be fit for all office based departments. Furthermore, in order for the public servant to be able to easily share knowledge, the IT systems of the buildings must be well supported within the plan. Finally, it is important to keep the different profiles in mind, since they may demand different work environments.

4.4 OFFICE INTERIOR ELEMENTS

For the business case in Rotterdam, the municipality has a document containing standard office interior elements. Since every organization is different, including other municipalities, also the elements which are used are slightly different. It could be of interest later to compare this specific document with the standard office elements in the previous chapters. This chapter will elaborate on the various “building blocks” of which an Rotterdam municipal office building must consist (Gosselink & Smeets, 2011).

The chosen elements are based on the specific housing goals of the organization (Gosselink & Smeets, 2011). In short, these goals are:

- Optimizing the support of the office work
- Flexibility which enables better coping with future developments of Rotterdam
- Ecological sustainability
- Structural savings on housing costs
- Being an “attractive” employer
- Supporting cultural changes

First of all, regarding the amount of working spots, the municipality has decided a norm of 0.8 spots per Full-Time Equivalent. The range for this norm is 0.7 until 0.9, which is dependant of the status and measurements of the specific building. The different types of spots will be determined based on the activity profiles.

The buildings also exists of four defined security zones. Zone 1 is publicly accessible, zone 2 is accessible while under guidance of an employee, zone 3 is accessible for employees only and zone 4 for authorized employees only. Working spots will mainly be situated in zones 3 and 4.

CASE SPECIFIC ACTIVITIES

Just like in the chapter Standard office interior elements, the municipality also divided the activities into the groups stated below. However, since the division in activities are specific to the organization, the percentage of each activity (illustrating the overall average time spent) has changed a bit. The activities are:

1.	General deskwork:	30.1%
2.	Undisrupted deskwork:	12.9%
3.	Interactive deskwork:	14.9%
4.	Meeting 2 persons - 4 persons:	11.6%
5.	Meeting 5 persons - 8 persons:	3.6%
6.	Meeting 9 persons - 12 persons:	1.8%
7.	Meeting 13 persons - 16 persons:	0.9%
8.	Meeting more than 16 persons:	0.8%
9.	Telephone work:	7.8%
10.	Reading:	5.7%
11.	Archiving and documenting:	5.8%
12.	Other activities:	4.0%

PART 4: CASE DESCRIPTION.

WORKING AND MEETING ELEMENTS

Based on the activities, a selection is made for the elements of which the office exists. Unlike the activities of the employees, the chosen elements do differ from the standard elements which has been studied earlier. For the research, this means that while the case specific elements are leading, it could be useful to change the elements later on toward the more general concept if this positively influences the goals function. The table below shows the working and meeting spots elements used by the municipality (Gosselink & Smeets, 2011).

Description of element	m2 / spot	Equipment	m2 / element
<i>Basic office working spots</i>			
- Flexible workstation (aanlandplek)	8.5 m2	-	8.5 m2
- Open workstation	8.5 m2	-	8.5 m2
- Half open workstation	6.0 m2	-	6.0 m2
- Closed workstation	6.0 m2	-	6.0 m2
- Closed workstation for 2 persons	6.0 m2	-	12.0 m2
- Closed workstation for teams (4 persons)	6.0 m2	-	24.0 m2
- Concentration workstation	6.0 m2	-	6.0 m2
<i>Meeting based working spots</i>			
- Open meeting station 4 persons	2.1 m2	4.1 m2	12.4 m2
- Half open meeting station 4 persons	2.1 m2	4.1 m2	12.4 m2
- Closed meeting station 4 persons	2.1 m2	4.1 m2	12.4 m2
- Closed meeting station 8 persons	2.1 m2	4.1 m2	20.8 m2
- Medium conference room 12 persons	2.1 m2	4.1 m2	29.2 m2
- Large conference room 20 persons	2.1 m2	4.1 m2	46.0 m2
- Large conference room 50 persons	2.1 m2	4.1 m2	109.0 m2
- Representative boardroom	3.0 m2	6.0 m2	-

Figure 4.1: Case specific working / meeting elements (Source: Gosselink & Smeets (2011))

The next step is to determine the activity support of the various elements. The municipality has made a simplified version of this tables, where activities 4 - 8 are combined as "Meetings", and then split up into planned and unplanned meetings. The scores are based on a three-figure scale*, where 1 means that the element fully supports the activity, 2 means the element partly supports the activity, and 3 means the element does not support the activity.

Activity support	1	1	1	P. 4 - 8	UP. 4-8	1	1	1
<i>Basic office working spots</i>								
- Flexible workstation (aanlandplek)	1	3	1	3	3	2	3	1
- Open workstation	1	3	1	3	3	2	3	1
- Half open workstation	1	2	1	3	3	2	2	1
- Closed workstation	2	2	2	2	2	2	2	2
- Closed workstation for 2 persons	1	2	2	3	3	2	3	3
- Closed workstation for teams (4 persons)	2	3	1	3	3	2	2	2
- Concentration workstation	3	1	3	3	3	3	1	3
<i>Meeting based working spots</i>								
- Open meeting stations	3	3	3	2	1	3	3	3
- Other meeting stations	3	3	3	1	1	3	3	3

Figure 4.2: element support for different activities (Source: Gosselink & Smeets (2011))

* The information is not created using a correct scaling technique, but is used as provided

PART 4: CASE DESCRIPTION.

MULTIFUNCTIONAL USE

Because of the flexible set-up of the rooms, the various closed off areas can sometimes be used for other activities. This will require that the rules regarding the use of the area (e.g. allowing telephones calls, loud talking and more) to be temporary changed. Therefore, it will not be possible to house different activities at one moment in time. The following table shows which closed of areas correspond in size to other closed off areas, meaning that the activities can be changed as well.

	Concentration workstation	Closed workstation	Closed workstation 2 persons	Closed workstation 4 persons	Closed meeting station 4 persons	Closed meeting station 8 persons	Closed meeting station 12 persons	Large conference room 20 persons	Large conference room 50 persons	Representative boardroom
Concentration workstation		X	X		X					
Closed workstation	X		X		X					
Closed workstation 2 persons	X	X			X					
Closed workstation 4 persons							X			
Closed meeting station 4 persons	X	X	X							
Closed meeting station 8 persons										
Closed meeting station 12 persons				X						
Large conference room 20 persons										X
Large conference room 50 persons										
Representative boardroom								X		

Figure 4.3: multifunctional use of elements (Source: Gosselink & Smeets (2011))

FACILITIES

Besides the working, and meetings facilities, the building must also house a large number of facilities to support all activities together. For each of these facilities, different sizes, amounts and rules apply. There are 8 main categories for the facilities:

1. Distribution, forwarding and waste processing
2. IT and service
3. Medical service
4. Reception and waiting
5. Storage
6. Other areas
7. Parking
8. Restaurants

The table in appendix I includes a summarized overview of the elements which are needed for the municipality of Rotterdam. In Gosselink & Smeets (2011), a more detailed table can be found.

4.5 DEMANDS OF THE STAKEHOLDERS

Interviews with the important stakeholders of the case of the municipality of Rotterdam were conducted, when a generic model was created. These interviews were taken for three main goals.

The first goal was to find out which elements were still missing of the model. Since many values were the result of assumptions, and others were not even implemented, the interviews had to provide much general information about the case and about the methods the municipality used to anticipate on the case.

Important missing elements were accurate drawings of the building, for the size and suitability of floors. Also obtaining the actual used program of requirements, and more information about the costs of the organization, of the building and of the individual elements were part of this first goal.

The second goal of the interviews was to find out what the constraints for the design were for the different stakeholders, and being able to quantify them. These constraints will be used within the model to define the solution space. Since each stakeholder has an unique area of expertise, their constraints can also be different.

The final goal was to find out if the stakeholders did have goals for the project, based on their expertise. These goals will be used to define the objective functions for which the design will be optimized.

In total, 7 interviews were conducted with different stakeholders. The stakeholders and their area of expertise, or role in the project, were the following:

1. Jaap Donkervoort - IT services
2. Martin Knijnenburg - Asset manager
3. Peter Klaver - Facility management
4. Arie van Vliet - Project controller
5. Odette de Koning - New ways of working & users
6. Leon Wielaard - Real estate developer
7. John Smeets - Design concept en program of requirement

JAAP DONKERVOORT

Within the project of implementing the news ways of working, IT services play a major role. Flexible working locations are based on the notion that every employee will be able to working from each computer or other devices. The task of IT services is to provide a network environment which supports the mobility of the employee.

The main goal is standardization of workstations, but within the organization this is not completely possible. Certain employees require specialized computers, called fat clients, in order to use complex computer programs, like AutoCAD. In total, there are a total of 5 different computer systems, which include the standard computers and 4 types of fat clients. For financial and certificate reasons, it is not possible to provide all workstations with the most capable fat clients.

This means that IT brings restrictions to the concept of a flexible organizations, but these restrictions are not clearly defined. Besides the goal of total standardization, IT services bring no additional goals.

PART 4: CASE DESCRIPTION.

furthermore, constraints only include the financial constraint of money spent of the IT equipment. What this constraint actually is, is not clearly defined since it is subjective to the total program of requirements.

MARTIN KNIJNENBURG

As asset manager, the goal of Martin Knijnenburg is to optimize the results of the assets of the organization, within acceptable risks and costs. Within this projects, this can be expressed in operating costs of the organizations per working spot, since a municipality is not a profit based organization. Costs include many variable and fixed costs, which are based on the building and on the employees or working conditions.

Martin Knijnenburg was also able to provide more information on the restrictions of the building itself, which are also part of the constraints in the model. This information included the use of the floors, and parking garage.

No quantified constraints were present for the asset manager. This could be the result of the municipality being a public organizations. Actual constraints regarding costs of the project all were subject to the program of requirements.

An overview of fixed facility costs, and accurate drawings of the building were provided after the interview.

PETER KLAVER

As part of the facility management team for the municipality, Peter Klaver had to approve the final program of requirements for the design. The program or requirements state most constraints for the project and is therefore very useful in order to create a realistic model. Peter Klaver agreed to share this information, but states that not all requirements are quantified or specifically based on the wishes of the involved stakeholders.

An important aspect for the design included the implementation of department areas (vlekken). This means that certain parts of the building houses the secretary and specific equipment for a department. Department areas create problems for the idea of flexible working locations, since employees are sticking to the workstations closes to their departments area, and don't feel welcome near other department areas. Peter Klaver however explains that the implementation of department areas is necessary since the culture of the organization would not allow a working environment without departments yet.

Specific goals for the facility management are not present. Since the project as a whole had a cost reduction goal, a maximum budget for facility management was present.

A program of requirement for the building was provided after the interview.

PART 4: CASE DESCRIPTION.

ARIE VAN VLIET

Within the project, Arie van Vliet has the role of project controller. This means that he is responsible for the overall budget of the project. Within the municipality however, the budget usually is determined later on based on the assumptions created by the program of requirements and the design, instead of working with a fixed budget from the start.

While the constraints include the overall budget for the project, the goals for this stakeholder can be set to minimizing the costs as well. Arie van Vliet agreed to share the data on the budget for the project.

A overview for the budget of the project was provided after the interview.

ODETTE DE KONING

The role of Odette de Koning includes giving advice for the design, where the new ways of working plays a major role. Within this concept of the new ways of working, user satisfaction should play a major role. In reality however, Odette de Koning explains that user satisfaction was in no way taken into account. Wishes of the employees were not even examined, and therefore no literature exists about what these wishes were prior to the project.

Odette de Koning explains however, that these wishes were examined, the most likely outcome would have been that the employees did not want to change anything about the way they were working. This is partly due to the culture of the public servants of Rotterdam, who do not favour change. After implementing the new working environment however, different experiences exists between the employees, including many positives as well.

This illustrates that the employee might not know for themselves what they would want in a working environment, and that they might be scared of changes.

Furthermore, Odette de Koning explains that the support for the new ways of working, which includes IT services and other facilities, was very lacking during implementation. This also resulted into employees disagreement with the changing working environment. This situation however is not part of the housing question for the research, so the model will not be able to find a fitting solution for this problem.

Since the new ways of working is the expertise of Odette de Koning, her goal is to implement this as suppose to. This means that she disagrees with the implementation of department areas because the flexibility of the workstations suffers from this.

LEON WIELAARD

Working close with the architect and interior architect, Leon Wielaard had the role of real estate developer for the municipality. He was responsible for the realization project, and discussed the program of requirement with the realization parties. This program of requirements was created with the presence of responsible team members of facility management and the new ways of working team.

PART 4: CASE DESCRIPTION.

Demands of the users were implemented within this program of requirement through demand managers, who got their input from the employees en departments. Leon Wielaard did not bring any additional constraints to the program, but has the task of safeguarding the process.

The goals of the real estate developer in this case was to assure the quality that was aimed for, regarding the interior of the building. This meant that the budget for realization of the workstations must be sufficient, but also that the building offers places for artistic experimentation and exposition.

JOHN SMEETS

Working together with the centre for people and buildings, John Smeets decided the interior elements of the municipality. Also, the concept for the design which fitted with these elements was created in this stage. The elements were chosen based on the average activity profile of the employee. Only one profile was used to be able to standardise all locations, assuring flexibility for the employee.

Some jobs however specifically required special elements, including drawings tables, additional storage or better computers. The goal of John Smeets within the project was to minimize these exceptions. Furthermore, some specific non-core functions within the building also required specialized areas, which meant an exception to the standard floor layout.

In order to provide flexibility, a constraint was created that set a ratio between different interior elements, that had to be implemented on each floor. Furthermore, constraints regarding the number of workstations per floor existed due to the fire safety regulations and climate installations.

A concept of the facilities for each floor was provided, as well as a document containing questions regarding the allowed workstations per floor.

CONCLUSION INTERVIEWS

The stakeholders find it difficult to express their goals and constraints as a quantitative variable. The interviews did result in qualitative descriptions of goals, which can later be related to aspects of the program of requirements, and other documents.

Stakeholder	Goals of role	Constraints of role
IT services		- Budget on IT - Standardise workstations (IT)
Asset manager	- Minimize operating costs / WS	
Facility management		- Budget on FM
Project controller	- Minimize costs	- Overall project budget
New ways of working		- Standardise workstations
Real estate developer	- Maximize quality	
Design concept		- Ratio of workstations on floor - Standardise workstations

Figure 4.4: Summary of findings of interviews

4.5 CASE DESIGN DOCUMENTS

The documentation provided many new constraints to be added to the generic model. Analysing the documents and adjusting the model was the next step in the process, and this chapter describes the input that was used for the research. A accurate description of the constraints present in the model itself, is given in the next part of the report, the product description.

PROGRAM OF REQUIREMENTS

The program of requirements provided the main constraints for the model. These constraints are based on the project goals, which are to stimulate working together, offer a professional environments, offer fitting stations for activities and standardise as much as possible (Brinkgroep, 2012). The goals are in turn based on the concept of HNWO10, which is the way the municipality implements the new ways of working as stated in the previous chapters.

Within HNWO10, flexibility and openness are important theme's. Flexibility can be reached by offering generic floor plans, which all support the various activities. In the model, mix of functions can therefore be entered, where each element can be given a minimum and maximum percentage of presence per floor, related to all elements. "Openness" can be controlled in the same way.

Some important numbers that the program of requirements states, is the flex factor of 0.7, which means 70 workstations per 100 FTE, and that at least 86% of the stations should be approved by the health and safety regulations (ARBO conform). All generic floors also contain the following facilities (total of 490m² for low-rise and 421m² for high-rise):

- Pantry of 19m²
- Living room of 39m²
- Service unit of 9m²
- Wardrobe of 19m²
- Toilets of 13 m²
- Storage of 19m²
- Lockers of 39m²
- Waiting of 9m²
- walking area of 324m² for low-rise, 255m² for high-rise

Furthermore, besides the generic elements, the program contains some "specials". The specials are areas, for which the function and size is already defined, and which will only be implemented once or a small amount of times through the building. The specials for this project are :

Name of special	Number to implement	Size each
<i>Post office</i>	1	19 m ²
<i>Expedition room</i>	1	19 m ²
<i>Storage cleaning</i>	1	19 m ²
<i>Storage coffee vending</i>	1	19 m ²
<i>Changing room</i>	1	19 m ²
<i>Security room</i>	1	19 m ²
<i>Workplace handyman</i>	1	39 m ²
<i>Service point desk</i>	1	39 m ²

PART 4: CASE DESCRIPTION.

General storage	1	19 m ²
Restaurant	1	1104 m ²
Coffee corner	1	500 m ²
Medical	1	68 m ²
Showers	1	137 m ²
Medium conference (12p)	3	30 m ²
Large conference (20p)	4	50 m ²
Large conference (50p)	1	125 m ²

Figure 4.5: Special elements to be implemented (source: Brinkgroep (2012))

Finally, in the program of requirements a small change to the activity profile and the used elements was made. The new activity profile only consists of 7 activities, instead of the 11 conceptual activities. Because meeting general and meeting brainstorm can be done on the same elements, these will be combined for the research. For this project, the workstations together support 100% of the people in the building, and the meeting areas 10%. Reason for this is that employees in a meeting still have to have a “claim” for a workstation.

Conceptual profile		Real profile	
General deskwork	30.1 %	Individual general	59 %
Undisruptive deskwork	12.9 %	Individual concentrated	29 %
Interactive deskwork	14.9 %	Cooperative work	12 %
Meetings 2 - 4 persons	11.6 %	Meeting general	3 %
Meetings 5 - 8 persons	3.6 %	Meeting brainstorm	2 %
Meetings 9 - 12 persons	1.8 %	Knowledge sharing (large groups)	3 %
Meetings 13 - 16 persons	0.9 %	Small meeting 4 persons	2 %
Meetings 17+ persons	0.8 %		
Telephone work	7.8 %		
Reading	5.7 %		
Archiving and documenting	5.8 %		
Others	4.1 %		

Figure 4.6: Real profile of the employee (source: Brinkgroep (2012))

The activities of the real profile can be conducted at the following elements:

Individual general

- Open flexible workstation (not ARBO) of 6,5m²
- Open workstation of 6,5m²
- Half open flexible workstation (not ARBO) of 6,5m²
- Half open workstation of 6,5m²

Individual concentrated

- Half open workstation of 6,5m²
- Concentration workstation of 13m²
- Closed workstation for 2 persons of 13m²

PART 4: CASE DESCRIPTION.

Cooperative work (max 4p)

- Half open flexible workstation (not ARBO) of 6,5m²
- Closed workstation for 2 persons of 13m²
- Closed workstation for 4 persons of 26m²

Meeting general / brainstorm

- Half open meeting for 4 persons of 10m²
- Half open meeting for 6 persons of 15m²
- Closed meeting for 6 persons of 15m²
- Closed meeting for 8 persons of 20m²
- Closed meeting for 20 persons of 50m²

Small meeting (max 4p)

- Half open meeting for 4 persons of 10m²
- Closed meeting for 6 persons of 15m²

Knowledge sharing 12+ persons

Since the conference rooms of 12 persons and more are part of the specials, the amount of these elements is determined in the program of requirements. The activity therefore is not taken into account for additional elements.

LETTABLE FLOOR AREA

The building De Rotterdam itself provides constraints for the model, some because of its size. B+M Den Haag bv (2013) has created a report in which the size of each floor is measured. This only includes the lettable floor area, which means elevators and non-rented areas are excluded. Toilets and rented storage areas are however fixed in the floor plan, but included as lettable floor area.

The ground floor only houses the lobby, and the actual floor area rented by the municipality here is only 266m². After this, floor 1 through 6 are parking garage, which is not included as rented area by the municipality.

Following this, is the low-rise of the building. Floors 7 through 21 all have around 1337m² lettable floor area. The floors are similar in shape and layout as well. Within the low-rise, all floors can be reached by 4 elevators, with the exception of floor 21 which can be reach by 8 elevators, since the high-rise elevators stop here as well. This means that while the floor is similar as the lower floors, floor 21 will be more suitable for crowded functions like a canteen.

The 22nd floor of the building is the transition between low-rise and high-rise, but can only be reached by the 4 high-rise elevators. This floor itself has twice the height of the other floors, which also resulted into floor 23 not existing. Only 690m² is the lettable floor area on the 22nd.

After this, floors 24 through 40 represent the high-rise part of the building. These floors are all reachable by 4 elevators, which also stop at floor 22, 21 and ground floor. The lettable floor area of these floor is slightly smaller than the low-rise floors, with a size of 1152m². The high-rise floors have the quality of a nice view of the city, which can result in them being more suitable for representative functions.

PART 4: CASE DESCRIPTION.

FIRE SAFETY AND INSTALLATIONS

Besides the size of the building, constraints also exist because of the installations, elevator capability and fire safety regulations. While the size would allow a floor to contain a maximum of 138 workstations, in reality only 71 persons on a high-rise floor, and 79 persons on a low-rise floor are allowed (Molenaar, 2010).

It is possible to modify the installations and escape routes which would allow for more persons per floor, but the addition costs this brings are not easily defined.

SUITABILITY

Certain functions have specific requirements, which may affect the suitability of the different floors to house these functions. The functions that are important here are the large conference room for 50 persons, the restaurant, the lobby, the parking facilities and the coffee bar which acts as reception and welcoming area.

For the conference room, the installations are limiting the suitability of the floors. Because the 40th floor is beneath the roof, this allows for the easiest and cheapest modification of the installations. The 40th floor also provides the best view of the city, which is preferred for the conference room (Municipality of Rotterdam, 2014). Therefore, the highest floors only are suited for this large conference facility.

The restaurant should be well reachable for all employees. The 21st floor is the only floor where all 8 elevators are accessible, and is therefore most suited for a restaurant. The floors directly surrounding this (16 through 25) are also suited since they could be connected using internal stairs (Molenaar, 2010). These stairs would bring additional costs to the project.

The lobby can only be implemented on the ground floor, and the ground floor does not lend itself for any other functions besides storage, because of its shape and size. Because of this, both the ground floor and the function of lobby are not included in the model.

Just like the lobby, also parking can only be done on the floors 3 - 6. These floors do not lend themselves for any other function. For the model, both the function of parking and those floors are therefore excluded.

The coffee bar should also be well reachable, like the restaurant. For this reason, the same floors are suited for this function. Because of the floor height of the 22nd floor however, this floor would be preferred since the coffee bar also has a representative function.

FACILITY COSTS

Facility costs are part of the operating costs of the building. This is important if the project has an overall budget restriction, which includes both variable costs and fixed costs. Part of the facility costs are fixed for the whole building, but some sections can be regarded as variable costs, bound to number of floors or m², number of workstations or number of employees. The facility costs calculation is done by DTZ Zadelhoff (2013), and includes the following 5 categories, combined with the costs:

PART 4: CASE DESCRIPTION.

1. Utility costs of € 5.000,- for the currently rented floors
2. Maintenance costs of € 165.000,- for the currently rented floors
3. Service costs of € 47.000,- which are fixed for the organization
4. Other costs of € 91.198,- which are fixed for the organization
5. Administration costs of € 11.960,- which is fixed for the organization

Since the more detailed information on facility costs is confidential information, no overview of these costs will be included in this report.

RENTAL COSTS

Just like facility costs, the rental costs are also calculated by DTZ Zadelhoff (2009). The calculation however is based on a price per m² rented area. The amount of m² rented area is not fully flexible, since in practice it might not be possible to only rent part of a floor or building. It is however possible to rent out the exceeding area to third parties if the office market allows this, and thereby in theory not renting it at all.

Because of this, rental costs can be seen as variables costs, based on the area rented. For the model, this means that the used floor area will be taken into account when minimizing costs. Besides floor area, rental costs also includes the rent of parking place. The following prices have been determined, together with the actual amount of m² or parking place now realized:

- Office space of € 235,66 per m². With 41.480m² rented, this makes € 9.775.177,-
- Bike storage of € 121,46 per m². With 488m² rented, this makes € 59.272,-
- Flexible parking places of € 2.004,03,- per place. With 198 places rented, this makes €396.798,-
- Fixed parking places of € 2.565,85 per place. With 22 places rented, this makes € 56.449,-
- Motorcycle place of € 1.127,84 per place. With 40 places rented, this makes € 45.114,-

PART 5

PROCESS DESCRIPTION.

- 5.1 - Introduction
- 5.2 - First technical cycle
- 5.3 - First social cycle
- 5.4 - Second technical cycle
- 5.5 - Second social cycle
- 5.6 - Third technical cycle
- 5.7 - Third social cycle

5.1 INTRODUCTION

For the creation of the final product, the Accommodation Support Tool, a cyclic process was followed (step 3 of the study design). The study can be divided into technical cycles and social cycles. During the technical cycles, the computer programming of the model took place. Objectives and constraints are translated into the model and into the LP structure.

The social cycles include using the model to generate solutions, and evaluations the solutions and the model itself with the involved stakeholders. Preference measurement is used in order to find the most preferred solution. This means that the stakeholders define criteria in order to rate the solutions, based on their expertise.

The social cycles may provide new constraints and objective for the model, which means that the research will again include a technical cycle, followed by a social cycle for the new findings. This study includes three round of technical and social cycles, as described in the following chapters.

5.2 FIRST TECHNICAL CYCLE

This chapter will start off a description of the initial set-up of the computer model to be used during the research. In this first phase, the model is made to include the mathematical structure of linear programming. This also means that some of the values stated in the model are only there as a placeholder, and not based on actual sources yet. This chapter describes the important parts.

First of all, the model includes an input sheet. This sheet is the only page of the spreadsheet where values can be entered. The model itself will in turn retrieve these values to be used for the calculations. The input sheet includes the following parts:

- General data: Includes total number of buildings and employees.
- Data for each building: Includes number of floors and size in m2 for each building, and automatically divides the total number of employees between them.
- Data on activities: Based on the literature review in this report, for each building the total amount of FTE per activity is calculated.
- Data on facilities: Based on the literature review in this report, input can be given about the space needed for various facilities. This will then be calculated to fit each building.

The screenshot shows a complex spreadsheet with multiple data tables. Key sections include:

- General data:** Total number of buildings (6) and total number of employees (112).
- Data for each building:** A table with columns for Building 1 through Building 6, and a 'Total' column. Rows include 'Building area', 'Number of floors', and 'Employees of FTE'.
- Data on activities:** Two tables showing 'Average' and 'Maximum' values for various activities like 'General desk work', 'Interactive desk work', 'Meeting 1-2 persons', etc., across different buildings.
- Data on facilities:** A table showing space requirements for facilities like 'IT and service', 'Medical services', 'Reception and waiting', etc., across buildings.

Figure 5.1: Initial model, input sheet (1)

PART 5: PROCESS DESCRIPTION.

- Data on finance: Includes financial constraints and various costs per building unit.
- User set constraints: Includes other constraints, where more can be added later on.

Figure 5.2: Initial model, input sheet (2)

Within the input sheet, the orange cells indicate the actual input cells. When these cells are adjusted, other cell will automatically update, after which the constraints for the calculations will update to.

Moving on to the calculation sheet, where the linear programming using What's Best takes place. At the top, the different building elements are listed, where the objective function represents the total m2 taken up by the elements. limited by the constraints below, the model will adjust the blue numbers in order to optimize the objective function, which in this case is to minimize the total space needed.

Figure 5.3: Initial model, model sheet

Underneath the objective functions are all the constraints based on the input sheet. This means that the values should not be adjusted in the calculation sheet itself. At this time, the constraints include minimum space per activity, where the fitting elements based on the literature review allows the fitting activity. Furthermore, the minimum amount of space needed for facilities, the maximum costs and the user set constraints are implemented.

PART 5: PROCESS DESCRIPTION.

ACTIVITY BASED ELEMENTS

Multifunctional use of elements created a problem within the mathematical system of the model. A minimum amount of workstations for each activity was generated, based on the working profile of the employee. However, since some elements were suited to support multiple activities, the model included these elements in the calculation for the total amount of fitting elements for each activity.

This resulted into certain elements taken into account multiple times, up to three times for three different activities. In theory, this means that one workstations offered a working place for three activities at the same time, which means supporting three employees instead of one.

In order to solve this problem, the elements used as endogenous variables now are based on an activity. This results into multiple variables actually being the same element, but related to different activities. In practice however, the elements can be used for all activities that it supports, but only for one activity at the time.

Activity	General deskwork	Undisturbed deskwork	Interactive deskwork	Meetings 2p-4p	Meetings 5p-8p	Meetings 9p-12p	Meetings 13p-16p	Meetings 17p-	Boardroom 50p
Endogenous variables	Flex workstation	Closed workstation 2p	Concentration workstation	Closed workstation 4p	Open meeting 4p	Closed meeting 8p	Large conference 20p	Large conference 50p	Boardroom 50p
Outcome floor 1	0	0	0	0	0	0	0	0	0
Outcome floor 2	0	0	0	0	0	0	0	0	0
Outcome floor 3	0	0	0	0	0	0	0	0	0
Outcome floor 4	0	0	0	0	0	0	0	0	0
Outcome floor 5	0	0	0	0	0	0	0	0	0
Outcome floor 6	0	0	0	0	0	0	0	0	0
Outcome floor 7	0	0	0	0	0	0	0	0	0
Outcome floor 8	0	0	0	0	3,82	0	0	0	0
Outcome floor 9	70,2	0	0	0	0	0	0	0	0
Outcome floor 10	0	0	0	0	0	0	0	0	0
Outcome floor 11	0	0	0	108	0	0	0	0	0
Outcome floor 12	0	0	0	0	0	0	0	0	0
Outcome floor 13	76,2	0	0	0	0	0	0	0	0
Outcome floor 14	0	0	0	0	0	19,6	0	0	0
Outcome floor 15	0	0	89,3	0	0	0	0	0	0
Outcome floor 16	0	0	0	0	0	0	0	0	0
Outcome floor 17	76,2	0	0	0	0	0	0	0	0

Figure 5.5: Integration of activity based elements

OUTPUT SHEET

The last important addition to the model is the creation of an output sheet. In this sheet, a clear overview of the design is given for the building as a whole, as well as for each floor. The reason for implementing this sheet is to provide the stakeholder with a better understandable image of the design, since the values can already be seen at the adjustable numbers within the model.

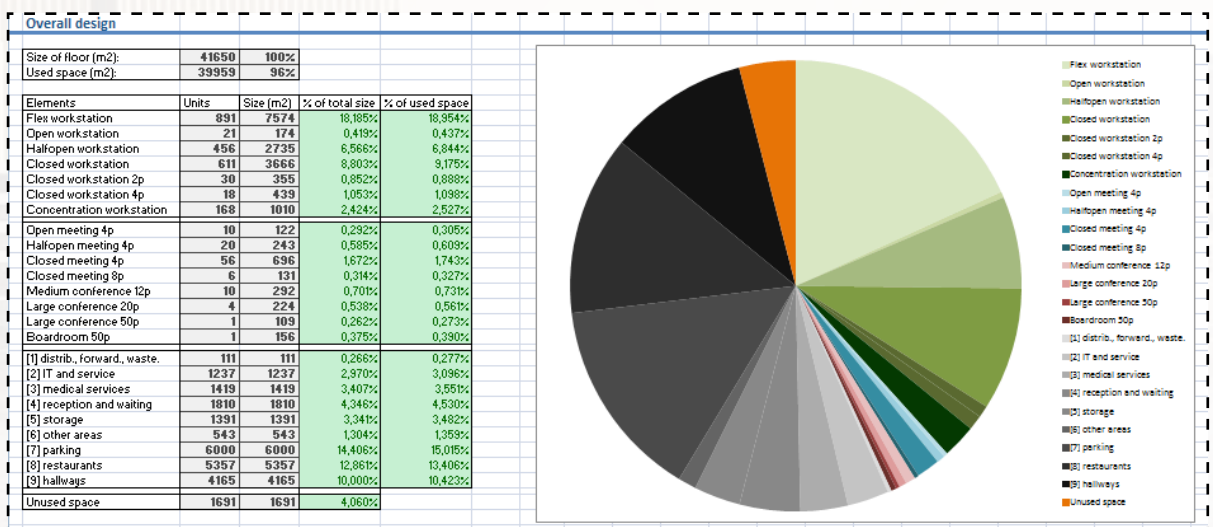


Figure 5.6: First output sheet

5.3 FIRST SOCIAL CYCLE

This first social cycle included the interview with the stakeholders, in order to gather more case specific constraints and objectives. These interview are already described in part 4 of the report, the case description.

In total, 7 interviews were conducted with different stakeholders. The stakeholders and their area of expertise, or role in the project, were the following:

1. Jaap Donkervoort - IT services
2. Martin Knijnenburg - Asset manager
3. Peter Klaver - Facility management
4. Arie van Vliet - Project controller
5. Odette de Koning - New ways of working & users
6. Leon Wielaard - Real estate developer
7. John Smeets - Design concept en program of requirement

The interviews led to more specific case constraints and objectives, partly based on the received documents which were also the result of the interviews. Because of these new findings, the study returned to the technical cycle of adjusting the model.

5.4 SECOND TECHNICAL CYCLE

During the interviews, much information was provided about the constraints of the project. The results of the interviews and the documents provided were implemented in the second technical cycle of the project. The documents are described in part 4 of the report, the case description.

First of all, the subjects of the program of requirements were implemented in the model. This included a new set of endogenous variables, which are the facilities, the activity based office elements and the specials. Because of the major changes for the model caused by these elements, the computer model itself was build up again from the start. After these changes, the endogenous variables included 18 different working and meeting stations, 10 different facility elements and 16 specials.

	Large conference (50 persons)
	Large conference (20 persons)
	Medium conference (12 persons)
	Shower room
	Medical ward
	Coffee corner
	Restaurant
	General storage
	Service point desk
	Workplace handyman
	Security room
	Changing room
	Storage coffee vending
	Storage cleaning
	Expedition room
Specials	Post office
	Fax client computer
	Waiting area (m ²)
	Waiting area (m ²)
	Lockers area (m ²)
	Storage area (m ²)
	Toilets (m ²)
	Wardrobe (m ²)
	Service unit (m ²)
	Living room (m ²)
Facilities	Pantry (m ²)
	Closed meeting for 20 persons
	Closed meeting for 8 persons
	Closed meeting for 6 persons
	Half open meeting for 6 persons
	Half open meeting for 4 persons
	Closed meetings for 6 persons
	Half open meeting for 4 persons
	Half open meeting for 6 persons
	Half open meeting for 4 persons
	Closed workstation for 2 persons
	Closed workstation for 4 persons
	Closed workstation for 6 persons
	Half open flexible workstation
	Concentration workstation
	Half open workstation
	Half open workstation
	Open workstation
	Half open flexible workstation
	Open flexible workstation

Figure 5.7: All endogenous variables (office elements) of the model

After this, the detailed building restrictions were implemented. This included the use of floor 7 to 40, instead on floor 1 to 44. The size of the floors were also adjusted to the actual floor sizes, based on the documentation. Furthermore, the allowed people per floor constraint was implemented, based on the fire safety regulations and the capacity of the regulations.

Finally, the first social cycle provided more information about the suitability of the elements on the floors. While the floors currently are suited for working and meeting elements, and the facilities, the model still contains the ability to adjust this. For the specials however, not all floors of the building are able to support these functions. Based on the interviews with the stakeholders, and the documents provided, the suitability of these specials was realistically implemented in the model.

5.5 SECOND SOCIAL CYCLE

When the new constraints of the stakeholders and the important documents were implemented in the AS-tool, 4 different strategies were created within the solution space, optimized for 4 different goals. Appendix III shows the 4 strategies (in Dutch) in the way they were presented to the stakeholders during the second social cycle, and the points below gives a short description of these strategies.

1. The first strategy was a mix of functions on each generic floor, which led to a solution closes to the actual case. Because of this mix, to many meeting areas were realized according to the activity profile, since every floor had to contain at least one of several types of elements.
2. In the second strategy, the same mix was kept for the building as a whole, but not specifically for each floor. This led to a plan with single-function floors, meaning that the interior could be improved to better support a specific function.
3. The third strategy shows that the amount of workstations spread over the whole building, could also fit when leaving 5 floors empty. Less meeting stations are created here, but still enough according to the activity profile.
4. The last strategy extends on the third, and was generated to maximize the amount of workstations in the building. This led to a strategy containing almost 850 additional workstations, 3140 instead of 2297.

After presenting the strategies to the stakeholders, they were asked to rate them for desirability, based on their own criteria from their expertise. Furthermore, discussion also provided additional constraints to the model, which meant that the 4 strategies were not all feasible at the end.

The following table shows the criteria that the stakeholders used, and their rating for each strategy ranging for 0 to 100, where 0 means least compatible (while still feasible), and 100 means best compatible.

PART 5: PROCESS DESCRIPTION.

Stakeholders criteria & ratings	STR 1	STR 2	STR 3	STR 4
<i>Stakeholder: project manager</i>				
- Financial (realization)	80	100	100	0
- Flexibility in space	80	100	25	0
- Monitoring abilities	70	100	0	25
- Number and choice of workstations	50	75	0	100
<i>Stakeholder: new ways of working</i>				
- Supporting current culture	100	50	0	25
- Supporting future culture	50	100	75	0
- Providing the right types of stations	100	100	0	60
- Amount of FTE to be stationed	100	100	75	0
<i>Stakeholder: asset manager</i>				
- Financial (operating)	0	50	75	100
- Ability to adjust flex norm	75	75	0	100
<i>Stakeholder: facility management</i>				
- Supporting the function mix concept	100	75	20	0
<i>Stakeholder: design concept</i>				
- Diversity in activity closeby	100	70	40	0
- Supporting the activity changing concept	70	100	30	0

Figure 5.8: Outcome of the preference measurement workshop

With the ratings shown above, the desirability of the different strategies can be measured. After the workshop however, the new constraints made strategy 4 unfeasible. For this research, strategy 4 will still be taken into account for the preference measurement. The results of the desirability research can be seen in part 7 of the report, the results.

After the workshop, final small changes were made to the computer model to better implement the constraints in a third technical cycle. The whole model, the final AS-Tool, can be seen in part 6 of the report, the product description.

5.6 THIRD TECHNICAL CYCLE

The third technical cycle was very short, since the data implemented in the second technical cycle was accurate. However, during the workshop with the stakeholders, it became clear that the model should also include the facility and rental costs.

Based on the documents described in part 4 of the report, the facility costs were implemented in the model, of which some are fixed, and some are per floor. The rental costs were also implemented in the model, which are per m² office space, and per parking place hired. The amount of floors in use, m² rented and parking places rented must be entered manually, since practice shows that less office space needed for the office elements does not automatically mean that this space can be excluded in the rental contract.

Finally, the final total facility and rental costs are also placed in the output sheet, to provide a clear overview. With these changes implemented, the third and final social cycle includes the final evaluation of the model, and the final generated solution, by the stakeholders.

5.7 THIRD SOCIAL CYCLE

After changing the constraints in the third technical cycles, the model was once again used to generate a solution. Looking back at the rating criteria of the second social cycle, an alternative was generated in which the positive aspects of the previous alternatives were implemented. This was done using additional constraints, just like the constraint method which is shortly discussed in part 3 of the report.

Using this technique allows for the model to find a solution not based at the corner of the original solution space, but at a corner of a new solution space which is somewhere within the original (see figure 5.9). As a result, solutions can be generated that might be more preferred than any solution at the corners of the original solution space.

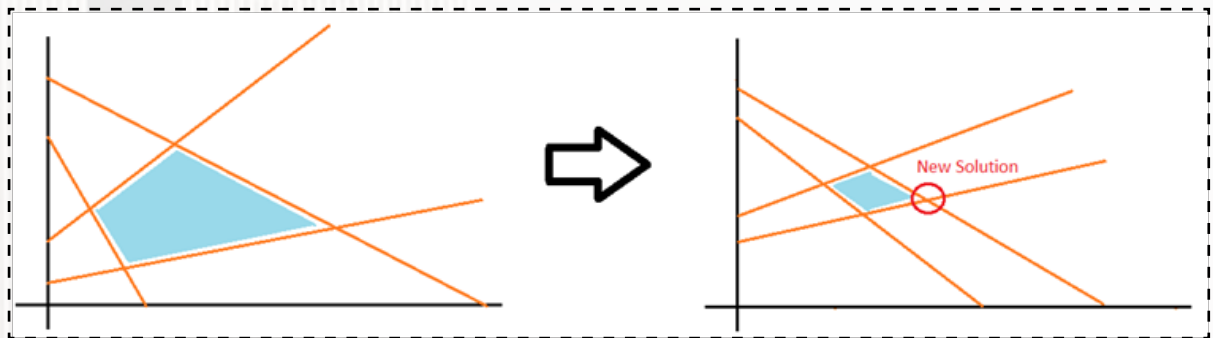


Figure 5.9: Finding a solution with a narrowed solution space

The solution that was generated for this third social cycle can be seen in appendix IV of the report. It uses 2 types of standard floors, one of which implementing open and half open workstations, and the other implementing concentration workstations and closed meeting rooms. Additionally, this solution saves 3 office floors of space, and allows departments to be implemented.

An evaluation with the stakeholders regarding the new solution, and the potential of the model itself, was the final step of the process. The stakeholders concluded that all constraints used during the negotiation process were represented well in the model. For a future project, the model has the potential to save a lot of time and money in the negotiation process, and could also influence design decisions if the future location is not yet realized.

Furthermore, the new generated solution was also preferred over the strategy 2 of the second social cycle. This shows that optimizing solutions for one objective function at the time, does not automatically lead to the most preferred solution that could exist. By using an adjusted form of the constraint method however, the model has the potential to find better preferred solutions based on the feedback within the decision making process.



PART 6

PRODUCT DESCRIPTION.

- 6.1 - Introduction
- 6.2 - Required input
- 6.3 - Input sheet
- 6.4 - Model sheet
- 6.5 - Output sheet
- 6.6 - Preference measurement
- 6.7 - Comparison with other models
- 6.8 - Place in process
- 6.9 - Limitations

6.1 INTRODUCTION

This part of the report provides an detailed description of the final product of the research, the Accommodation Support Tool. As stated multiple times before, this product is in the form of a computer model. To be more specific, the model has a spreadsheet format and is made in Microsoft Excel, with the plug-in called What's Best which can be used for large scale linear programming.

The AS-Tool contains 3 sheets in total, being the input sheet, the model sheet and the output sheet. The input sheet is where the user or client can specify the constraints in a clear way. First, a summary of the required input is given. The next chapter will describe the included constraints more in detail, and additional constraints could always be added by the programmer. The model sheet is only used for calculations, and not for presenting any data to the client. Finally, the output sheet gathers the important data from the model sheet in a format that is presentable and very easy to understand for clients or users who are inexperienced with the method of linear programming. Following the spreadsheet model, is a concise overview of the preference measurement technique.

The final product can be compared to existing models, to both determine differences and similarities. The last chapter of the part contains a description of limitations of the AS-Tool for practice.

6.2 REQUIRED INPUT

For determining the feasibility of a project, a set of input data is required. This chapter briefly states all input that is required for the AS-Tool which is specified for the case of the municipality of Rotterdam. For other cases, the required input can be the same, but can also be elaborated to be more case specific. The list of required input data is:

- All office interior elements, their sizes and how place workplace they offer.
- Number of employees and flex factor.
- Activity profile of the employee, and the support of the different elements.
- Number of floors, and for each floor the size, allowed persons and suitability for the elements.
- Minimum or maximum amount (or percentage) of workstations and meeting stations for each floor of the building, and the building as a whole.
- Min & max amount of facilities for each floor and the building as a whole.
- Amount of specials to be implemented (type of specials already specified at point 1, suitability of floors at point 4)
- Realization costs budget and realization costs per element
- Operations costs budget en operations costs per element, floor or building.

6.3 INPUT SHEET

The first sheet of the AS-Tool has 6 main categories, indicated by colored frames. The categories are organization & activity, building restrictions, working & meeting stations, facilities, specials and financial. The numbers that are used in the input sheet are fixed constraints for the model, which means that the clients has to adjust them manually if the solution space at the end does not suffice, or does not exist at all.

PART 6: PRODUCT DESCRIPTION.

ORGANIZATION & ACTIVITY

The first category contains input about the total number of employees, the flex factor and beforehand the types of activities. The model will then calculate the required number of workstations. After this, the client can specify the activity profile of the employee, where the types of activities are fixed at that moment. This means that the client can make changes in de percentages, after which the model will calculate how many work or meetings stations should be implemented to support this.

Organization & Activity			
Organization			
Total number of employees (FTE)	2800		
Flex factor	0,7		
Total number of workstations	1960		
Activity profile			
Individual general	59%	=	1156 Workstations places
Individual concentrated	29%	=	568 Workstations places
Cooperative work	12%	=	235 Workstations places
Small meeting for 4 persons	2%	=	39 Meeting stations places
Meeting general / brainstorm	5%	=	98 Meeting stations places

Figure 6.1: Input sheet, organization & activity category

The chosen activities in appendix IV are based on the profile of a Rotterdam municipal employee. The number or type of activities is not limited by this. However, if an activity have to be added, changed in nature or deleted however, this must be done by the programmer.

BUILDING RESTRICTIONS

The second category contains the input about the building specification. There are several types of input here, of which some can be specified per floor of the building, and some can be specified per element to be implemented.

First of all, for each floor in the building the clients can adjust the size which is available for the design, and the number of employees (FTE) that the floor is allowed to house, limited by fire safety and installations. These numbers are summed up at the bottom for a user friendly overview. If the total number of allowed FTE is already lower than the total workstations to be implemented, this would mean infeasibility already.

Next to the size and allowed FTE, the suitability of the floors for containing the specific elements can be adjusted. This matrix, containing all elements at the top, and all floors at the left side, uses a binary approach. In each cell, the user must either enter a 1 (meaning the floor is suitable for that specific element) or a 0 (not suitable to house that specific element).

The image on the next page shows a section of the building restrictions input category. Note that the real model has more floors, added below, and more elements, added to the right. The choice to only show a small section relates to being able to understand and read the model more clearly.

PART 6: PRODUCT DESCRIPTION.

Building Restrictions							
Size, Allowed & Suitability of elements							
	Size of floor in m2	Allowed FTE per floor (by installations)	Open flexible workstation	Halfopen flexible workstation	Open workstation	halfopen workstation	Concentration workstation
Floor 7	1337	79		1	1	1	1
Floor 8	1337	79		1	1	1	1
Floor 9	1337	79		1	1	1	1
Floor 10	1337	79		1	1	1	1
Floor 11	1337	79		1	1	1	1
Floor 12	1337	79		1	1	1	1
Floor 13	1337	79		1	1	1	1
Floor 14	1337	79		1	1	1	1
Floor 15	1337	79		1	1	1	1
Floor 16	1337	79		1	1	1	1
Floor 17	1337	79		1	1	1	1

Figure 6.2: Input sheet, building restrictions category (1)

Finally, for each element the size can also be specified, and also the workplaces that it offers related to fire safety and installations restrictions. The size will be used in the model to determine that the chosen composition of elements fit on the total floor size, and the places offered will be used to make sure that the allowed FTE per floor is not violated.

Size and places offered of elements							
	Open flexible workstation	Halfopen flexible workstation	Open workstation	halfopen workstation	Concentration workstation	Closed workstation for 2 pers	
Size in m2 for low-rise	6,5	6,5	6,5	6,5	13	13	
Place offered in FTE	1	1	1	1	1	2	

Figure 6.3: Input sheet, building restrictions category (2)

WORKING & MEETING STATIONS

The next category contains input about the required number of work en meeting elements on each floor. The client can specify for each floor what the minimum and maximum amount of workstations or meetings station may be. This is not the same as determining the activities, since activities are related to multiple elements, and some elements also support multiple activities. Therefore, the client can (but does not have to) specifically set the minimum and maximum amount of workstations for a chosen activity.

By adjusting the “general” row, the model relates this to all not-manually adjusted floor. At the bottom row, the minimum and maximum number of specific elements can also be stated for the building as a whole, without assigning them to floors. A section of the input table is shown on the image on the next page.

PART 6: PRODUCT DESCRIPTION.

Working & Meeting stations							
Minimum and maximum units per floor							
	Open flexible workstation		Halfopen flexible workstation		Open workstation		
	MIN	MAX	MIN	MAX	MIN	MAX	
General	0	100	0	100	0	100	
Floor 7	0	100	0	100	0	100	
Floor 8	0	100	0	100	0	100	
Floor 9	0	100	0	100	0	100	
Floor 10	0	100	0	100	0	100	
Floor 11	0	100	0	100	0	100	
Floor 12	0	100	0	100	0	100	
Floor 13	0	100	0	100	0	100	
Floor 14	0	100	0	100	0	100	
Floor 15	0	100	0	100	0	100	
Floor 16	0	100	0	100	0	100	
Floor 17	0	100	0	100	0	100	

Figure 6.4: Input sheet, working & meeting stations category (1)

Besides the minimum and maximum number of the different elements, the client can also express this in minimum and maximum percentages based on the total amount of elements. In the second and third matrix of the category working & meeting stations, in the same way minimum and maximum percentages can be assigned to the different elements. Note here that a certain percentage for a workstation relates to the total amount of workstations only, while a certain percentage for a meeting station relates to the total amount of meeting stations only.

Minimum and maximum % of total workstations							
	Open flexible workstation		Halfopen flexible workstation		Open workstation		
	MIN	MAX	MIN	MAX	MIN	MAX	
General	0%	100%	0%	100%	0%	100%	
Floor 7	0%	100%	0%	100%	0%	100%	
Floor 8	0%	100%	0%	100%	0%	100%	
Floor 9	0%	100%	0%	100%	0%	100%	
Floor 10	0%	100%	0%	100%	0%	100%	
Floor 11	0%	100%	0%	100%	0%	100%	

Figure 6.5: Input sheet, working & meeting stations category (2)

The client can choose to both use a minimum and maximum number for the elements and a percentage which relates to either to total amount of work or meeting stations. Using both of these instead of either however, creates more risks of constraints that deny each other, resulting in a infeasible solution.

Finally, the client can specify in percentages the minimum and maximum of workstations and meeting stations, relating to the total sum of both these stations. Since the case also including elements that were not approved by the health and safety regulations (ARBO), the minimum (and maximum) amount of approved stations in the last constraint specified in the category.

PART 6: PRODUCT DESCRIPTION.

FACILITIES

The fourth category only contains one matrix, in which the minimum and maximum amount of facilities can be specified per floor, in general or for the building as a whole, in the same way as in the previous category. Since most facilities are calculated in m2 for the model, the amount of m2 must be used as input, and not the amount of the specific elements (e.g. the amount of toilets).

Facilities									
Minimum and maximum units per floor									
	Party (m ²)		Living room (m ²)		Service unit (m ²)		Wardrobe (m ²)		
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
General low-rise	19	19	39	39	9	9	9	19	19
General high-rise	19	19	39	39	9	9	9	19	19
Floor 7	19	19	39	39	9	9	9	19	19
Floor 8	19	19	39	39	9	9	9	19	19
Floor 9	19	19	39	39	9	9	9	19	19
Floor 10	19	19	39	39	9	9	9	19	19
Floor 11	19	19	39	39	9	9	9	19	19
Floor 12	19	19	39	39	9	9	9	19	19
Floor 13	19	19	39	39	9	9	9	19	19
Floor 14	19	19	39	39	9	9	9	19	19
Floor 15	19	19	39	39	9	9	9	19	19
Floor 16	19	19	39	39	9	9	9	19	19
Floor 17	19	19	39	39	9	9	9	19	19

Figure 6.6: Input sheet, facilities category

SPECIALS

The next category is the smallest of all. This only contains the total amount of specials for the whole building. Since specials are usually only implemented once, or very little, there has specifically been chosen to not being able to assign a minimum and maximum per floor for this. The client can still manipulate where the special will be places, within the suitability matrix in the second category stated above.

Specials								
Amount of specials to be implemented								
	Post office	Expedition room	Storage cleaning	Storage coffee vending	Changing room	Security room	Workplace handjyman	Service point desk

Figure 6.7: Input sheet, specials category

PART 6: PRODUCT DESCRIPTION.

FINANCIAL

The final category of the input sheet contains financial constraints and the costs of each element to be implemented. Also fixed facility costs, and facility costs per floor can be specified here, and the rental costs based on the number of m2 rented in the building.

The numbers of floors in used, and m2 rented have to be manually changed here, because using less space for elements does not always mean that this space excluded in the rental contract, or for maintenance and utility costs.

Financial							
General constraints							
Realization budget of project	50000000						
Facility costs budget	2000000						
Rental costs budget	2000000						
Realization costs per element							
	Open flexible workstation	Halfopen flexible workstation	Open workstation	halfopen workstation	Concentration workstation	Closed workstation for 2 pers	Closed workstation for 4 pers
Realization costs	2500	2800	5000	5500	12000	17000	30000
Facility costs							
	Fixed		Variable per floor	Number of floors		Total	
Utility costs	0		147,06	34		5000	
Maintenance costs	0		4852,941	34		165000	
Service costs	47000		0	34		47000	
Other costs	91198		0	34		91198	
Administration costs	11960		0	34		11960	
Total facility costs						320158	
Rental costs							
	Price per m2	Number of m2		Price per unit	Number of units		Total
Office space	235,66	41480					9775177
Bike storage	121,46	488					59272
Flexible parking places				2004,03	198		396798
Fixed parking places				2565,85	22		56449
Motorcycle places				1127,84	40		45114
Total rental costs							10332810

Figure 6.8: Input sheet, financial category

6.4 MODEL SHEET

This report does not contain images of this whole sheet since it is more than 2000 constraint related rows in size. At the top, the What's Best plug-in allowed excel to change the values in the blue cells, when the solve button is pressed. The blue cells represent a matrix between the used elements, specified per activity, and the floors in the building. By changing the values of the blue cells, the model is determining the number of elements to be implemented on each floor. A section of the matrix is shown below.

Calculation model												
Category	Individual general			Individual concentrated			Cooperative work			Small meeting for 4 persons		
Endogenous variables	Open flexible workstation	Halfopen flexible workstation	Open workstation	Halfopen workstation	Concentration workstation	Closed workstation for 2 persons	Halfopen flexible workstation	Closed workstation for 2 persons	Closed workstation for 4 persons	Halfopen meeting for 4 persons	Halfopen meeting for 6 persons	Closed meetings for 6 persons
Outcome floor 7	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 8	0	0	0	0	79	0	0	0	0	0	0	0
Outcome floor 9	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 10	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 11	0	0	0	0	79	0	0	0	0	0	0	0
Outcome floor 12	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 13	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 14	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 15	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 16	79	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 17	0	0	0	0	79	0	0	0	0	0	0	0

Figure 6.9: Model sheet, adjustable matrix to define the solution

Besides the elements, the matrix also includes three objective functions. These are used to optimize the outcome for a specific goal, and these columns only communicate with the constraints at the bottom of the sheet, which define the objectives. By entering a 1 for one of the objective functions, the model will optimize for that objective. The numbers shown in blue are then the results for the (other) objectives. The number in the blue cell is the optimized result, but the actual solution (which is the composition of workstations) can be seen in the overall matrix (as illustrated above).

Endogenous variables	Minimize realization costs	Minimize space usage	Maximize workstations				
Outcome total	20659200	29675	1962				
Objective function	1	0	0			20659200	

Figure 6.10: Model sheet, different objective functions

PART 6: PRODUCT DESCRIPTION.

Constraints that are related to the building as a whole, like total amount of workstations for an activity, or number of specials in a building, communicate with the “outcome total” row, which is not directly adjustable by the model (no blue numbers), but is a sum of the outcomes on each floor. Other constraints, which are specified per floor, communicate to the specific row of that floor.

Endogenous variables	Open flexible workstation	Halfopen flexible workstation	Open workstation	Halfopen workstation	Halfopen workstation	Concentration workstation	Closed workstation for 2 persons	Halfopen flexible workstation	Closed workstation for 2 persons	Closed workstation for 4 persons	Halfopen meeting for 4 persons	Halfopen meeting for 6 persons	Closed meetings for 6 persons
Outcome floor 37	1	0	0	0	0	0	0	0	0	0	0	0	5
Outcome floor 38	70	0	0	0	0	0	0	0	0	0	0	0	0
Outcome floor 39	0	0	0	0	71	0	0	0	0	0	0	0	0
Outcome floor 40	0	0	0	0	0	0	0	0	0	0	0	0	0
Outcome total	1157	0	0	0	569	0	0	0	0	59	1	6	0
Objective function													

Figure 6.11: Model sheet, outcome total row

All constraints are defined using Excel’s “SUMPRODUCT” code. This code requires 2 row sections of a sheet of the same width, and sums up the product of each two cells in the same column. For the constraint “minimum amount of workstations for individual concentrated work” for example, that row contains the number of places offered by each element supporting individual concentrated work, which is 1 for half open workstation, 1 for concentration workstation and 2 per closed workstation for 2 persons. The SUMPRODUCT will then grab the whole row, and the whole row of “outcome total”, but since the constraint row has many empty cells, the products in those columns are 0.

This assures that only the relevant elements are taken into account. At the end, the value produced by the SUMPRODUCT code must either be smaller, greater or equal to a specific value which is imported from the input sheet.

Organization & Activity													
Amount of stations for activities													
MIN Individual general	1	1	1	1									
MIN Individual concentrated					1	1	2						
MIN Cooperative work							1	2	4				
MIN Small meeting for 4 persons										0	0	0	
MIN Meeting general / brainstorm										0	0	0	0

MIN		MAX
156	<=	1157
568	<=	569
236	<=	236
39	Not <	0
98	Not <	0

Figure 6.12: Model sheet, constraints implemented in the calculation model

This method is used for each constraint. When pressing the solve button, the What’s Best plug-in assures that the adjustable values will only be changed when all constraints are taken into account. Failing to take into account all constraints results in a infeasible solution.

6.5 OUTPUT SHEET

The output sheet provides an overview of all implemented elements, the size of these elements, and what percentage of the total size this is. This is also visualized in a pie chart, to be able to quickly compare different results. Other important values are also stated here, related to the different objective functions.

After the overview, a more detailed framework of elements per floor is provided. This is not the same as the matrix in the model sheet, since the output sheet is no longer related to activities. Reason for this is that the elements are not specifically bound to one activity, but in order to provide enough activity support overall, this had to be taken into account in the model sheet. The overview is also provided for each individual floor and should be a clear set of input values to be used by an architect, when actually working out a design, or to be used for further negotiations.

Overall design summary				
Overall size (m2)		40329	100%	
Used space (m2)		29675	74%	
Objective function results				
Final realizations costs		20.659.200		
Final space usage		29675		
Final amount of workstations		1962		
Work & Meeting				
	Units	Size (m2)	% of overall size	
Open flexible workstations	1157	7521	18,6%	
Halfopen flexible workstations	0	0	0,0%	
Open workstations	0	0	0,0%	
Halfopen workstations	569	3699	9,2%	
Concentration workstations	0	0	0,0%	
Closed workstations for 2 persons	0	0	0,0%	
Closed workstations for 4 persons	1	26	0,1%	
Halfopen meeting for 4 persons	1	10	0,0%	
Halfopen meeting for 8 persons	6	90	0,2%	
Closed meeting for 6 persons	0	0	0,0%	
Closed meeting for 8 persons	0	0	0,0%	
Closed meeting for 20 persons	5	250	0,6%	
Facilities				
	Units	Size (m2)	% of overall size	
Pantry (m2)	589	589	1,5%	
Living room (m2)	1209	1209	3,0%	
Service unit (m2)	279	279	0,7%	
Wardrobe (m2)	627	627	1,6%	
Toilets (m2)	429	429	1,1%	
Storage area (m2)	627	627	1,6%	
Lockers area (m2)	1209	1209	3,0%	
Waiting area (m2)	297	297	0,7%	
Walking area (m2)	8871	8871	22,0%	
Fat client computers	0			
Specials				
	Units	Size (m2)	% of overall size	
Post office	1	19	0,0%	
Expedition room	1	19	0,0%	
Storage cleaning	1	19	0,0%	
Storage coffee vending	1	19	0,0%	
Changing room	1	19	0,0%	
Security room	1	19	0,0%	
Workplace handyman	1	39	0,1%	
Service point desk	1	39	0,1%	
General storage	1	19	0,0%	
Restaurant	1	1104	2,7%	
Coffee corner	1	500	1,2%	
Medical ward	1	68	0,2%	
Shower room	1	137	0,3%	
Medium conference (12 persons)	3	90	0,2%	
Large conference (20 persons)	4	200	0,5%	
Large conference (50 persons)	1	125	0,3%	
Unused space (m2)	10654	10654	26,4%	

Figure 6.13: Output sheet, overview of all elements

PART 6: PRODUCT DESCRIPTION.

Overview per Floor		Workstations total	Meetings total	Specials total	Open flexible workstations	Halfopen flexible workstations	Open workstations	Halfopen workstations	Concentration workstations	Closed workstation for 2 person	Closed workstation for 4 person	Halfopen meeting for 4 persons	Halfopen meeting for 6 persons	Closed meeting for 6 persons	Closed meeting for 8 persons	Closed meeting for 20 persons	Pantry (m2)	Living room (m2)	Service unit (m2)	Wardrobe (m2)	Toilets (m2)	Storage area (m2)	Lookers area (m2)	Waiting area (m2)	Walking area (m2)
Floor 7		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 8		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 9		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 10		79	0	1	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 11		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 12		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 13		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 14		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 15		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 16		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 17		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 18		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 19		55	0	2	55	0	0	55	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 20		79	0	0	79	0	0	79	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	324
Floor 21		0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Floor 22		0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Floor 24		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 25		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 26		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 27		5	4	0	5	0	0	0	0	0	0	0	1	0	0	3	19	39	9	19	13	19	39	9	255
Floor 28		17	0	0	17	0	0	0	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 29		0	1	3	0	0	0	0	0	0	0	1	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 30		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 31		17	0	0	17	0	0	0	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 32		8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 33		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 34		17	0	0	17	0	0	0	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 35		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 36		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 37		1	7	0	1	0	0	0	48	0	0	0	0	0	0	2	19	39	9	19	13	19	39	9	255
Floor 38		70	0	0	70	0	0	0	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 39		71	0	0	71	0	0	71	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255
Floor 40		0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	19	39	9	19	13	19	39	9	255

Figure 6.14: Output sheet, overview per floor

6.6 PREFERENCE MEASUREMENT

After the calculation model is used to generate feasible solutions, preference measurement is used to find the overall most preferred solution. The computer program TETRA SDM is used for this, and this is not directly connected with the Excel sheets stated before.

In TETRA SDM, first the different alternatives must be defined. These can just have the names of the different solutions (figure 6.15), while the details and properties concerning those solutions are not needed here. This is because the solution was already proven to be feasible given the constraints, and the output sheet of the Excel model can be used as an overview of the properties.

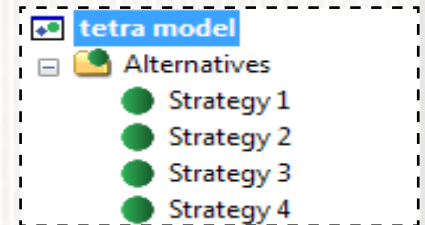


Figure 6.15: Alternatives

With the alternatives defined, the criteria of each stakeholder can be added. These criteria are also “folded” per stakeholder (figure 6.16). For each criteria, the stakeholder can rate the alternatives as shown in figure 6.17, where the least alternative for that criteria should receive a 0 and the best alternative for that criteria a 100.

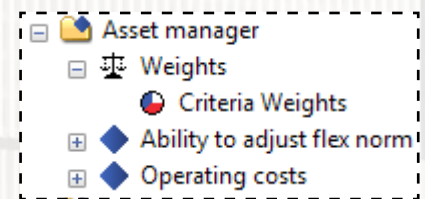


Figure 6.16: Criteria

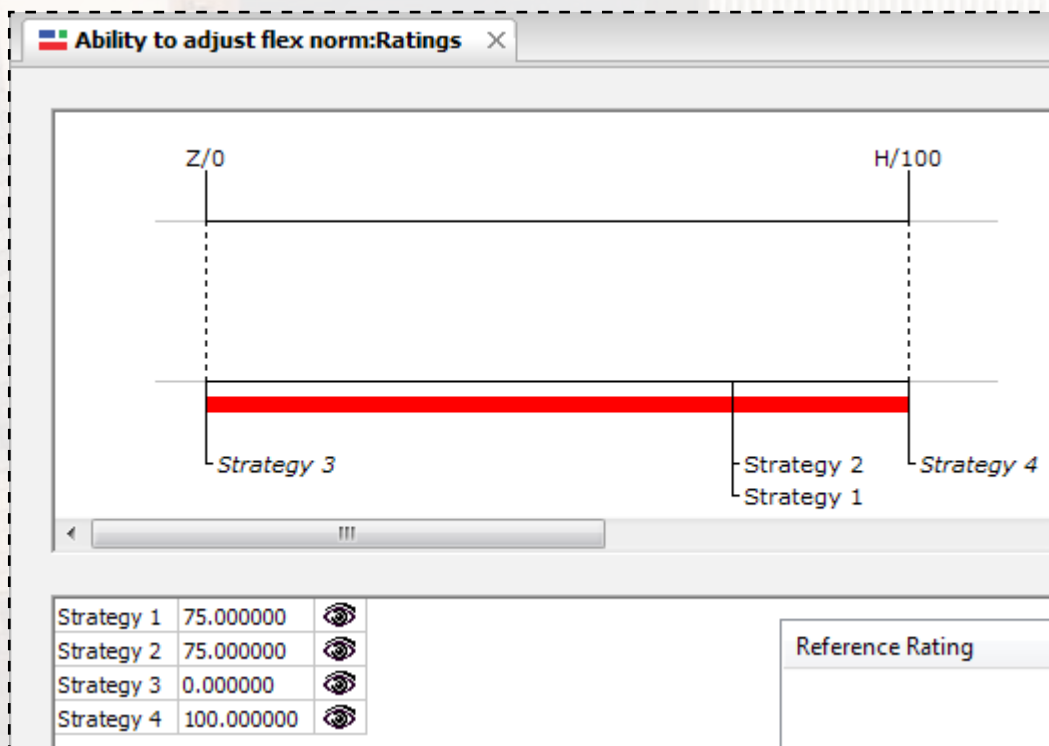


Figure 6.17: Rating of the alternatives for a criteria

Furthermore, a weight can be assigned to the different criteria of the stakeholders, and also a weight between the stakeholders themselves, as some stakeholders might have more influence on the decision making process than others. After assigning all of these weights, and entering the criteria ratings, TETRA SDM uses an algorithm to find the overall most preferred solution, and also shows the “scores” of the other solutions. This overview can be seen in part 7 of the report, which is the results chapter.

6.7

COMPARISON WITH OTHER MODELS

To determine the relevance of the AS-Tool constructed in this research project, the most important aspects are briefly explained and discussed:

- Integrate object: The real estate object is implemented as constraints within the LP model.
- Quantify demands: Stakeholder demands, which are set as constraints, are expressed in numbers and can therefore always be measured in a mathematical LP system.
- Determine feasibility: Because the solution space is generated using both constraints stated above, the model only give solutions that can be implemented. This means that, when no solution exists, the constraints need to be renegotiated with the stakeholders.
- Determine desirability: Multiple designs are generated, based on the dominant design criterion of one stakeholder at the time. Preference measurement is used to determine the desirability of other stakeholders for all designs.
- Process oriented: The model is not only a calculation model, but is place within a cyclic process where demands of stakeholders might change when the solution is not fit.

Since the AS-Tool is now described in detail, comparisons with the existing models described before can be made.

HK MODEL

Differences include:	Similarities include:
<i>A qualitative approach, which means that the HK model does not include calculations</i>	<i>A cyclic and iterative process, meaning that the goals can change if the solution does not fit.</i>
<i>The solution space is not defined because no explicit constraints are given, only goals / intentions</i>	<i>Taking into account the demands of multiple stakeholders</i>
<i>Generates one best solution for all stakeholders, but no multiple solutions optimized for different stakeholders each time.</i>	<i>The use of empirical data about organization and building</i>

Figure 6.18: Comparison with HK model

PACT MODEL

Differences include:	Similarities include:
<i>Only based upon the goal of optimizing WS's, while no optimization for separate stakeholder goals.</i>	<i>Optimization structure, using one objectives and many constraints.</i>
<i>The existing RE objects is not implemented in the model, only organization specific constraints.</i>	<i>Using qualitative calculation to assure feasibility regarding the given constraints.</i>
<i>Does not include preference measurement to determine the desirability.</i>	<i>Providing a design that can be implemented by an architect.</i>

Figure 6.19: Comparison with PACT model

6.8 PLACE IN THE PROCESS

This chapter will describe the different roles that the AS-Tool can have in a real estate process, containing the phases: initiative, design, construction and use. For this study, the model is used between the initiative and design phase, where a set-up of the elements based on the constraints and objectives of the stakeholders, can be used by an architect within the final design. This use of the AS-Tool, where it supports the decision making process of the stakeholders for the design, is its main goal. However, the AS-Tool is not limited by this use only.

Another use of the AS-Tool can be at the very beginning of the process, which is at the start of the initiative phase. Here, the tool can be used purely as a feasibility tool, where fixed constraints can be tested in order to conclude whether they exclude each other. In this phase, not yet all important aspects of the project will be clear yet, but this first test could for example conclude that the chosen building is not fit for the project, or that the budget is too low.

Furthermore, during the construction phase of a project, the design is sometimes still subject to changes. These can be caused by unexpected aspects in a building, new techniques because of the time-frame or other reasons. When this happens, the AS-Tool can be used to assure that the changes still fit within the feasible solution space for the project, and preference measurement can be used to determine the best alternative for the required change of the design.

Finally, in the use phase of the process, which can take up to 30+ years, the AS-Tool can actively be used to evaluate the implemented design and compare it to other and new plans. This allows for an organization to be up-to-date with their real estate, regarding changes in company cultures, technology and other aspects.

The time-line below briefly shows the places in the process for the AS-Tool, where the places of the HK model and PACT model are also illustrated.

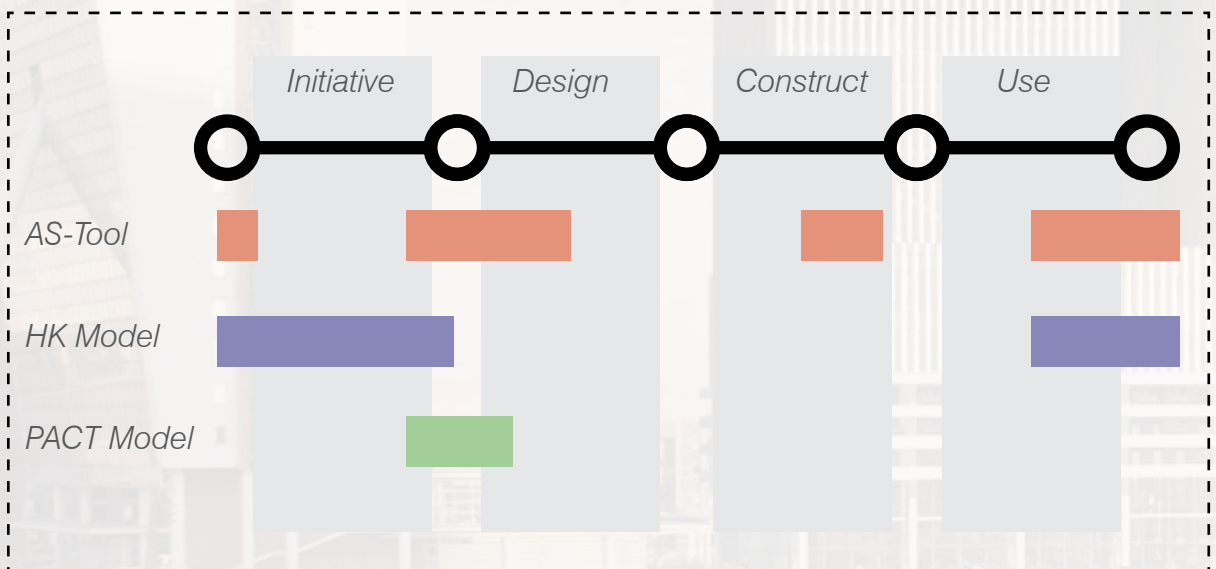


Figure 6.20: Place in the process

6.9 LIMITATIONS

In the previous chapter 6.7 it becomes clear that the AS-Tool offers new aspects compared to existing methods of supporting organizations in choosing an accommodation plan. This chapter will address the limitations of the new model.

First of all, it is important to realize that the model is limited in detail and accuracy, based on the availability and accuracy of the input data. If no accurate floors plans or activity profiles are provided, the model could generate accommodation plans which in reality are not feasible. It is therefore important for a model creator to be critical about the input data that is provided.

Also crucial here, is that the input must all be quantifiable for each office element which it involves, in order to set up the constraint. For example, when an overall realization budget is included as a constraint, realization costs of each office element must be provided. If variables cannot be expressed as a quantitative value, it is either very hard or impossible to include them in the model. Examples of non-quantifiable variables are the influence of organization culture or peacefulness.

Furthermore, the technique of linear programming has the limitation of optimizing for one objective function only. The constraint method is a solution which takes the objective function value of an optimized solution, and implements this as a constraint for a new objective function optimization. But in most cases this would mean that the second optimization is not fully optimized. The mathematical system does not provide a method to optimize a solution for multiple objectives, finding the overall most optimized solution.

Because of the mathematical system as well, it is not possible to clearly include “soft” constraints into the AS-Tool. What this means is that the model cannot tell the difference between a constraint which is fixed, like the size of a floor plan, and a constraint which is very much open for negotiation, like the minimum number of workstations on a floor. Because of this, it is advised to not specify the soft constraint as strict as they are at the start, in order to validate the feasibility within the “hard” constraints. If the solution is feasible, the soft constraints should be adjusted to a more strict value, after which another run of the model can validate the feasibility.

Another limitation of the AS-Tool is that it cannot be used to find the most preferred solution possible within the solution space. Reason for this is again the method of LP, which means that a solution is always optimized for one objective function only. As a result, the solutions that are generated for the preference measurement, are located at the “corners” of the solution space. The HK model generates one best solution for all stakeholders, where they all “give in” for their goal, while the AS-Tool generates multiple best solutions, each for an individual stakeholder.



PART 7

CONCLUSIONS.

- 7.1 - Results
- 7.2 - Conclusion
- 7.3 - Product reflection
- 7.4 - Recommendations
- 7.5 - Personal reflection

7.1 RESULTS

Based on the social cycles of the modelling process, conclusions can be drawn regarding the organisation and the role that the AS-Tool can have in the choosing of an accommodation plan. The results chapter is split up into the results of the three social cycles.

FIRST SOCIAL CYCLE

While the interviews with the stakeholders did not include preference measurement of generated solutions, still included interesting results. By showcasing the structure of the model, and asking for their expertise-related input, the stakeholders were persuaded to think about their constraints and objectives, and how these could be quantified.

The first social cycle therefore resulted in a more clear overview of the quantified demands of the stakeholders which can be used in the negotiation process, even when the actual computer model would not be used.

SECOND SOCIAL CYCLE

In the second social cycle, preference measurement was used to determine the most preferred solution. The stakeholders defined their criteria and rated the different solutions, which resulted in the overview given in the chapter second social cycle, in part 5 of the report. In order to draw conclusion from this data, the TETRA SDM program was used to provide the algorithm which determines the most preferred solution. The result can be seen in the image below.

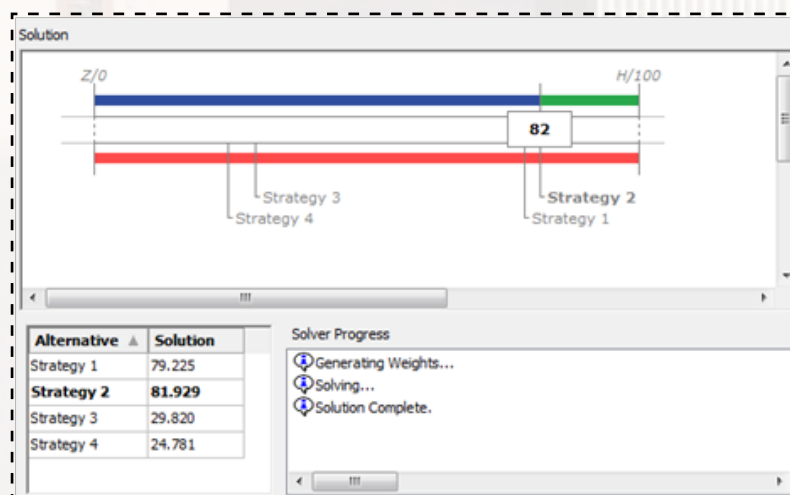


Figure 7.1: TETRA SDM result of preference measurement

The image shows that strategy 2 is the most preferred solution by the stakeholders. However, strategy 1 reflects the strategy chosen in the actual process. This means that the current accommodation plan is not optimized for the stakeholders objectives. The reason that strategy 2 was not implemented is twofold.

First of all, because the AS-Tool was not available for the actual decision making process for the case, there was no method used to determine the most preferred solution. Since the scores of strategy 1 and 2 are so close, it was not clear which one of the strategies was to most preferred one.

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The second reason is that some of the stakeholders believe that the organization itself is not yet fit to support strategy 2, because it does not support the fixed spots for departments. The argument of the stakeholders is that the process to adapt to the new ways of working is a long one, because of the culture of the municipality. Strategy 2 requires the employees to work on different floors for different working activities, while strategy 1 offers support for all activities on each floor, and the employee is not yet willing to move to other floors of the building for different activities.

THIRD SOCIAL CYCLE

In the third social cycle, an alternative solution was generated which implemented the positive aspects of the previous 4 alternatives, as a constraint. This led to an alternative with an even higher preference rating than strategy 2. The result shows how the model can be used within a negotiation process, using feedback of the stakeholders to find higher preferred solutions.

A form of the shortly described constraint method is used here, what resulted in additional constraints and therefore a “smaller” solution space. This means that the new solution was not bound to be at the corners of the original solution space. Using this method to narrow the solution space can be used to find more preferred solutions because the most preferred solution will not always be located at a corner of the solution space.

7.2 CONCLUSION

The AS-Tool created during the study is an answer to the research question stated in part 1 of the report, which is: How can a tool be developed to support organizations in choosing an accommodation plan to implement the new ways of working, while simultaneously taking into account feasibility and desirability?

Feasibility is taken into account by quantifying both the demands of the stakeholders and the physical building properties and regulations. The model uses all of these constraints to validate if the solution space is empty or non-empty, containing all solutions that are allowed. If a solution space is empty, then the constraints are too strict and are excluding each other. Within a process of choosing an accommodation plan, this means that the stakeholders should negotiate about their demands.

Within a non-empty solution space, the objectives of the stakeholders are used to find optimized solutions for different objective functions. Each optimized solution will fit at least one stakeholder the best, since it is based on their objective (if the stakeholder has only 1 objective).

In order to find the overall most preferred solution, preference measurement is used. All stakeholders define criteria which they use to rate the alternative solutions. The preference measurement algorithm is then used to find the overall most preferred solution, which is still a feasible outcome of the computer model.

To validate the AS-Tool, an existing case of the municipality of Rotterdam was simulated for the model. After 3 technical and social cycles, the model was able to provide feasible alternatives which could then be discussed by the stakeholders, in order to support the process of choosing an accommodation plan.

7.3 PRODUCT REFLECTION

The purpose of this product reflection is to discuss the graduation process and product. The completeness of data and validity of the results are important discussion subjects here. This chapter is also used to reflect back on the scientific- and societal relevance and utilisation potential which are stated at the start of the report.

COMPLETENESS OF DATA

In order for the AS-Tool to produce a realistic accommodation plan, the input data should be accurate, detailed and complete. While the documentation provided much of the required information, the completeness of data was still not optimal. Multiple reasons were causing this.

First of all, since such a model was not used during the actual negotiation process of the case, but for a simulation, not all constraints and objectives were quantified to begin with. The stakeholders had difficulties to express some of their demands in numbers. This might be less of a problem if the validation of the model took place during a real case, instead of a simulation.

Secondly, other crucial data was never provided because of the sensitivity of the numbers. This primarily includes the financial data regarding realization costs of different elements. The stakeholders involved with this data were not able to get approval to share their documents within the timeframe of the graduation project.

Because of the incompleteness of the data, many assumptions had to be made regarding the constraints of the model. This could mean that the generated solutions might not be feasible after further investigation. However, the structure of the computer model is not influenced by this, which means that the validation of the model can still be done.

VALIDITY OF THE RESULTS

The results of the field test were different than the actual chosen accommodation plan. If the model would be accurate and complete, this would mean that the municipality did not implement an optimal most preferred solution within their real estate. As stated in the section above however, the model had some incomplete data and was partly based on assumptions. Besides this, some aspects of the organization were on purpose not implemented in the computer model, because of the time-frame of the graduation project. The most important aspect was the influence of company culture, and this aspect is also the main reason why the result of the field test differs from the actual implemented solution.

However, the results, while being incomplete for some aspects, are still valuable for an organization as leverage and clarity within the negotiation process. Also, with sufficient time and (quantifiable) data available, the structure of the model allows for the addition of all important constraints in a process.

The result of the field test was not the chosen result for the case, because it was not feasible for reasons that were not implemented in the model, but the stakeholders still agreed that that result would have been more preferred. In the future, when the organization culture has adjusted more to the new ways of working, the result of the field test is indeed the strategy that the municipality want to implement, according to the involved stakeholders.

SCIENTIFIC RELEVANCE

This research project adds value to the scientific domains of real estate management and design and decision modelling. One of the ways it does this is by relating them together by means of a computer model for an accommodation plan, using methods of both domains. For real estate management, the model offers accommodation solutions based on stakeholder constraints and objectives. The constraints and objectives are subject to change because of the new ways of working, and the domain of real estate management focuses on the added value that real estate can have in meeting these constraints and objectives.

For design and decision modelling, 2 separate techniques are combined into one model, using the strengths of both methods. While linear programming offers a way to determine the existence of a solution space for a problem, and thereby determining the feasibility, the technique of preference measurement can determine the desirability of the solutions in that solution space. Both techniques are practiced before but using them simultaneously is new for the domain of design and decision modelling.

DAS-FRAME

For a better understanding of the relation of this study to real estate management, the AS-Tool can be related to the DAS-frame discussed in part 2 of the report, where the future supply should be adjusted for the future demands of an organization. The third step of the DAS-frame is to generate alternative solutions (alternatives of what we could have). The solutions created here cover the mismatches between future and current demand, and current supply, which is what this model achieves very well.

Not only does the AS-Tool provide different solutions based on the stakeholder demands and objectives, but also a method to evaluate and select the overall most preferred solution, which is also part of the DAS-frame. These solutions form the basis for the creation of a step-by-step plan.

UTILIZATION POTENTIAL

The final product, which is the AS-Tool, is constructed inductively, and therefore is not limited to support the case of the municipality of Rotterdam only. The structure used allows for easy changes in constraints, objectives and decision variables (which are the office elements), and the case of Rotterdam is only used to validate its correctness.

Because of this, the model has much utilisation potential. As stated earlier in the report, the use of this model can save time and money determining the existence of the solution space given the constraints, which in other words is the feasibility of the project. Within the solution space, preference measurement is used to determine the most preferred solution without potentially unfair or unclear discussions. Furthermore, by actively using the model in the negotiation processes, stakeholders can be shown the consequences or effect of their demands, creating more transparency in an organization. While the AS-tool is not able to design the layout of the separate office floors itself, it has the potential to provide the architect with very detailed information on the required elements. The level of detail here is set by the level of detail of the implemented constraints, and data on decision variables.

7.4 RECOMMENDATIONS

Recommendations for future research relate to the limitations of the AS-Tool. While the structure of the model allows for adjustments and additions, it should be clear that accurate and detailed input data is required for accurate and detailed results. The first recommendation therefore is to develop a method to “translate” case data into model variables, which are validated by the stakeholders. This could be particularly interesting for soft data that the current model fails to include, such as the influence of organizational culture and the change of that culture over time. This first recommendation is based on the real estate management research area, where stakeholder goals lead to model criteria.

Future research could also be focussed at including preference from the start at the model, which means changing from a single criterion optimization model to a multi-criteria optimization model. For this study, it was not possible to use linear programming to do multi-criteria optimization, so other techniques must be used. If succeeded, this could result into a model which can find the overall most preferred solution that exists for the situation, based on the stakeholder objectives and their weights defined at the start. This second recommendation is based on the design and decision systems research area, and argues to compare linear programming with other techniques.

Furthermore, future projects could be done to extend the model to where it is able to create an actual building design. This would require the complete floor plans as input, instead of just the size and suitability. If the model was able to do this, many additional constraints could be taken into account, such as the pillar placements in a building, and the shape of a room.

A brief recommendation to future clients who would use the AS-Tool, is to provide constraints and other variables on a building-level instead of a organization level. This would create a more realistic simulation leading to more realistic results, by reducing the amount of involved assumptions. As a final recommendation, the AS-Tool should be given an own GUI (Graphical User Interface) instead of using the excel program. This would be more professional, and would allow the feasibility and desirability check with the same system. This last recommendation is based on computer programming, and not so much on the research areas for this study.

7.5 PERSONAL REFLECTION

The purpose of this personal reflection is to discuss my personal experience regarding the graduation process. The study goals defined at the start of the academic year are evaluated, and the striking positive and negative experiences.

STUDY GOALS

At the start of the research project, 3 study goals were defined. The first was to better understand the demands and criteria of stakeholders, and how these demands can be implemented in a real estate object. The qualitative demands and criteria of the stakeholders were easy to gather and understand, but in my experience it was more difficult to find a way to implement these. The most important reason for this was because stakeholders have difficulties translating their qualitative thoughts and wishes into quantitative constraints or variables. The process of doing this involved suggesting these “translations” myself, as well as making assumptions about what was meant with a qualitative description.

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The second study goal was to better understand the relevant factors in real estate decisions. This was interesting since the study involved the case of the municipality, instead of a real company. Where I had thought that the most relevant factors would probably be finance related because of the times we live in, this was not so much the case. For the municipality, important factors were the city development (explaining the choice of office building), employee satisfaction and image. The final study goal was to gain more insight in computer modelling, and the study has certainly achieved this. Not only did I get more familiar with the used computer programs Microsoft Excel and TETRA SDM, but the modelling itself forces the programmer to think of constraints and objectives in mathematical terms.

THE CASE OF THE MUNICIPALITY

The study involved the case of the municipality of Rotterdam, and this part of the reflection describes the experience I had with working together with the stakeholders. In general, this was a positive experience and the stakeholders were very helpful for the study. Getting permission to use the case was easier than expected. Since I have family relatives working at the municipality, I was quickly provided with the contact data of the right stakeholder in the process, the project leader. The first appointment was used to illustrate what value my research project could have, also specifically for the municipality, after which I had approval for the execution of the study. The stakeholders working in the team for the project manager were important for my study, and the benefits of having approval from a “project champion” meant that they were also willing to assist.

While my overall experience with working together with the stakeholders was positive, one negative aspect was that some of them were very slow to answer e-mail and to send the documents promised during the interviews. Specifically, the program of requirements for the case was a document which I asked multiple stakeholders multiple times for, and only received 3 weeks after. The (legit) reason for this is that the stakeholders simply have more work to do and forgot or postponed it, and I had to emphasize the time limit to which I was bound for the research project.

SCIENTIFIC DEFINITIONS

One of my greatest difficulties within this research project, was to correctly define the aspects of the literature study, mostly concerning the aspects of linear programming. Writing a research paper is one of my weak points, and especially for defining a mathematical method like linear programming, I find it hard to use the correct terms. At the end, with the help of my first mentor, I did improve my skills regarding the use of correct terms. Still, I am not always able to correctly translate what I want to say from Dutch to English, resulting in spoken language sentences.

NO CLEAR INSTRUCTIONS

What makes the graduation project unique compared to other study projects, is that there is not fixed format for the end product, and little concrete guidelines for the contents. In my experience, this much freedom also results in much uncertainty. It is difficult to estimate the value of individual work, since all students have a different subject, method and research area. For me, uncertainty generates stress which might or might not be well placed. Still I appreciate this format and freedom of graduating, because I think it does a good job preparing the student for the assignments in real life, where many times also no guides exist.

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APPENDIX I: FACILITIES.

Name of facility	Description	Size	Amount	Situation
1. DISTRIBUTION, FORWARDING AND WASTE PROCESSING				
Garbage spot in office	Garbage spots that allow separating waste	Neglect able	1 bin per 4 work spots	At work spots and central on floor
Waste container room	Closed of area for gathering all waste	Depends on building	1 per building	Low in building, preferred direct access to street
Grease trap	Disposing oil / fat	Depends on building	1 per building	Underground or ventilated container
Mailroom	Sorting incoming and outgoing mail	0.1m per work spot	1 per building	Preferred direct access to street
Forwarding room	Processing incoming and outgoing goods (other than mail)	Depends on building	1 per building	Low in building, preferred direct access to street
2. IT AND SERVICE				
Service-unit	Copy / print machine, mail distribution and sending, office items storage	12 m2	1 per floor	Preferred central on floor, close to coffee, not too close to work spots
Multifunctional	Print / scan / copy / fax machine	4 m2	2 per service-unit	Not too close to work spots
"Patch" area	Used for connecting devices to work spots	6 m2	-	Max 90 meters from any work spots
MER area	Servers and connecting devices to work spots	24 m2	1 per building	Not at ground floor or outer walls
3. MEDICAL SERVICES				
Doctor room	Medical conversation / examination	18 m2	1 per building	Quite area, not close to open work spots
Emergency response facilities	Mainly storage of ERF items	Neglect able	1 closet per 30 work spots	-
AED device	For reanimation purposes	Neglect able	1 per 300 m2	Also one at front desk
Evac chair	For evacuating disabled persons	Neglect able	1 per 3 floors	-
Restroom	For employees with medical limitations, a room to lay down	12 m2 - 16 m2	1 per building	Quite area, not close to open work spots
Dressing room	For employees to change clothes	12 m2	1 per building	Close to entrance
Shower room	For showering	5 m2	-	Close to entrance
Lactation space	To express milk for mothers	10 m2	1 per building	-
Disables toilet	Toilet for disabled persons	5 m2	1 per floor	-
Toilets	Rules of Dutch "bouwbesluit" apply	-	-	-
4. RECEPTION AND WAITING				
Living room	Area for informal meeting, relaxing	Around 40 m2	1 per floor	Not close to open work spots
Security room	Observing and staying of security staff	12 m2	1 per building	Close to entrance
Wardrobe	For hanging coats / jackets	6 m2	1 per large meeting room	Also on at front desk

APPENDIX I: FACILITIES.

Waiting room	For visitors to wait to be met	20 m ²	-	Near front desk and meeting rooms
Seat	To lounge, take a break and informal meeting	5 m ² for 2 spots	-	Close to meeting areas, pantry, coffee machine
Central entrance	Entrance for employees and visitors	-	1 per building	Ground floor, entrance to outside
5. STORAGE				
General storage area	For storing general goods	Min 12 m ² or max 2% of floor	1 per floor	Near core of building
Dynamic archive	Closets for dynamic archive	0.6 m per FTE	-	Close to work spots
Static archive	Closets for static archive, policy to minimize	Close to 0	Close to 0	Near core of building
Personal storage	Lockers for employees	33 cm * 54 cm	1 per employee	Close to coffee machine or living room
Storage of caretaker	Storage for tools and other goods	6 m ²	1 per building	Central location, preferred ground floor
Working closet	For cleaning equipment and goods	4 m ²	1 per floor	Near water facilities
6. OTHER AREAS				
Smoking area	For employees and visitors	5 m ²	1 per floor	Close to pantry / coffee machine
Prayer room	For employees and visitors	12 m ²	1 per building	Quiet area, not close to open work spots
Installation rooms	Rules of Dutch "bouwbesluit" apply	-	-	-
7. PARKING				
Bicycle parking	For employees	50 cm * 400 cm	-	Policy not defined
Bicycle parking	For visitors	-	-	Outside building, at public area
Car parking	For employees and visitors	300 cm * 500 cm	-	Policy not defined
8. RESTAURANTS				
Pantry	Small kitchen incl. water, refrigerator, dish washer, boiler	6 m ²	1 per floor	Combined with living room and coffee machine
Coffee machine	For providing hot drinks	2 m ²	Multiple per floor	In combination with pantry or living room
Canteen	For lunch / catering employees	1.6m per FTE	1 per building	Close to elevators
Snack machine	For providing snacks	2 m ²	-	Near canteen / living room
Soda machine	For providing drinks	2 m ²	-	Near canteen / living room

APPENDIX III: EXAMPLE LP.

The following situation is used for this example:

An organization uses open workstations and closed workstation. These elements have to following characteristics:

- Open workstation: size of 5 m² and costs of €1000 to implement
- Closed workstation: size of 10 m² and costs of €500 to implement

The available space in the building is 200m² and the budget is €25000. Furthermore, at least 10 workstations must be implemented. Within the project, 3 stakeholders exists with the following goals:

1. Stakeholder 1 want to minimize the implementation costs
2. Stakeholder 2 want the maximize the amount of workstations
3. Stakeholder 3 wants to minimize the total space usage.

First of all, the situation will be related to the elements of the model. This means that the following lists will be used for calculation:

CONSTRAINTS: demands of the stakeholders:

- Maximum space usage of 200m²
- Maximum budget of €25000
- Minimum workstations of 10

SOLUTION SPACE: design space

- All designs that fit the demands above

OBJECTIVE FUNCTION: dominant design criterion, based on goal

- Stakeholder 1: minimize costs
- Stakeholder 2: maximize amount of workstations
- Stakeholder 3: minimize total space usage

Because of the three different objective functions, also three solutions are generated. One optimized for each stakeholder.

SOLUTION 1: based on minimizing costs

- This solution is to implement 10 closed workstations
- in relation to constraints: used space of 100m², used budget of €5000, 10 workstations

Endogenous variables	Open W.S	Closed W.S			
Outcome	0	10			
Objective function 1	1000	500	5000	MIN	
Maximum space	5	10	100	<=	200
Maximum budget	1000	500	5000	<=	25000
Minimum W.S.	1	1	10	=>=	10

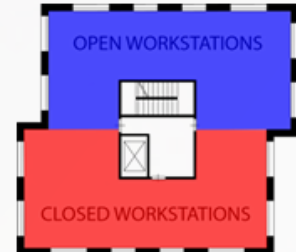


APPENDIX II: EXAMPLE LP.

SOLUTION 2: based on maximizing the amount of workstations

- This solution is to implement 20 open workstations and 10 closed workstations
- in relation to constraints: used space of 200m², used budget of €25000, 30 workstations

Endogenous variables	Open W.S	Closed W.S			
Outcome	20	10			
Objective function 2	-1	-1	-30	MIN	
Maximum space	5	10	200	=<=	200
Maximum budget	1000	500	25000	=<=	25000
Minimum W.S.	1	1	30	>=	10



SOLUTION 3: based on minimizing space usage

- This solution is to implement 10 open workstations
- in relation to constraints: used space of 50m², used budget of €10000, 10 workstations

Endogenous variables	Open W.S	Closed W.S			
Outcome	10	0			
Objective function 2	5	10	50	MIN	
Maximum space	5	10	50	<=	200
Maximum budget	1000	500	10000	<=	25000
Minimum W.S.	1	1	10	=>=	10



The desirability is measure in the following matrix. Here, the stakeholders mark the three different designs based on their criteria. To determine the scale, the stakeholder must at least mark one design as 0 and one design as 100, respectively fitting their goals the least and the most.

	STAKEHOLDER 1 (minimize costs) (sub criteria 1) (sub criteria 2) (sub criteria 3)	STAKEHOLDER 2 (maximize W.S.) (sub criteria 1) (sub criteria 2) (sub criteria 3)	STAKEHOLDER 3 (minimize space) (sub criteria 1) (sub criteria 2) (sub criteria 3)	Avg score	
SOLUTION 1 (10 closed W.S.)	100	0	80	60	Most desirable solution
SOLUTION 2 (20 open W.S, 10 closed W.S)	0	100	0	33	
SOLUTION 3 (10 open W.S.)	20	0	100	40	

The conclusion for the example is that solution 1 is the most desirable solution, because of the highest average mark.

STRATEGIE 1

FUNCTIEMIX OP IEDERE VERDIEPING

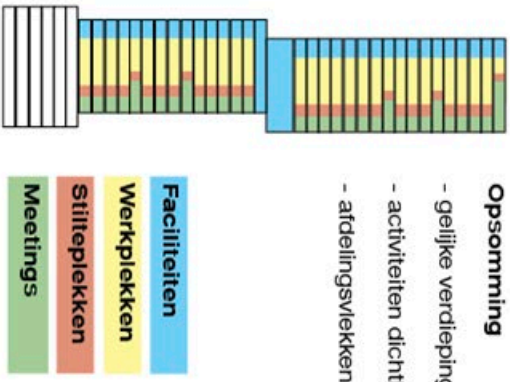
Overzicht

Category	Units	Size (m ²)	% of overall size
Overall size (m²)	40239	100%	
Used space (m²)	36376	88%	
Remaining function specific	1	€ 213,000	
Final realizations costs		36376	
Final space usage		2297	
Final amount of workstations			
Work & Meeting	Units	Size (m²)	% of overall size
Open flexible workstations	388	1209	3.02%
Hotdesks	307	486	1.22%
Hotdesks with workstations	430	946	2.35%
Open workstations	880	6436	16.00%
Concentration workstations	240	3930	9.77%
Closed workstations for 2 persons	0	0	0.00%
Closed workstations for 4 persons	N1	1836	4.81%
Hallopen meeting for 4 persons	13	100	0.25%
Hallopen meeting for 6 persons	30	450	1.19%
Hallopen meeting for 8 persons	30	450	1.19%
Closed meeting for 8 persons	30	450	1.19%
Closed meeting for 20 persons	5	250	0.65%
Facilities	Units	Size (m²)	% of overall size
Party (m ²)	589	589	1.52%
Living room (m ²)	200	1000	2.49%
Service unit (m ²)	279	627	1.57%
Vatolcke (m ²)	429	429	1.07%
Toilets (m ²)	627	627	1.57%
Overleg area (m ²)	1009	1009	2.51%
Lockers area (m ²)	237	237	0.59%
Waiting area (m ²)	974	974	2.42%
F&M client computers	0		
Specials	Units	Size (m²)	% of overall size
Post office	1	19	0.05%
Expedition room	1	19	0.05%
Storage cleaning	1	19	0.05%
Storage coffee vending	1	19	0.05%
Changing room	1	19	0.05%
Security room	1	19	0.05%
Voorkluis handigman	1	19	0.05%
Service point desk	50	50	0.13%
General storage	1	19	0.05%
Restaurant	1	104	2.61%
Coffee corner	1	500	1.25%
McDonald wafel	1	49	0.12%
Shower room	1	127	0.32%
Madam conference (12 persons)	4	100	0.25%
Large conference (20 persons)	6	300	0.75%
Large conference (60 persons)	1	156	0.39%
Unused space (m²)		4954	12.3%

Beschrijving

De eerste strategie lijkt het meest op het daadwerkelijke strategie. Hier is het belangrijk dat elke verdieping van alle functies een beetje heeft. In strategie 1 is het mogelijk afdelingsvleken te realiseren, en om bij directe collega's in de buurt te zitten, ook al hebben zeel op dat moment een andere "activiteit".

In deze strategie worden 2297 werkplekken gerealiseerd. De geschatte realisatiekosten zijn 12.213.000 euro. Schematisch ziet het er als volgt uit:



Floor	Large conference (60 persons)	Large conference (20 persons)	Large conference (12 persons)	Shower room	McDonald wafel	Coffee corner	Restaurant	Service point desk	Voorkluis handigman	Security room	Change room	Storage cleaning	Storage coffee vending	Post office	General storage	Service point desk	Service unit	Living room	Party	Waiting area	Overleg area	Toilets	Vatolcke	Expedition room	Hotdesks	Hotdesks with workstations	Open workstations	Closed workstations for 2 persons	Closed workstations for 4 persons	Closed workstations for 8 persons	Closed meeting for 8 persons	Closed meeting for 20 persons		
Floor 7																																		
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Floor 50																																		

STRATEGIE 2

FUNCTIEMIX VOOR HET GEBOUW IN HET GEHEEL

Overzicht

Overall size (m ²)	40229	100%	
Used space (m ²)	34835	87%	
Objective function results			
Final realizations costs	1	11.910.600	
Final space usage	34835		
Final amount of work at home	2297		
Work & Meeting			
Open flexible workstations	177	101	2,3%
Halligan flexible workstations	365	683	1,7%
Open workstations	706	488	11,4%
Halligan workstations	630	5396	13,4%
Concentration workstations	200	2030	6,5%
Closed workstations for 2 persons	0	0	0,0%
Closed workstations for 4 persons	63	1794	4,4%
Halligan meeting for 4 persons	8	80	0,2%
Halligan meeting for 6 persons	28	420	1,0%
Closed meeting for 6 persons	28	420	1,0%
Closed meeting for 8 persons	28	560	1,4%
Closed meeting for 20 persons	4	200	0,5%
Facilities			
Parking (m ²)	658	658	1,5%
Living room (m ²)	1039	1209	3,0%
Service unit (m ²)	279	279	0,7%
Verdeler (m ²)	627	627	1,6%
Toilet (m ²)	429	429	1,1%
Storage area (m ²)	627	627	1,6%
Lockers area (m ²)	1039	1209	3,0%
Waiting area (m ²)	287	287	0,7%
Valling area (m ²)	974	974	22,7%
Fat cabinet components	0	0	0,0%
Specials			
Post utility	1	19	0,0%
Exposition room	1	18	0,0%
Storage cleaning	1	18	0,0%
Storage coffee vending	1	18	0,0%
Changing room	1	18	0,0%
Storage room	1	18	0,0%
Workplace burglarman	1	38	0,1%
Service point desk	1	38	0,1%
General storage	1	19	0,0%
Restaurant	1	104	2,7%
Coffee corner	1	500	1,2%
Shower room	1	49	0,1%
Medical at wall	1	17	0,0%
Medium conference (12 persons)	4	120	0,3%
Large conference (20 persons)	6	300	0,7%
Large conference (80 persons)	1	625	1,6%
Unused space (m ²)	5394	5394	13,4%

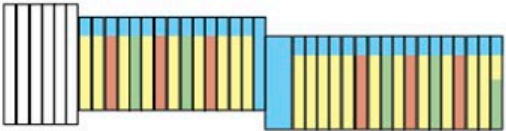
Beschrijving

Deze strategie laat de verdeling per verdieping los, en realiseert juist verdiepingen met één hoofd functie, namelijk werkplekken, stilleplekken of meetings. Hierdoor kunnen de verdiepingen veel specifiekter worden gericht op een activiteit, door meubilaar en huisregels. Wel voldoet het gehele plaatje nog aan de vereiste hoeveelheid plekken per activiteit. Afdelingsvlekken zijn onmogelijk hier. De verdiepingen zijn zo verdeeld dat een werknemer altijd in de buurt van een andere functieverdieping zit.

In strategie 2 worden ook 2297 werkplekken gerealiseerd. De geschatte realisatiekosten zijn 11.910.600 euro.

Opsomming

- één functie verdiepingen
- activiteit bepaald locatie
- geen afdelingsvlekken



- Faciliteiten**
- Werkplekken**
- Stilleplekken**
- Meetings**

Overview per Floor	Large conference (80 persons)	Large conference (20 persons)	Medium conference (12 persons)	Shower room	Medical at wall	Coffee corner	Restaurant	General storage	Service point at H	Workplace burglarman	Storage room	Changing room	Storage coffee vending	Storage cleaning	Exposition room	Post utility	Unused space	Verdeler	Waiting area	Lockers area	Storage area	Toilet	Service unit	Living room	Parking		
Floor 7																											
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STRATEGIE 3

RUIMTEBESPARING

Overzicht

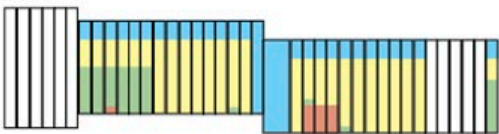
Facilities	Units	Size (m ²)	% of overall size
Overall size (m ²)	4029	800%	
Used space (m ²)	3271	79%	
Objective function results			
Final realizations costs	1 10,401,750		
Final Space usage	3271		
Final amount of workstations	2297		
Work & Meeting	Units	Size (m ²)	% of overall size
Open flexible workstations	4	36	0.11%
Halleagon flexible workstations	92	500	1.55%
Open workstations	189	729	17.92%
Halleagon workstations	848	593	13.72%
Concentration workstations	0	0	0.00%
Closed workstations for 2 persons	0	0	0.00%
Closed workstations for 4 persons	61	586	3.93%
Halleagon meeting for 4 persons	36	360	0.92%
Halleagon meeting for 6 persons	20	248	0.90%
Closed meeting for 8 persons	29	436	1.13%
Closed meeting for 6 persons	5	300	0.72%
Closed meeting for 20 persons	0	0	0.00%

Specials	Units	Size (m ²)	% of overall size
Post office	1	19	0.05%
Exposition room	1	19	0.05%
Storage cleaning	1	19	0.05%
Storage coffee vending	1	19	0.05%
Charging room	1	19	0.05%
Security room	1	19	0.05%
Workplace hangman	1	39	0.11%
Service point desk	1	39	0.11%
Geniet afdelink	1	19	0.05%
Geniet Storage	1	19	0.05%
Restaurant	1	1004	2.72%
Coffee corner	1	200	1.27%
Make aloud	1	69	0.23%
Shower room	4	137	0.33%
Medium conference (12 persons)	4	120	0.33%
Large conference (20 persons)	1	300	0.72%
Large conference (60 persons)	6	75	0.72%
Unused space (m ²)		908,5	22.52%

Beschrijving

De derde strategie toont aan dat het gehele huisvestingsvraagstuk ook kan worden uitgevoerd op 5 verdiepingen minder. Om dit waar te kunnen maken heeft het model gekozen voor 4 persoons gesloten ruimtes voor concentratie werk, en andere ruimte winnende elementen. Nog steeds wordt er aan de eisen van de activiteitgericht plekken voldaan. De overige 5 verdiepingen kunnen voor een andere functie worden gebruikt, of worden onderverhuurd.

In deze strategie worden ook 2297 werkplekken gerealiseerd. De geschatte realisatiekosten zijn 10.401.750 euro. Schematisch ziet het er als volgt uit:



Opsomming

- ruimte efficiënt
- besparingen op huur
- plek voor nieuwe functie



Deel van de vloer

Functie	Floor 7	Floor 8	Floor 9	Floor 10	Floor 11	Floor 12	Floor 13	Floor 14	Floor 15	Floor 16	Floor 17	Floor 18	Floor 19	Floor 20	Floor 21	Floor 22	Floor 23	Floor 24	Floor 25	Floor 26	Floor 27	Floor 28	Floor 29	Floor 30	Floor 31	Floor 32	Floor 33	Floor 34	Floor 35	Floor 36	Floor 37	Floor 38	Floor 39	Floor 40				
Large conference (60 persons)																																						
Medium conference (12 persons)																																						
Small meeting																																						
Workplace																																						
Storage cleaning																																						
Post office																																						
Geniet afdelink																																						
Service point desk																																						
Workstation																																						
Meeting																																						
Stilleplekken																																						
Werkplekken																																						
Faciliteiten																																						

STRATEGIE 4

HOGERE DICHTHEID

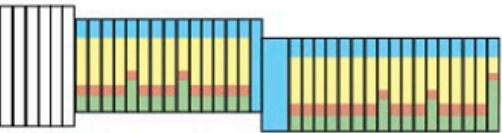
Overzicht

Overall size (m ²)	40229	100%	
Used space (m ²)	38536	95%	
Objective function results			
Final realizations costs	1	13.717.900	
Final space usage	38536		
Final amount of workstations	3140		
Work & Meeting			
Open flexible workstations	158	1287	3,2%
Halligren flexible workstations	119	774	1,9%
Open workstations	181	757	19,0%
Halligren workstations	945	6143	15,2%
Concentration workstations	57	741	1,8%
Closed workstations for 2 persons	0	0	0,0%
Closed workstations for 4 persons	80	480	10,3%
Halligren meeting for 4 persons	5	90	0,1%
Halligren meeting for 6 persons	31	440	1,2%
Closed meeting for 6 persons	35	575	1,3%
Closed meeting for 8 persons	18	380	0,9%
Closed meeting for 20 persons	7	390	0,9%
Facilities			
Pantry (m ²)	589	589	1,5%
Lobby room (m ²)	1500	1200	3,0%
Service unit (m ²)	279	279	0,7%
Wardrobe (m ²)	627	627	1,6%
Toilet (m ²)	429	429	1,1%
Storage area (m ²)	627	627	1,6%
Locker area (m ²)	1009	1009	3,0%
Waiting area (m ²)	297	297	0,7%
Waiting area (m ²)	974	974	2,2%
Fat diet computers	0		
Specials			
Post office	1	19	0,0%
Exposition room	1	19	0,0%
Storage cleaning	1	19	0,0%
Storage coffee vending	1	19	0,0%
Changing room	1	19	0,0%
Security room	1	19	0,0%
Workplace handgrip	1	33	0,1%
Service point desk	1	50	0,1%
General storage	1	19	0,0%
Restaurant	1	1004	2,7%
Coffee corner	1	900	1,2%
Mac-desa veld	1	69	0,2%
Shower room	4	157	0,3%
Medium conference (12 persons)	4	120	0,3%
Large conference (20 persons)	6	300	0,7%
Large conference (60 persons)	1	126	0,3%
Unused space (m ²)	7935	794	2,0%

Beschrijving

De laatste strategie optimaliseert op het aantal werkplekken. Hiervoor is er uitgegaan dat met kleine aanpassingen aan de installaties, liften en vluchtwegen, er per etage 15 personen extra aanwezig mogen zijn. De hogere kosten hiervoor, en de hogere realisatiekosten moesten dan worden afgewogen tegen de optie van een extra kantoorlocatie.

In deze strategie worden 3140 werkplekken gerealiseerd. De geschatte realisatiekosten zijn 13.717.900 euro. Schematisch ziet het er als volgt uit:



- Opsomming**
- ondersteunt meer FTE
- aanpassingen nodig
- ruimte efficiënt
- hogere kosten
- Faciliteiten**
- Werkplekken**
- Stilleplekken**
- Meetings**

Overzicht per Floor

Floor	Open flexibel	Halligren flexibel	Open	Halligren	Concentratie	Gesloten 2 pers	Gesloten 4 pers	Gesloten 6 pers	Gesloten 8 pers	Gesloten 20 pers	Faciliteiten	Specials
Floor 7	0	0	0	0	0	0	0	0	0	0	0	0
Floor 8	0	0	0	0	0	0	0	0	0	0	0	0
Floor 9	0	0	0	0	0	0	0	0	0	0	0	0
Floor 10	0	0	0	0	0	0	0	0	0	0	0	0
Floor 11	0	0	0	0	0	0	0	0	0	0	0	0
Floor 12	0	0	0	0	0	0	0	0	0	0	0	0
Floor 13	0	0	0	0	0	0	0	0	0	0	0	0
Floor 14	0	0	0	0	0	0	0	0	0	0	0	0
Floor 15	0	0	0	0	0	0	0	0	0	0	0	0
Floor 16	0	0	0	0	0	0	0	0	0	0	0	0
Floor 17	0	0	0	0	0	0	0	0	0	0	0	0
Floor 18	0	0	0	0	0	0	0	0	0	0	0	0
Floor 19	0	0	0	0	0	0	0	0	0	0	0	0
Floor 20	0	0	0	0	0	0	0	0	0	0	0	0
Floor 21	0	0	0	0	0	0	0	0	0	0	0	0
Floor 22	0	0	0	0	0	0	0	0	0	0	0	0
Floor 23	0	0	0	0	0	0	0	0	0	0	0	0
Floor 24	0	0	0	0	0	0	0	0	0	0	0	0
Floor 25	0	0	0	0	0	0	0	0	0	0	0	0
Floor 26	0	0	0	0	0	0	0	0	0	0	0	0
Floor 27	0	0	0	0	0	0	0	0	0	0	0	0
Floor 28	0	0	0	0	0	0	0	0	0	0	0	0
Floor 29	0	0	0	0	0	0	0	0	0	0	0	0
Floor 30	0	0	0	0	0	0	0	0	0	0	0	0
Floor 31	0	0	0	0	0	0	0	0	0	0	0	0
Floor 32	0	0	0	0	0	0	0	0	0	0	0	0
Floor 33	0	0	0	0	0	0	0	0	0	0	0	0
Floor 34	0	0	0	0	0	0	0	0	0	0	0	0
Floor 35	0	0	0	0	0	0	0	0	0	0	0	0
Floor 36	0	0	0	0	0	0	0	0	0	0	0	0
Floor 37	0	0	0	0	0	0	0	0	0	0	0	0
Floor 38	0	0	0	0	0	0	0	0	0	0	0	0
Floor 39	0	0	0	0	0	0	0	0	0	0	0	0
Floor 40	0	0	0	0	0	0	0	0	0	0	0	0

VERBETERDE STRATEGIE

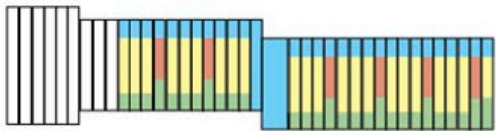
Overzicht

Overall size (m ²)	40329	100%
Used space (m ²)	32451	80%
Objective function result		
Final realisation costs	1	23.237.800
Final space usage	32451	
Final amount of workstations	2297	
Work & Meeting		
Open meeting workstations	10	0,32%
Open meeting workstations	10	0,32%
Open local workstations	1075	32,5%
Open local workstations	1075	32,5%
Hallopen workstations	576	16,3%
Hallopen workstations	576	16,3%
Concentrated workstations	30	0,9%
Concentrated workstations	30	0,9%
Closed workstations for 2 persons	429	12,4%
Closed workstations for 2 persons	429	12,4%
Closed workstations for 4 persons	88	2,5%
Closed workstations for 4 persons	88	2,5%
Hallopen meeting for 4 persons	21	0,5%
Hallopen meeting for 4 persons	21	0,5%
Hallopen meeting for 6 persons	25	0,7%
Hallopen meeting for 6 persons	25	0,7%
Private meeting for 6 persons	20	0,6%
Private meeting for 6 persons	20	0,6%
Conferencing for 20 persons	6	0,2%
Conferencing for 20 persons	6	0,2%
Facilities		
Living room (m ²)	522	1,5%
Living room (m ²)	522	1,5%
Smoker room (m ²)	240	0,7%
Smoker room (m ²)	240	0,7%
Value office (m ²)	522	1,5%
Value office (m ²)	522	1,5%
Coffee (m ²)	364	1,0%
Coffee (m ²)	364	1,0%
Storage area (m ²)	292	0,9%
Storage area (m ²)	292	0,9%
1 rest area (m ²)	180	0,5%
1 rest area (m ²)	180	0,5%
Waiting area (m ²)	226	0,7%
Waiting area (m ²)	226	0,7%
Waiting area (m ²)	789	2,3%
Waiting area (m ²)	789	2,3%
Far alone computer	89	0,3%
Far alone computer	89	0,3%
Opzetplan		
Port office	1	0,0%
Port office	1	0,0%
Exhibition room	8	0,0%
Exhibition room	8	0,0%
Storage cleaning	8	0,0%
Storage cleaning	8	0,0%
Storage coffee vending	10	0,0%
Storage coffee vending	10	0,0%
Changing room	8	0,0%
Changing room	8	0,0%
Storage room	8	0,0%
Storage room	8	0,0%
Value office (m ²)	30	0,1%
Value office (m ²)	30	0,1%
Coffee point desk	20	0,1%
Coffee point desk	20	0,1%
General storage	8	0,0%
General storage	8	0,0%
Coffee corner	1327	3,3%
Coffee corner	1327	3,3%
Medical ward	690	1,7%
Medical ward	690	1,7%
Medical ward	60	0,2%
Medical ward	60	0,2%
Show room	107	0,3%
Show room	107	0,3%
Medium conference (12 persons)	3	0,0%
Medium conference (12 persons)	3	0,0%
Large conference (20 persons)	4	0,0%
Large conference (20 persons)	4	0,0%
Large conference (50 persons)	65	0,2%
Large conference (50 persons)	65	0,2%
Used space (m ²)	7879,5	19,5%
Used space (m ²)	7879,5	19,5%
Financial		
Realisation costs	1	23.237.800
Realisation costs	1	23.237.800
Facility costs	1	305.956
Facility costs	1	305.956
Medical costs	1	3.987.517
Medical costs	1	3.987.517

Beschrijving

Deze strategie is het resultaat van het combineren van de sterke punten van de 4 vorige strategien, en deze punten implementeren als eisen aan het ontwerp. Er is een verdeling tussen werkplek verdiepingen, en concentratie verdiepingen. Op de concentratie verdiepingen bevinden zich ook de gesloten overlegruimtes, terwijl op de werkplek verdiepingen enkele hallopen overlegplekken worden gerealiseerd. Daarnaast zal deze strategie 3 verdiepingen leeg laten voor ander gebruik of onderhoud.

In deze strategie worden 2297 werkplekken gerealiseerd. De geschatte realisatiekosten zijn 23.237.800 euro. Schematisch ziet het er als volgt uit:



Opsomming

- 2 types verdieping
- activiteiten dichtbij elkaar, maar niet altijd zelfde vloer
- afdelingsvlekken mogelijk
- 3 verdiepingen besparing



Overview per floor

Floor	Open meeting workstations	Open local workstations	Hallopen workstations	Concentrated workstations	Closed workstations for 2 persons	Closed workstations for 4 persons	Hallopen meeting for 4 persons	Hallopen meeting for 6 persons	Private meeting for 6 persons	Conferencing for 20 persons	Living room	Smoker room	Value office	Coffee	Storage area	1 rest area	Waiting area	Far alone computer	Port office	Exhibition room	Storage cleaning	Storage coffee vending	Changing room	Storage room	Value office	Coffee point desk	General storage	Coffee corner	Medical ward	Medical ward	Show room	Medium conference	Large conference	Large conference			
Floor 1																																					