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Department of Industrial Engineering and Management
Master's Thesis

Multi Criteria Decision Analysis on Real Estate Portfolio Management

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UNIVERSITY OF OULU **Thesis Abstract**
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Abstract

The thesis applies the theories of Multi Criteria Decision Analysis (MCDA) with a constructive research to the environment of real estate portfolio management. The aim of the research is to create a preference model for sorting real estates.

There are multiple conflicting and incommensurable criteria involved in MCDA that cause a challenging decision situation for the decision maker. The advantage of using MCDA is decision maker's ability to learn and understand both his own and others' values and judgments. These benefits are received by actions such as taking the decision maker's preferences into account and concerning the decision problem explicitly by structuring and synthesizing the information. Previously, Multi Attribute theories have been successfully applied to the portfolio selection of road pavement and bridge repairing projects, for example.

The research was implemented in three sections from which the first one was a theoretical review that sought to present the basics of MCDA by defining the Multi Attribute Value Theory (MAVT) process. After theoretical review followed the data collection and analysis that aimed to identify the guiding criteria for the decision making and the attributes by which the achievement of the criteria being measured. The thesis was outlined to consider only the effect of the property specific endogenous factors. The last section of the study, construction, applies the information got from the previous sections by creating a preference model for the decision making of property portfolio management. The process and value tree described in the study were constructed from the perspective of real estate owners who own properties only as an investment.

As a result of the thesis, five criteria were formed by which the sorting of real estates is evaluated. The criteria were: a macro location that seeks to describe the macro environmental development, a micro location that takes a stand on how reachable the real estate is, a contract price that presented the income side of the cash flow, a repairing need that was included because it has a high effect on the outcomes, and the ability to develop which means the capability of a building to produce financial benefits with the development operations. The suggested attributes for the criteria were for macro location the new construction production of the property type in relation to the development of areal GDP, for micro location the transportation time and type from the areal center, for the contract price the average of the contract prices in relation to the area of each rental agreement, for repairing needs the repairing costs got from the long term repairing plan and for ability to develop was seen that best option to measure the achievement of it would be expert opinion. The study did not take a stand on the weights of the criteria nor the value functions of the attributes because it would require focusing on the single real estate investor whereas this thesis was desired to keep on the general level.

As a whole, it was concluded that creating a universal model for sorting real estates is not possible because of the unique nature of the weights and value functions. Therefore it would be more appropriate to execute the model constructing process with the case investor. The process described in this study should, however, give readiness to create a preference model for the investors that were in the focus of this work. The preference model formed as a result of the process will propose an interest of sorting based on the endogenous property specific features. However, the model should be used only as an assistance in decision making so that the decision maker would use it to support his decisions.

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OULUN YLIOPISTO **Tiivistelmä opinnäytetyöstä**
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Monikriteeriset päätösanalyysiteoriat kiinteistöportfoliohallinnassa

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Tiivistelmä

Diplomityö pyrkii konstruktiivisen tutkimuksen avulla soveltamaan monikriteerisiä päätösanalyysiteorioita (Multi Criteria Decision Analysis - MCDA) kiinteistöportfoliohallinnan päätöksentekoon. Teorioita sovelletaan työssä kehittämällä kiinteistöportfoliohallinnan päätöksentekoa avustava malli.

MCDA on oppi metodeista ja lähestymistavoista, joissa eri vaihtoehtojen paremmuutta arvioidaan suhteessa päätöksentekijän asettamiin tavoitteisiin. Teorioiden käsittelemien päätösongelmien luonteeseen kuuluvat useat ristiriitaiset ja yhteismitattomat kriteerit, jotka tekevät päätöksenteosta erittäin haasteellista. MCDA:n tuoma arvo päätöksentekoon syntyy sen jäsennellystä ja selkeästä tavasta käsitellä päätösongelmaa, minkä johdosta päätöksentekijä tulee tietoisemmaksi itse päätösongelmasta sekä omista ja muiden sidosryhmien arvoista ja tavoitteista. Monikriteerisiä päätösanalyysiteorioita on sovellettu aiemmin esimerkiksi infrapuolella siltojen kunnossapitoprojektien valintaan. Kehitetyn matemaattisen mallin avulla pystyttiin analyyttisesti arvioimaan kunkin vaihtoehdon hyvyyttä ja poimimaan siltakannasta eniten päätöksentekijän tavoitteita vastaavat kohteet.

Tutkimus toteutettiin kolmessa osiossa, joista ensimmäisessä selvitettiin MCDA:n perusteet määrittämällä kirjallisuuskatsauksen avulla päätöksentekijän preferenssejä mallintava MAVT-prosessi. Kirjallisuuskatsauksen jälkeen seurasi työn empiirinen osio, mikä pyrki haastatteluiden avulla selvittämään kiinteistöportfoliohallinnan päätöksentekoa ohjaavat kriteerit ja niiden toteutumista mittaavat attribuutit. Työ keskittyi käsittelemään vain kiinteistökohtaisten sisäsyntyisten tekijöiden vaikutusta kiinteistöportfoliohallintaan. Lopuksi empiriasta saatujen tuloksien pohjalta kuvattiin MAVT prosessi kyseessä olevassa kontekstissa ja kehitettiin esimerkkimalli kiinteistöportfoliohallinnan päätöksenteon tueksi. Esitetty malli on suunnattu yksityisille kiinteistönomistajille, jotka omistavat liike- ja toimistokiinteistöjä vain sijoitusmielessä.

Tutkimuksen tuloksena saatiin viisi kiinteistöportfoliohallinnan päätöksentekoa ohjaavaa kriteeriä: makrosijainti, mikrosijainti, sopimushinta, kiinteistön korjaustarpeet ja kiinteistön kehittymiskyky. Sijainti kriteerit pyrkivät huomioimaan sekä makroympäristön kehittymisen että kiinteistön saavutettavuuden. Sopimushinta ja kiinteistön korjaustarpeet puolestaan kuvaavat kiinteistön kassavirran negatiivisen ja positiivisen puolen tärkeimpiä tekijöitä. Kiinteistön kehittymiskyvyllä tarkoitetaan kuinka paljon kehitystoimenpiteillä nähdään saatavan taloudellista hyötyä. Edelle mainittujen kriteereiden attribuuteiksi ehdotettiin makrosijainnille alueellisen BKT:n suhdetta uusiin rakennushankkeisiin, mikrosijainnille keskimääräistä matka-aikaa ja kulkuvälinevaihtoehtoja aluekeskukseen, sopimushinnalle kohteen sopimushintojen neliöillä painotettua keskiarvoa, korjaustarpeille pitkän tähtäimen suunnitelmasta saatavaa korjaustarvearviota ja kiinteistön kehittymiskyvylle asiantuntijan toteuttamaa arviota kiinteistön kehityskelpoisuudesta. Tutkimus ei ottanut kantaa kriteereiden painotukseen tai attribuuttien mittaustulosten pisteyttämiseen, koska työ haluttiin pitää yleisellä tasolla ja edellä mainitut toimenpiteet olisivat vaatineet työn rajaamista koskemaan vain yhtä kiinteistösijoittajaa.

Kokonaisuudessaan nähtiin, että yleisen mallin kehittäminen kiinteistöportfoliohallintaan on mahdotonta, johtuen mallissa käytettävien painotusten ja arvofunktioiden yksilöllisestä luonteesta. Tästä johtuen preferenssimallin laadinta olisikin parempi toteuttaa käyttäen vain yhtä kiinteistönomistajaa. Tässä työssä kuvattu prosessi antaa kuitenkin työn kohteena olleille kiinteistönomistajille valmiudet luoda kvantitatiivinen malli oman päätöksenteon tueksi. Prosessin tuloksena saatava malli ehdottaa perustuen kiinteistön sisäsyntyisiin tekijöihin, miten kiinteistöt tulisi lajitella eri salkkuihin. Malli on kuitenkin tarkoitettu vain päätöksentekijän avuksi, ei päätöksentekijäksi.

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Muita tietoja

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Eemeli Antinmaa
Oulussa, 18.12.2012

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1 Introduction

Real estate as an investment asset has widely found favor with investors. For a real estate investor, managing the real estate portfolio is a crucial task by which the continuing and high incomes of investment asset are ensured. Portfolio management includes decisions related e.g. to acquisition, keeping, developing, and selling real estates. Generally, the management of the investment portfolio is mostly based on Modern Portfolio Theory (MPT) that simply attempts to minimize the risks in relation with a given level of expected profits. However, this theory is mainly meant for "paper assets" like shares and bonds, and therefore its suitability for the real estate portfolio management has been under criticism. (Hishamuddin 2006, Hoesli & Macgregor 2000) The criticism results from the distinctive characteristics of real estates as an investment asset such as fixed location, heterogeneity, high unit value, and illiquidity (Hoesli & Macgregor 2000).

Referring to previous, managing a real estate portfolio is not an easy task and finding a precise framework of real estate portfolio creation is challenging (Hishamuddin 2006). Additionally, decision making in the real estate portfolio management is affected by multiple conflicting and not commensurable distinct set of physical, market-related, legal, and financial characteristics (Pyhrr *et al.* 1989). Thus, it is challenging to take all these factors into account when making decisions that matter. By courtesy of portfolio management challenges, there is a need for the formal model that explicitly structures and synthesizes the information. These challenges work as a starting point of this study that will be done as a development project for Pöyry Finland Ltd.

This thesis will take a closer look at the problem of managing real estate portfolios. It applies one of the multi criteria decision analysis theories called Multi Attribute Value Theory to the decision making in real estate portfolio management. Multi Criteria Decision Analysis (MCDA, also known as MCDM), i.e. Multi Criteria Decision Making) is a study of methods and approaches that take multiple criteria into account when assisting a decision maker to make decisions that matter (Belton & Steward 2002). One of the main principal aims of MCDA, according to Belton & Steward 2002, is to "facilitate decision makers' learning about and understanding of the problem faced and realizing organizational as well as their own and other parties' priorities, values and objectives and through exploring these in the context of the problem to guide them in identifying a preferred course of action." Multi attribute value theory (MAVT) instead, is one of the theories inside the broad context of MCDA that have roughly the same process and aims like MCDA. However, unique characteristics can be seen when executing the theory.

In MAVT, the degree to which one decision option may be preferred to another is described in the hierarchic structuring model called "value tree". The value tree consists of the fundamental objectives, criteria, attributes and alternatives. Fundamental

objectives mean essential reason for the interest in a current decision situation, and criteria equals factors by which decision is evaluated and judged. Whereas alternatives are simply the subjects of evaluation and attributes are the factors that are used to measure alternative's degree to which criterion is achieved. The value tree is built so that the fundamental objective is on the top and criteria form the branches of the tree. Criteria can be cut up into even more specific "sub-criteria" and finally to the lowest level objectives, i.e. attributes. The criteria in the value tree are "weighted" according to their importance for the decision maker, and decision alternatives are valued in relation to these criteria. As a result of this analysis an overall value which describes the relative advantages of the alternatives will be achieved. After the preference analysis, the results can be concerned with a sensitivity analysis, and the effects of the changes in the weights of the criteria on the overall value can be explored. (Keeney & Raiffa 1976)

Applying MCDA methods to the decision making of real estate management is scarcely studied. Still, MCDA in general is a well-studied area. Some examples of application can be found in different environments; e.g. the Robust Portfolio Modeling (RPM) has been tested to the portfolio selection of road pavement and bridge repairing projects. As a conclusion of road pavement experiment, the real decision makers suggested that using RPM for multi-criteria portfolio selection problems was intuitively appealing and transparent (Liesiö *et al.* 2006). In the study of bridge repairing projects, work group found that RPM was an encouraging approach for concerning multi-criteria problems systematically (Mild 2006a).

Normally, the value gained from using MCDA methods is hard to prove numerically or other concrete way. However, the best advantage of using it is learning about and understanding the decision situation in question (Belton & Steward 2002), because learning about and understanding the faced problem is advancing people's competence as decision makers. Furthermore, as Keeney 2004a notes, teaching people to become better decision makers is worth a while because it is the only way people can purposefully influence their lives.

1.1 Research Objective, Questions, and Approach

The fundamental aim of the thesis is to create a preference model for property portfolio management. Work seeks to construct a MCDA based quantitative model for sorting real estates into different classes, to be precise. Reflecting to the previous object of the research, the three research questions can be stated:

Q1: What are the elements of MCDA?

In the environment of real estate portfolio management

Q2: What criteria are guiding the decision making and by which attributes are the achievement of the criteria being measured?

Q3: What kind of preference model can be created?

The generation of the model is implemented as constructive research where the existing theories of MCDA are applied into the environment of real estate portfolio management. The research logic of the thesis is illustrated in Figure 1 where every step of the construction process of the preference model can be seen. In the following, the phases

of the study will be described shortly while the more specific description of the research method will be presented in Chapter 3.1.

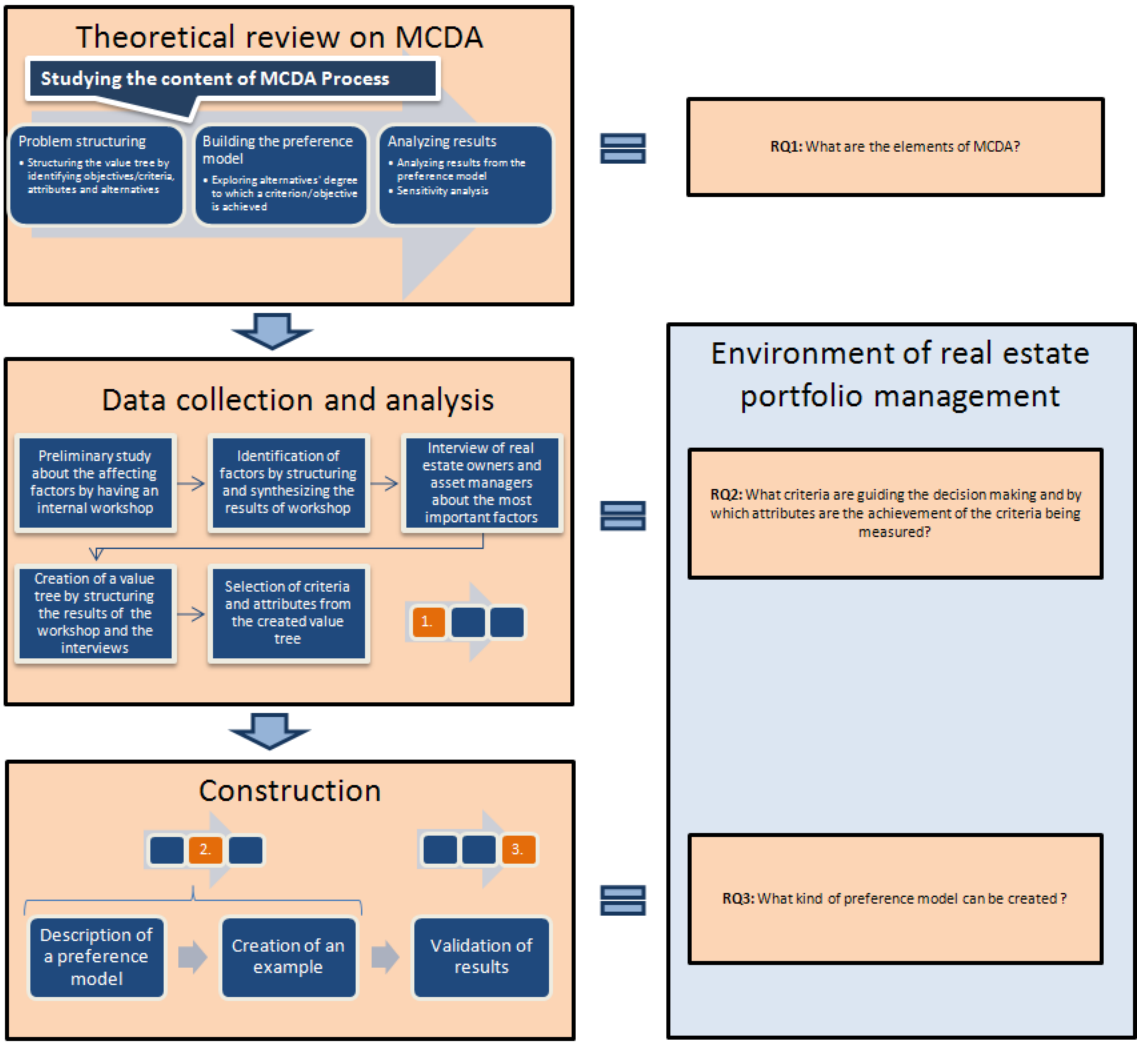


Fig. 1. **Research logic of the thesis**

To begin with, the basics of MCDA are presented by defining the phases of MAVT process. The identification is implemented with the theoretical review by studying written articles and literature on the issue. The results of the review work as a base for the empirical study by giving a picture about the possibilities and constraints of the multi criteria methods. Furthermore, the latter phases of the study; data collection and analysis, and the construction, follow the identified MAVT process as shown in Figure 1.

After theoretical review, follows the data collection and analysis that match with the content of the problem structuring of MAVT process. The main target of this phase is to identify the guiding criteria for the decision making and the attributes by which the achievement of the criteria is measured. The process where previous objects were achieved included several steps. First, all the affecting factors were listed in Pöyry Finland Ltd's internal workshop. This preliminary study worked as a preparation for the latter interviews because it defined the content of the enquiry. Furthermore, the results of the brainstorming were used in the latter creation of a value tree. As a result of the workshop will not, however, received a list of unambiguous factors since they are needed for the creation of enquiries. Therefore the data from the list needs to be structured and synthesized so that the real purpose of the factor can be seen and the factors with the same aim are deleted.

The data about the most important factors and attributes are collected by interviewing real estate owners and asset managers. The meaning of the interview is to prioritize the factors that guide the decision making in real estate portfolio management. Prioritizing is needed because not all of the affecting factors can be included in the model when trying to keep it as simple as possible. As a further result from the interviews, some attribute suggestions by which the achievement the criteria are measured emerged. These are again crucial features to facilitate the creation of the model in the first place.

The value tree demonstrates the whole decision environment of property portfolio management by presenting a network of fundamental objectives and means-ends objectives. The tree is created by structuring the data got from the workshop and the interviews and the methods presented in the written theories give their support in this process. The value tree is created because it helps to see the decision situation as a whole and hence makes the creation of the preference model easier. Furthermore, illustrating the factors in a logical network verifies the understanding about the affecting features. The final criteria and attributes are selected by using the new understanding about the decision situation achieved from the workshop, the interviews and the value tree.

The last section of the study, construction, includes the remaining phases of MACD process, the model creation and the result analysis. The construction applies the information got from the previous sections by creating a preference model for decision making. The idea of the construction is to describe the model creation process, present an example model and validate the model creation process. An example model for real estate portfolio management is created to demonstrate the operation of the described process and make the idea behind the preference model more understandable. The example was created by following the described process and using hypothetic values as an input data.

The model described in the construction was evaluated by real estate owners and asset managers who estimated how well the model meets their preferences and would the model work in practice. Evaluations were conducted in order to discover the validity of the model.

1.2 Scope of the Study

The aim of this chapter is to specify the scope of the study by describing the outlines of the work. As mentioned in the introduction chapter, MCDA is a broad concept that covers multiple schools and theories, and therefore it needs to be outlined in order to efficiently test its value for decision making in real estate portfolio management. The thesis is limited in extent, so it deals with only one MCDA theory, namely MAVT. Inside the MAVT, some outlining related to model creation and criteria weighting has also been done. All this outlining was selected for this study because of its simplicity and wide popularity. Especially the simplicity of the theory is important aspect in this kind of pilot project, because it helps the central idea of the theory in question to be easily explained and understood. Moreover, user-friendliness and the ease of adoption have been seen as essential characteristics of the acceptance of the approach (Mild 2006, Archer and Ghasemzadeh 1999, Cooper *et al.* 2001).

From the perspective of real estate portfolio management, this thesis focuses on Finnish real estate owners who own properties only as an investment. Furthermore, real estate type has been outlined to office- and business properties, and portfolio

management in this work concentrates in the existing stock of real estate. These outlines support Pöyry Finland Ltd.'s business operations and make model creation more simple.

When concerning the sorting process, the thesis focuses on the analysis made on the property level. Furthermore, on the property level the endogenous factors of the real estate are in the center. Therefore, evaluating properties on the portfolio level is not in the scope of the study, although it has more importance for sorting decision than the property level analysis. The study was outlined on the property level because it was seen that the endogenous factors matter more on that level, and because on the other hand, endogenous factors were more in the interest of Pöyry Finland Ltd.

1.3 Structure of the Thesis

The thesis starts with a section that addresses the theoretical framework of Multi Criteria Decision Analysis (MCDA) and Multi Attribute Value Theories (MAVT). The first chapters of the section observe broadly the concept of MCDA and its aims. In the latter parts of the section, a closer view to MAVT is taken. The theory describes all the crucial characteristics of MAVT related to the subject of the thesis such as the general process of MAVT, problem structuring, model creation, and result analysis.

In the beginning of the next section, the research logic of the thesis will be described. After the research method follows a short description about the context of the study, which first gives a short overlook of the real estate management generally and then a more specific look at real estate portfolio management. When the research environment of the work has been described, follows the empirical part of the study. In that part, the empirical results of the study will be presented and analyzed.

Section 4 synthesizes the results of the empirical study by first describing a process of the preference model creation in the environment of property portfolio management. After the process illustration, an example model that is created by using hypothetic values will be presented. At the end of this section, real estate owners' and asset managers' evaluations of how well the model constructed as a result of the process meets their own preferences.

The last section presents the contribution of the work and observes the research process critically. Furthermore, it suggests multiple subjects for further research that have emerged during the work.

2 Theoretical Review on Multi Criteria Decision Analysis

This section deals with the theoretical framework of Multi Criteria Decision Analysis (MCDA) and Multi Attribute Value Theories (MAVT). The aim of the section is to create an image about the possibilities and restrictions of *(the)* MCDA. Required outlining has been conducted in order to make the theory meet the focus of the thesis as good as possible. In other words, the models and methods presented in the theoretical part are chosen to match the problem in question as good as possible. Outlines of the thesis have been validated more specifically in the following chapters.

The first three chapters give a broad view of MCDA by concerning issues such as how MCDA is defined, what are the aims of MCDA, what kind of decision situations are suitable for applying MCDA, and how the broad process of MCDA proceeds. In chapter 2.4, a closer overview to one of the most cited MCDA approaches called Multi-attribute value theory (MAVT) is taken. The whole process of MAVT aiding decision makers to make decisions that matter is described. Chapter 2.5 concerns roughly the multi-criteria portfolio models and how they differ from the basic multi-criteria models and how they are used in practice.

2.1 An Overview to Multi Criteria Decision Analysis

Decisions that require the balance of multiple criteria are constantly made in everyday life. These decisions include for example answers to questions such as what to eat, which shoes to wear, and when to wake up. These kind of decisions are so simple that they can easily be processed in one's head. Deciding on what shoes to wear, for example, requires the balance of criteria such as what is the weather like, what kind of activities you will do, and what kind of impression you want to make on other people. With the daily routines, the processing is usually made with intuition and without concerning or even noticing all the related criteria. However, the increase of stakeholders and criteria cause a decision situation where information is conflicting and complex. To the nature of the multiple criteria problem belongs also that information is reflected from different viewpoints and changes in the process of time. These challenges combined with the humans' limited capacity of processing multiple factors simultaneously cause a need for a formal model. (Belton & Steward 2002) With the help of a formal model, it is ensured that all the essential factors have been taken into account (SYKE 2008).

Multi Criteria Decision Analysis (*i.e.* MCDA, also known as MCDM, *i.e.* Multi Criteria Decision Making) is a study of methods and approaches that take multiple criteria into account when aiding (the) a decision maker to make decisions that matter (Belton & Steward 2002). The earliest references of Multi Criteria Decision Analysis methods can be traced back to the 17th century when Benjamin Franklin used his simple

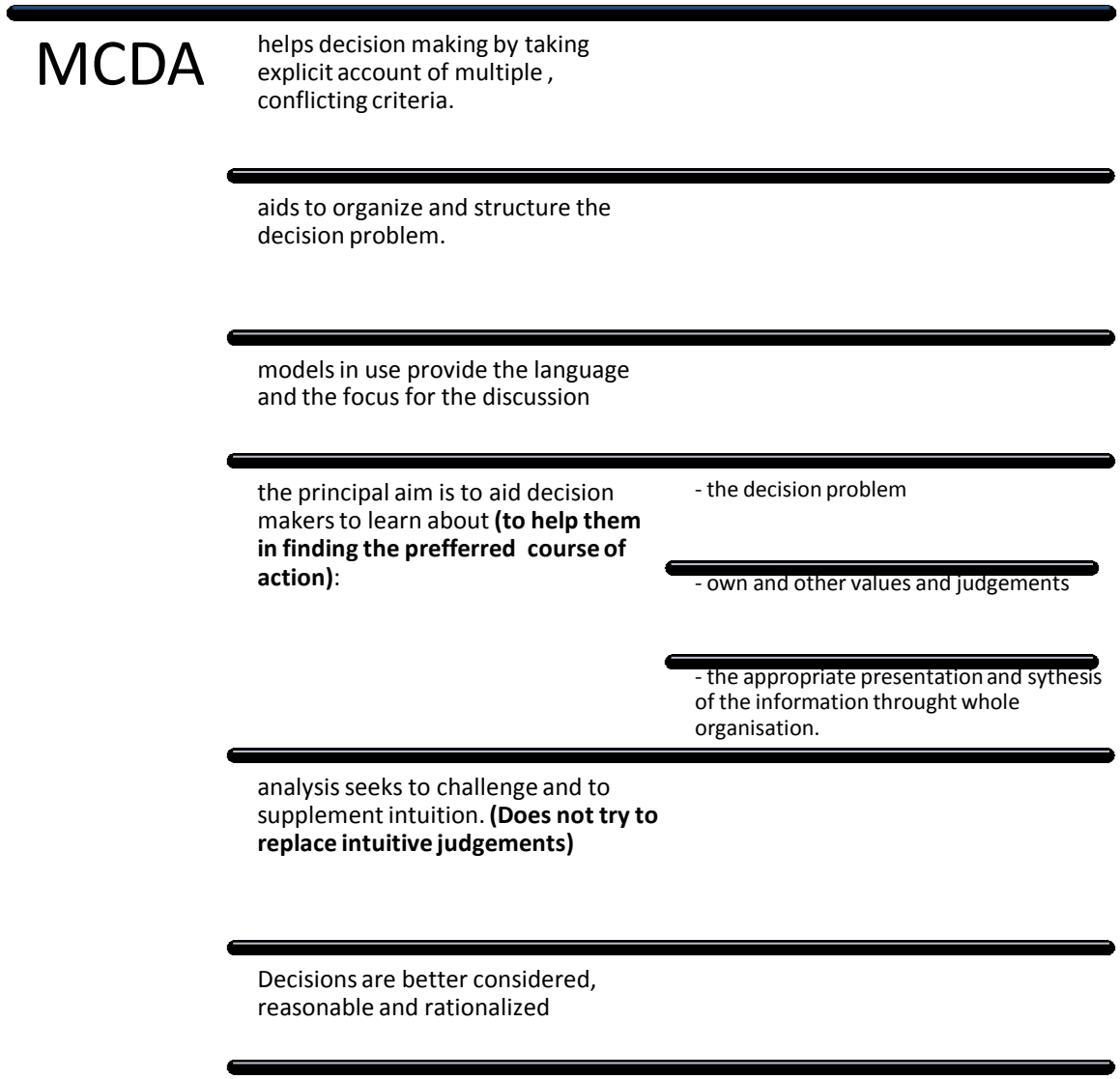
paper method to aid decision making (International MCDM Society 2012). Nowadays MCDA have become highly researched area, and there are a significant number of MCDA methods and schools (International MCDM Society 2012, Belton & Steward 2002).

Decision Analysis seeks to assist the decision maker to create explicit understanding about the problem under consideration by modeling the decision maker's subjective evaluations (Seppäläinen & Hämäläinen 1986) whereas MCDA is a decision analysis that concerns multiple criteria (SYKE 2008). Definitions of MCDA emphasize points such as the nature of concerning multiple conflicting and incommensurable criteria, taking decision makers preferences into account, concerning the decision problem explicitly, and structuring and synthesizing the information. Characteristics just presented can be found in the following definition of MCDA. "Multi-Criteria Decision Making (MCDM) is the study of methods and procedures by which concerns about multiple conflicting criteria can be formally incorporated into the management planning process" (International MCDM Society 2012). The following definition can be summarized from Belton & Steward's work: MCDA is a method where the preferences of different alternatives are analyzed in relation to the objectives set by the decision maker.

Different schools have their differences when we look at the methods and models of MCDA; however, principal aims are commonly the same (Belton & Steward 2002). According to Belton and Steward, one of the main principal aims of MCDA is to "facilitate decision makers' learning about and understanding of the problem faced, about their own, other parties' and organizational priorities, values and objectives and through exploring these in the context of the problem to guide them in identifying a preferred course of action." Referring to the previous citation, the learning process caused by MCDA is usually more important than the numerical values itself (SYKE 2008). Another important perspective is that MCDA does not give one right answer but the decisions are still made by a human (Belton & Steward 2002). In other words, MCDA should only work as a useful help in decision making, not as a substitute for the decision maker (Keeney 1992).

The way MCDA is utilized in decision making situation is based on structuring and synthesizing the information. Furthermore, it can be used as an aid in the value judgments which means prioritizing between the different criteria. This prioritizing is made by balancing the decision makers' preferences by giving relative "weights" for the criteria. (Belton & Steward 2002) The characteristics and aims of MCDA presented in this chapter have been synthesized in Table 1.

Table 1. The characteristics and aims of MCDA (Belton & Steward 2002).



2.2 Favorable Environments for Implementation

As already defined, MCDA offers methods that concern multiple conflicting and *(not)* incommensurable criteria, take decision makers preferences into account, observe the decision problem explicitly and structure and synthesize the information. When the previous list is turned the other way round, we will have the list of the grounds for applying MCDA. In the first chapter, some of the points where the use of MCDA is validated were mentioned. However, the more comprehensive list of the grounds is presented in Table 2.

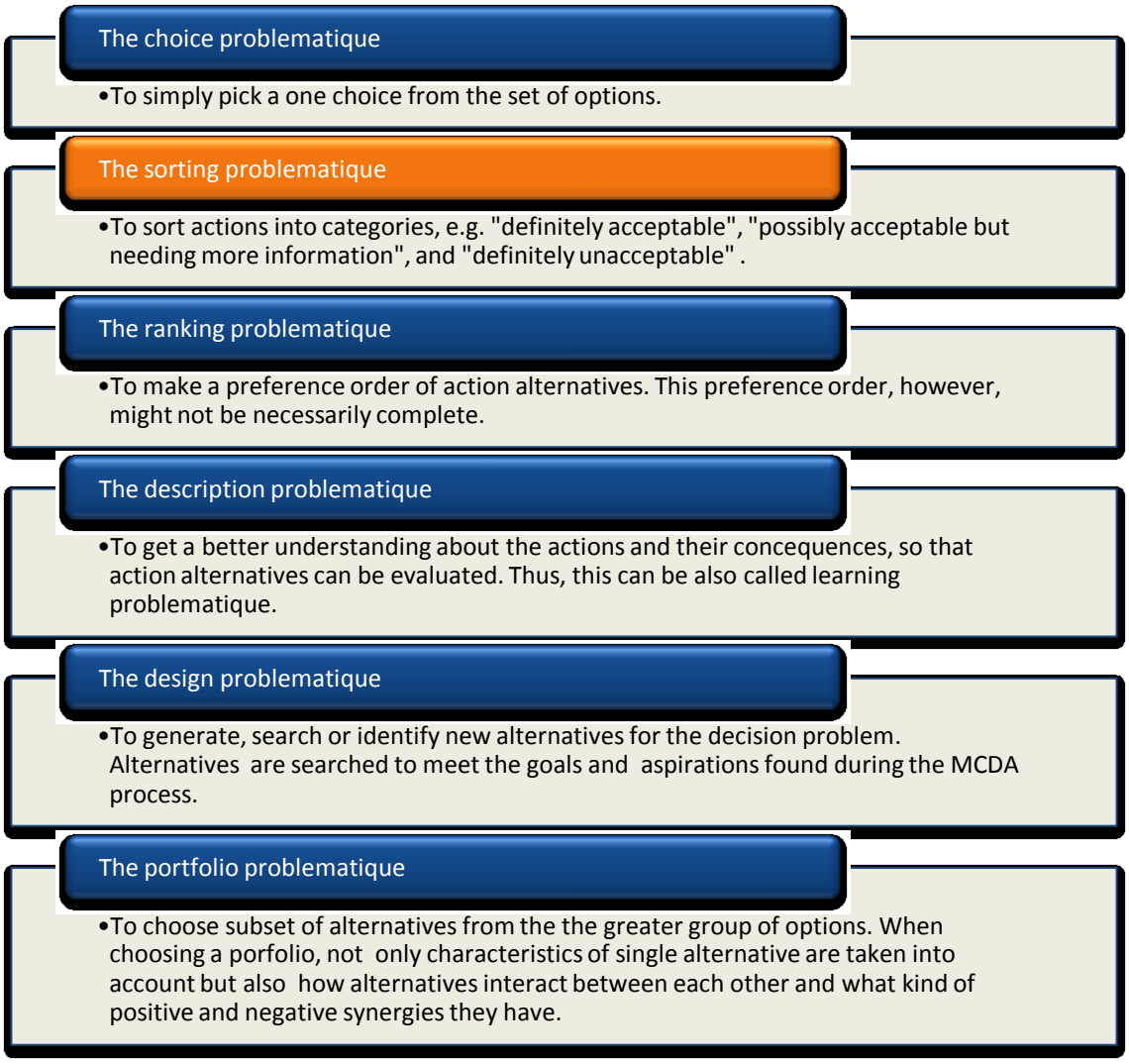
The need for MCDA's applications is based on complex decision problems that have multiple stakeholders (Belton & Steward 2002). Complexity creates a need for structuring the problem so that it can be understood easier. Since multiple stakeholders mean multiple objectives and because usually there are many criteria, the consequences are incommensurable and all of the factors cannot be measured. Because of the previous issues, there is a lot of uncertainty in the future's development. When the decision problem includes issues of this kind there is a need for knowledge that can be used to validate the decision. As a conclusion, MCDA is valuable when facing the decision contexts characterized in Table 2. (Belton & Steward 2002, SYKE 2008)

Table 2. Favorable situation for the application of MCDA (SYKE 2008).

In the previous chapters, the useful environments for MCDA were described from the perspective of the characteristics of the decision problem. In addition to these, favorable situations for applying MCDA can be considered from the viewpoint of the desired outcome. The result in demand defines MCDA's purpose of use. Thus, the output required by the decision maker dictates the usefulness of MCDA. In other words, the output required by the user of MCDA reveals how MCDA may or may not be used in the case under consideration. Belton and Steward have collected and identified six broad categories of desired outputs from Roy's and Keeney's works for which MCDA could be useful. These classes of problems are listed in Table 3. (Belton & Steward 2002)

This study seeks to apply MAVT model for sorting real estates into different portfolios. Hence, this thesis deals with sorting problematique that aims to sort actions into categories (Tab. 3.).

Table 3. Different problematiques for which MCDA might be useful (Belton & Steward 2002, Roy 1996, Keeney 1992).



2.3 The Process of Multi Criteria Decision Analysis

An application for the "divide and conquer" philosophy works as a starting point for the process of MCDA. The process solves complex problems by first cutting the problem into smaller issues and studying them in their simpler forms. Furthermore, it synthesizes these little parts to a coherent whole. This is the broad concept of how MCDA is used for making decision processes more explicit. (SYKE 2008)

The multi criteria problem is usually focused too much on model creation and getting some numerical facts out of the model. However, as mentioned in the definitions of MCDA before, it is not only a process of the model creation but it is also meant for getting better understanding about the situation under consideration. Thus, the process of MCDA does not include only the model construction and use phases but also two other steps, namely problem identification and structuring, and the development of action plans. The structure of MCDA's process is presented in Figure 2. This structure is broadly the same among all schools in this field and differences can be noticed till the phases are studied more closely. (Belton & Stewart 2002)

As described in the figure, when the process proceeds, the situation changes from complex to simple. This means that during the process the complex multiple criteria problem is transformed into the simpler form by structuring and synthesizing information. (Belton & Stewart 2002) It is also essential to notice that the picture

doesn't show the process as linear but it has iteration loops within and between every main phase. The loops exist because the process is also a continual learning process where every now and then there is a need for returning to the previous phase or even back to the start and begin the process again with better understanding about the problem. In other words, these loops are done so that the developed understanding about the decision problem and situation can be exploited in the earlier phases as well. The knowledge about the situation is developing through the whole process because of the huge number of internal and external factors that influence and pressure the process. (Belton & Steward 2002, SYKE 2008)

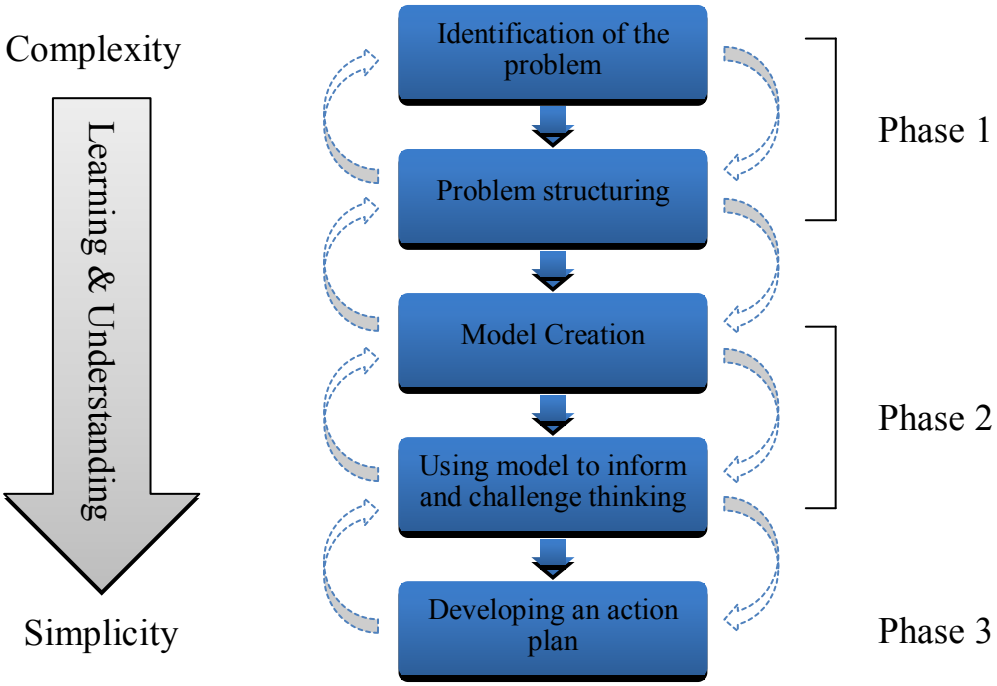


Fig. 2. **The process of MCDA (Belton & Steward 2002)**

The first main phase of MCDA's process is called problem identification and structuring phase. This phase is for making the issue more transparent by identifying key concerns, goals, stakeholders, actions, uncertainties, etc. The definition is made between various stakeholders so that the common approval about the decision problem and criteria is made. Criteria mean factors by which decision is evaluated and judged. (Belton & Steward 2002) Besides defining the criterion, it is essential that a decision problem, which means an "unsatisfying" situation that is wanted to be changed, is defined closely (SYKE 2008, Keeney 1992).

The process of MCDA is in a way similar to a house building process, because in both of them, the foundation work has to be done properly in order to guarantee that the following steps would not be pointless. In other words, there is no use working for numerical results if the problem structuring and identification have not been done at all or have conducted poorly. In conclusion, the problem structuring and identification is one of the most vital phases of the process, because mismatch between the problem and the model used is the most common reason for the failure of the operation research interventions (Tilanus *et al.* 1983).

In the model creation and -using phase the model itself is built so that the decision alternatives can be compared systematically and with transparency. Furthermore, decision maker's objectives and preferences have been taken into account so that the decision alternatives can be compared in relation to each other. (Belton & Steward

2002) Multiple models have been created during MCDA's history. Therefore, Belton and Steward have made one kind of categorizing for them. This broad categorizing is presented in Table 4. The thesis has been outlined to concern only one value measurement model that is presented later in Chapter 2.2.1.

Table 4. Categories for MCDA models (Belton & Steward 2002).

Value measurement models
•Models create numerical "weights" for the decision alternatives to clear out the preferred option •"Weights" are originally given to every individual criteria and later sythetized •The sum of "weights" is calculated in order to effect higher level preference models.
Goal, aspiration or reference level models
•Satisfactory levels of achievement are established for each of the criteria. •Seeks to discover opinions that are closest to achieving desirable goals.
Outranking models
•Alternative courses of action are compared pairwise, inorder to identify the extent to which a preference for one over the other can be asserted. •The model seeks to establish the strength of evidence favouring selection of one alternative over another

In the last face, the results of analysis (model) are implemented. MCDA does not give the complete answer to the decision problem but it is used to analyse different alternatives. By studying the model's results, concrete alternatives of action can be created. In summary, MCDA does not only focus on the analytical modelling but also supports the implementation. (Belton & Steward 2002)

2.4 Multi-Attribute Value Theory

As mentioned earlier, there are multiple different decision analysis methods for modeling decision maker's preferences (Von Winterfeldt & Edwards 1986, Clemen 1996, Belton & Stewart 2002). Although the process is broadly the same there are also big differences, e.g. in how the comparison between different objectives is made. This thesis has been outlined to concern a decision analyze method called Multi-attribute value theory (MAVT), which is one of the more applied theories among MCDA (Keeney & Raiffa 1976).

In MAVT, the degree to which one decision option may be preferred to another is described in the hierarchic structuring model called "value tree". The value tree consists of the fundamental objectives, criteria, attributes and alternatives. Fundamental objectives mean essential reason for the interest in the current decision situation and criteria mean factors by which decision is evaluated and judged. Furthermore, alternatives are simply the subjects of evaluation, and attributes are the factors that are used to measure the degree to which a criterion/objective is achieved. The value tree is built so that the fundamental objective is on the top and the criteria form the branches of the tree. Criteria can be cut up into even more specific "sub-criteria" and finally to the lowest level objectives i.e. attributes. The criteria in the value tree are "weighted" according to their importance for the decision maker and the decision alternatives are valued in relation to each attribute. As a result from this analysis, an overall value which describes the relative preference of the alternatives will be achieved. After the preference analysis, the results can be concerned with the sensitivity analysis and the

effects of the changes in the weights of criteria on the overall value can be explored. (Keeney & Raiffa 1976)

In Figure 6, there is an overview to the process of MAVT. As shown in the figure, the process of MAVT follows roughly the process of MCDA that was stated in the previous chapter. In the following chapters, the main phases of MAVT's process are presented more specifically.

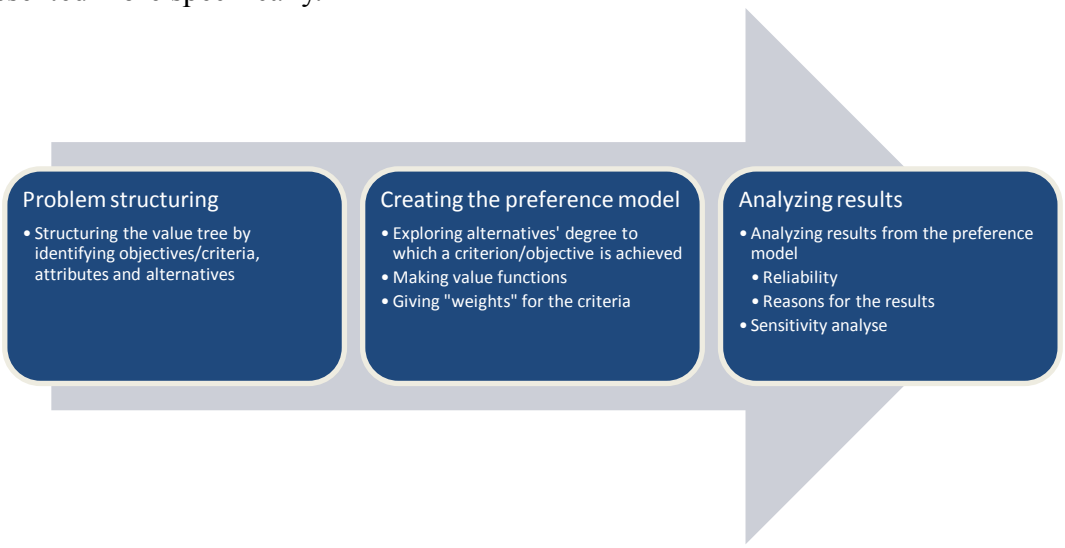


Fig. 3. **The process of MAVT (SYKE 2008, Belton & Stewart 2002)**

2.4.1 Problem Structuring

The problem structuring phase was defined by Rosenhead in 1989 as "the identification of those factors and issues which should constitute the agenda for further discussion and analysis." Alternatively, the first phase of the process identifies decision maker's objectives, alternatives and connections between the factors. As mentioned earlier, this phase is the crucial part of the process and the most challenging one because the coming phases will be based on the factors identified in this phase. Furthermore, actions made in this part of the process can have wide-ranging influence on aspects such as duration, scale, quality, and allocation. Thus, it is recommended to owe enough time to problem structuring. Getting the best results from this part of the process requires taking into account different viewpoints, creativeness, and logic, because usually at the start of the process even the decision problem is unclear. Communicating with as many stakeholders as possible means getting as many viewpoints as possible from the situation in question. (Belton & Stewart 2002) A potential way of identifying stakeholders is presented for example by Eden and Ackermann in 1998.

Practically, there are multiple ways how problem structuring can be realized e.g. in different stakeholder workshops that are led by a facilitator. In theory, there are many soft methods for the structuring, e.g. SODA, JOURNEY, COPE, and soft systems analysis (Eden & Simpson 1989, Eden & Ackerman 1998, Friend & Hickling 1987, Checkland 1981, Checkland 1989, Belton & Stewart 2002). However, this thesis has been outlined to concern the most directly relevant method presented by Ralph Keeney in his work "Value-Focused Thinking" (Belton & Stewart 2002). It is a systematic approach to structuring the decision problem and identifying the fundamental objectives of different stakeholders. Like the headline of Keeney's work shows, the decision making is based on values emerged in the beginning of the process. In a word, value-focused thinking includes two types of activities, first deciding on what one wants, and

then finding how to get it. In typical alternative-focused thinking instead, the alternatives are decided first, and then the best option will be chosen. Decision making that is based on alternatives often concentrates only on the obvious alternatives and selecting one of them. This is often a too narrow overview to the problem, while thinking about one's values is constraint free. Thus, with the value-focused thinking a decision that is widely considered and validated by the fundamental values of a decision maker will be achieved. The summarized overview of the value-focused decision making is presented in Figure 4. (Keeney 1992)

Fig. 4. **Overview of the value-focused thinking (Keeney 1992).**

The starting point in value-focused problem structuring is the objectives and values. The objectives are first identified and structured and after that the alternative ways to cover the objectives will be under consideration. When defining one's objectives it is useful to exploit e.g. common objectives, the problems that have been detected, alternatives on the table, and different points of view. Furthermore, some questions can be used for help such as what would be one's objectives if there were no constraints; what makes one option preferred than the other, and which alternatives would be preferred by which stakeholder. Discussion about the values and objectives keeps the focus on the issues that matter instead of the alternatives. (Keeney 1992)

Keeney divides objectives into two different concepts, namely the fundamental objectives and means objectives. The fundamental objectives can be defined as an essential reason for interest in the current decision situation while the means objectives are simply means to achieve the fundamental objectives. Alternatively, the means objectives implicate the degree to which more fundamental objective can be achieved. The fundamental objectives are usually self-evident i.e. it is hard to answer the question "Why this is important?". From the perspective of the overall picture, the means objectives can be useful for structuring the decision problem and for creating alternatives. However, the fundamental objectives should be the essential ones which guide all the effort in the decision situations and in the evaluation of the alternatives. When the fundamental objectives and means objectives have been identified and separated, the decision problem is mainly defined and structured. The difference and the

meaning of these two types of objectives can be characterized better by example. (Keeney 1992)

A good example could be a decision situation of managing the traffic agency where the fundamental objective could be maximizing safety. One mean for this objective could be e.g. traffic accidents. Thus, minimizing traffic accidents is a means objective where the minimization is the preference orientation and the volume of traffic accidents is the object. Figure 5 below presents visually how the objectives are structured. In some cases, it is challenging to separate these two types of objectives. However, the essential part is that the opinions from different stakeholders can be systematically aggregated. (Keeney 1992)

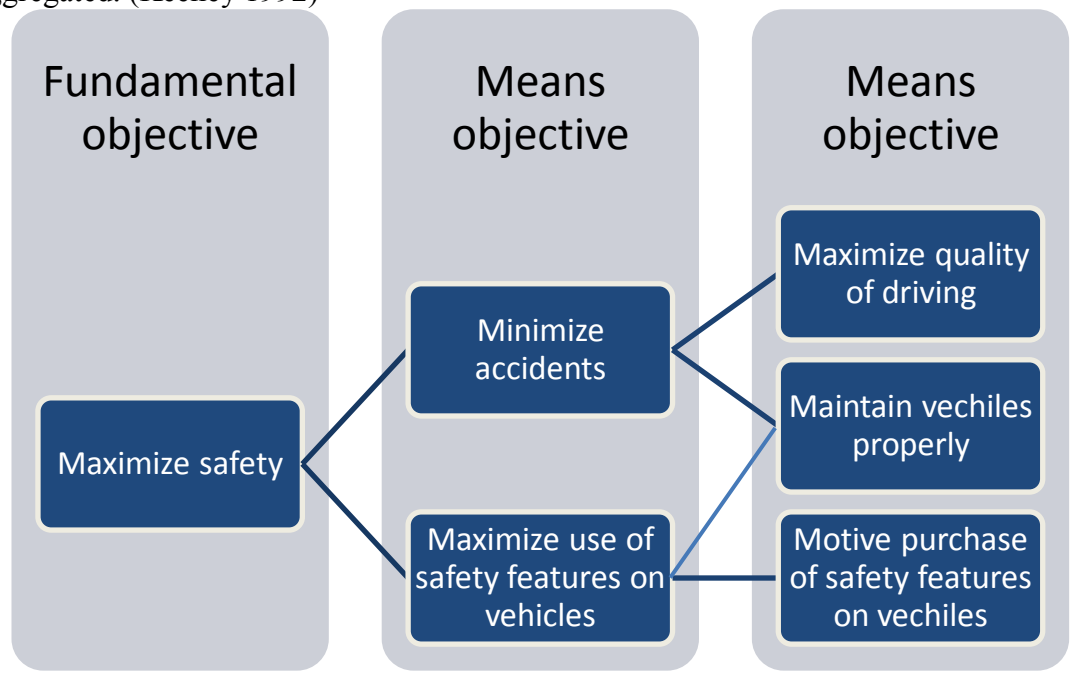


Fig. 5. **An example of the differences between fundamental and means objective (Keeney 1992).**

The problem structuring phase of MAVT is based on Keeney's value-focused thinking theory. In practice, different alternatives are considered in relation to the objectives defined by the decision makers. This is made with the criteria that describe the degree to which an objective is achieved. From this structuring, a value tree is created and is presented in Figure 6. As noticed in the picture, the value tree consists of four different levels. On the top is the overall objective that describes what is desired to achieve. On the next level are the criteria that are means for achieving the overall objective. Criteria can also be divided further into the "sub-criteria". It depends on the desired precision level how specific the "sub-criteria" need to be. The degree of alternative to which a criterion is achieved is measured by the attributes that form the third level. On the lowest level are the alternatives that are the subject of the evaluation. (SYKE 2008)

Created value trees are always subjective so the number of different value trees can be great. In a word, there is no "right" value tree but as many subjective views as there are decision makers. Therefore, opinions from all of the stakeholders are important when creating the value tree. (SYKE 2008)

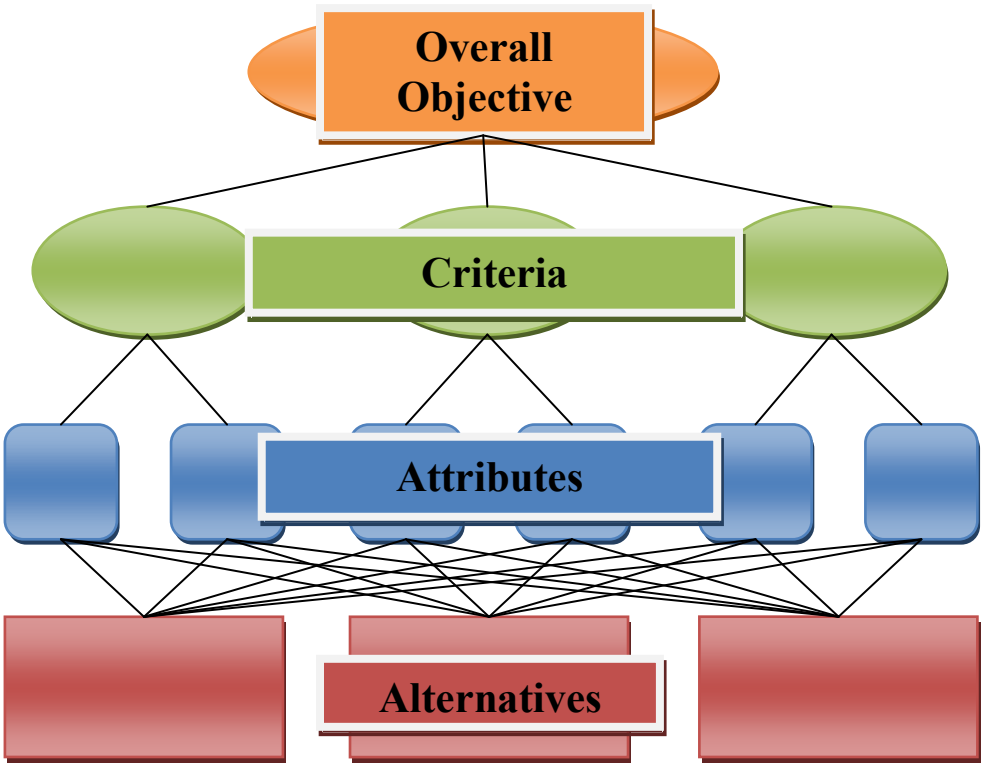


Fig. 6. **The form of the value tree (SYKE 2008)**

As mentioned previously, the criteria mean factors that define how the decision is evaluated and judged (Belton & Steward 2002). When choosing the criteria, issues presented in Table 1 should be taken into account. One way to select the criteria is first to consider all of the objectives that matter for decision makers. As assistance, the views presented in the value-focused thinking theory can be used. After considering the objectives, the value tree is created obeying the issues presented in Table 5 (Belton & Steward 2002). The principal aim of selecting the criteria is that all the values that matter could be taken into account according to as few criteria as possible, because the number of criteria defines the complicity of the model (SYKE 2008).

Table 5. The five desired properties of criteria (Keeney & Gregory 2005)

The degree to which a criterion/objective is achieved is measured by what Keeney refers an attribute (Keeney 1992). Keeney divides the attributes in three different types: natural, constructed, and proxy attributes. Natural attributes are in general use and they have a common interpretation to everyone. For example, if an objective was to maximize incomes, the attribute would be "incomes measured in euro". Constructed attributes instead are built measurement tools for the objectives in situations where it is impossible to identify any natural attribute. Attitudes, for example, mean a criterion that is very hard or impossible to measure directly. Thus, a built attribute is needed to measure it. This can be realized e.g. with a verbal scale that describes the levels of the attitudes. If a natural attribute cannot be found and constructed, the attribute cannot be created so that it would adequately measure objective's degree of achievement, and that causes a need for proxy attribute. These are not directly the issues that matter but they indirectly describe the achievement of some objective. It is hard to measure directly, for example, the status of the lake. However, it can be measured with attributes such as oxide concentration and pH number. It is important to notice that proxy attributes measure the achievement of the fundamental objective only from one perspective. (Keeney & Gregory 2005, Keeney 1992)

Alternatives mean the subjects of evaluation which can be set already in problem identification phase or later on during the process. When screening the alternatives, it is helpful to use either fundamental or means objective subsets (Keeney 1992). In practice, this is made by concerning how one objective or multiple objectives simultaneously could be achieved (Keeney 2004b). Alternatives should be defined as widely as possible so that they would take the opinions of different stakeholders into account. Alternatives, like criteria, are subjectively readable. Thus, they should be defined as specifically as possible so that the differences between interpretations would be minor. (SYKE 2008)

2.4.2 Creating the Preference Model

Second phase of MAVT's process was preference modeling. In this part of the process, the alternatives are ranked according to decision makers' preferences. MAVT aims to find a function X for decision problem that describes the decision maker's preferences.

With function X, the attributes of each alternative can be transformed into one single value. This value can be used to make a ranking list of the alternatives. (Keeney & Raiffa 1976) One well known and the most used MAVT method is weighted summation. Because of the popularity and simplicity of the method, this thesis has been outlined to concern only weighted summation as a preference modeling method (Heidenberger & Stummer 1999, Henriksen & Traynor, 1999).

Weighted summation relies on the mutual preferential assumption of independence. This means that between attributes and interpretations for the criterion, weights should have mutual preferential independence (Keeney & Raiffa 1976, Mild 2007). The simple operational idea of weighted summation can be presented as follows: First, attributes w_i are "weighted" to describe their importance for the decision maker. Second, the performance values of alternatives a_i are measured by evaluating them in terms of attribute i. Third, scores $v_i(a_i)$ are given to alternatives' performance values a_i (*with*) on a scale from 0 to 1, then weights of the attribute w_i are multiplied with the given scores of the alternatives $v_i(a_i)$, and finally, the total values V(a) for the alternatives are calculated by adding the products $w_i v_i(a_i)$. The total value V(a) is a number that describes the preference of each alternative. (Belton & Steward 2002) In conclusion, the function of weighted summation is presented in below.

$$V(a) = \sum_{i=1}^{m} w_i \, v_i(a_i) \tag{2.1}$$

The idea of weighted summation is very simple. However, there are some challenging operations when seeking the total value for alternatives. One of these is deciding scores $v_i(a_i)$ for the alternative's performance value a_i. Generally, there are two ways to do that. In case where there is no natural measure for the attribute, the scores can be given directly e.g. relying on the professional evaluations. Another option is to create the value function that describes the correlation between the measured performance value of the alternative a_i and decision maker's received value from the alternative a_i. When presented graphically, the measured performance value of the alternative a_i forms the horizontal axis, and scores from a_i shape the vertical axis on the scale from 0 to 1. The shape of the function depends on how the decision maker wants these factors to correlate with each other. However, the function is usually linear in order to keep it simple. In Figure 7, an example of the value function is presented where the profit of the product correlates positively and linearly with the value received from it. (Keeney 1992)

Fig. 7. **An example of linear value function.**

Other challenging operation when seeking the most preferred alternative is deciding on weights for the criteria. Weights mean scaling constants for balancing the indifferent consequences of the criteria. There are multiple methods developed for this operation and all of them rely on value trade-offs (SYKE 2008). When doing value trade-offs, it is decided "how much achievement with respect to one objective the decision maker is willing to forgo in order to improve the achievement of another objective by a specified amount" (Keeney 1992). In this thesis one of the methods is concerned, namely SWING-method, that is quite simple and a theoretically validated method (von Winterfeldt & Edwards 1986). In the method, all the attributes are first set on their lowest level. Then the question "which one of these attributes would you preferably raise to the highest level?" will be asked. For this attribute 100 points will be given. After this, other attributes are valued according to how important raising some attribute to the highest level is in relation to raising the most important attribute to the highest level. The final weights are received when the sum of the points is normalized to number 1. (Belton & Steward 2002) Although the value trade-off method just presented sounds quite simple, it includes many risks. Ralph Keeney has listed in his article twelve most common mistakes in making value trade-offs (Keeney 2000).

2.4.3 Analyzing Results

Analyzing the results of the preference model is the last phase of MAVT's process. The aim of the preference model was to find out differences between the alternatives relative to the overall objective. In this phase, results are analyzed so that the reasons for these results are identified. Furthermore, the reliability of results is tested with the methods presented in the following chapters.

From the previous phase, total values are received for each of the alternatives on a scale from 0 to 1 that describe the achievement of the objectives. The bigger the total value is the better the alternative fulfills the objectives. The results received from the preference model are always subjective and that aspect should be taken into account when analyzing the reliability of the results. In other words, the results rely strongly on

assessors' preferences. Thus, it is reasonable to proportion the results to the values of the assessor. (SYKE 2008)

One example for analyzing the result is to go one step backwards and observe the scores that each criterion has received. With this kind of analysis, the factors that have had the main impact on total value can be recognized. Other analyzing method is called sensitivity analysis, which will be presented in the following chapter. As mentioned in the definition of the process of MCDA, results got from the preference model can be used as an assistance when developing or implementing the action plans. In conclusion, the results and learning from the earlier phases create understanding about the problem at issue. With this understanding, stakeholders can reach a consensus when deciding about the action plans (SYKE 2008).

Sensitivity Analysis

Sensitivity analysis tests the robustness of the result and its sensitiveness to changes in the aspects of the model. Sensitivity analysis is a useful method in situations where there is a need to investigate the significance of missing information or study the effects of a decision maker's uncertainty about their values and objectives. Furthermore, the method can be used to offer a different perspective to the problem and, as mentioned previously, it can be used simply to test the robustness of the results. Sensitivity analysis can be viewed from three different perspective, namely technical, individual, and group perspective. (Belton & Steward 2002)

Technical sensitive analysis changes a single input parameter and explores the consequences for the output of a model. Input parameters include the value function, scores, and weights. Output parameters, on the other hand, mean any synthesized information. Changing the weight of the criterion and exploring the effects on the overall value is a good example of doing technical sensitive analysis. Technical analysis will show which, if any, of the input parameters have a critical effect on the overall value. When concerning a critical parameter, even minor changes in the weight of the criterion or alternative's performance score affect the preference order. (Belton & Steward 2002)

Sensitive analysis from the individual perspective means that individuals can test their intuition and understanding about the problem. This is made by questions such as "Does this result satisfy you, if not, why not?" and "Have all the important criteria taken into account?" (Belton & Steward 2002)

Alternatives' different perspectives on the problem are explored when concerning the sensitive analysis from the group perspective. For example, a decision problem that concerns a place for a power plant can be looked from financial, logistical, and social perspectives. (Belton & Steward 2002)

2.5 Multi-criteria Portfolio Models

Multi-criteria portfolio models extend the previously presented preference modeling into portfolio problems. With portfolio models, the aim is not to seek a single alternative but the set of alternatives that best achieve the objectives. Just like there are multiple methods and approaches to multi criteria problems, there is also great variety of approaches to the multi criteria portfolio problems. (Liesiö *et al.* 2005, Golabi *et al.* 1981, Kleinmuntz & Kleinmuntz 1999) These models are useful for example when choosing a project portfolio.

The operational idea of a portfolio model is based on maximizing the overall sum of the additive values from the single alternatives (Liesiö *et al.* 2005, Golabi *et al.* 1981, Kleinmuntz & Kleinmuntz 1999). In the referred approaches, the overall value for each of the alternatives is first calculated (presented e.g. in Chapter 2.4.2), and after that an overall sum for the whole program is created by adding the overall values of each alternative (Fig. 8.). The program means a set of alternatives that forms the portfolio. One of the multi criteria portfolio models is Robust Portfolio Modeling (RPM) that is presented in the example in the next chapter (Liesiö *et al.* 2005).

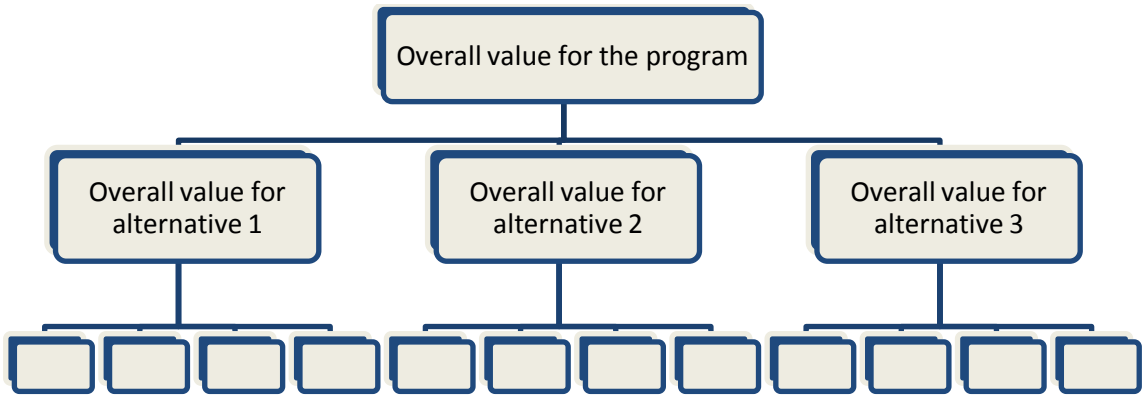


Fig. 8. **An example of the multi-criteria portfolio model (Mild 2006).**

2.6 The Elements of the MCDA

In this chapter, the information of the theoretical section will be shortly synthesized by describing MAVT process and the phases of it (Fig. 9.). In short, the MAVT process shows how the preferences of the decision maker can be modeled, thus it is simply a process for preference model creation. As defined in the previous chapters, the process of MAVT consists of three phases, namely problem structuring, model creation, and analyzing results.

The problem structuring identifies decision maker's objectives, alternatives, and the connections between the factors. In practice, different alternatives are considered in relation to the objectives defined by the decision makers. This is made with the criteria that describe the degree to which an objective is achieved. From this structuring a hierarchic structuring model called value tree is created. Problem structuring is both the crucial part of the process and the most challenging one because the coming phases of the process will be based on the factors identified in this phase. Furthermore, actions made in this part of the process can have wide-ranging influence on aspects such as duration, scale, quality, and allocation. Thus, it is recommended to spend enough time for problem structuring. To get the best results from this part of the process, it is required to take different viewpoints into account because usually at the start of the process even the decision problem is unclear.

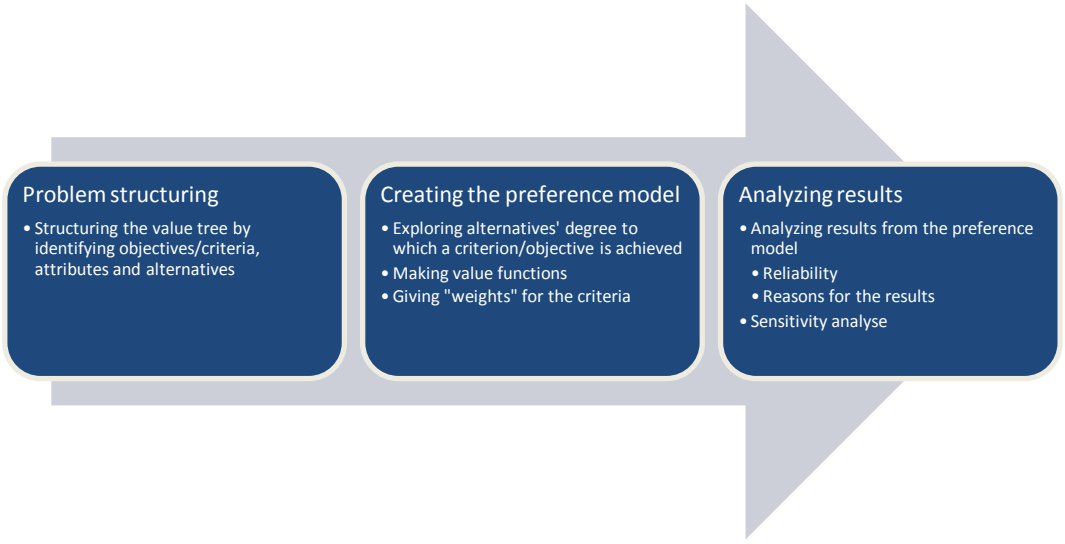


Fig. 9. **The process of MAVT**

Second phase of MAVT's process was preference modeling. In this part of the process the alternatives are ranked in relation to decision makers' preferences by constructing a model so that decision alternatives can be compared systematically and in transparent manner. Furthermore, decision maker's objectives and preferences have been taken into account so that decision alternatives can be compared in relation to each other. One well known and the most used MAVT method is weighted summation. Because of the popularity and simplicity of the method, this thesis has been outlined to concern only weighted summation as a preference modeling.

Analyzing the results of the preference model is the last phase of MAVT's process. The aim of the preference model was to find out differences between the alternatives in relation to the overall objective. In this phase, the reliability of the results will be tested. Furthermore, the results are analyzed so that the reasons for these certain results will be identified.

3 Problem Structuring on Real Estate Portfolio Management

The previous section gave an image of MCDA's possibilities and constraints. It described the situations where MCDA is useful, how the process works, and defined the aims and gains of the context. As a conclusion of previous section, the phases of MAVT process were presented. They show, in theory, step by step how the decision maker's preferences can be modelled. This section is again the empirical part of the study that seeks to execute the problem structuring phase of the MAVT process (Fig. 10). Hence the empirical study is focused on creating the value tree by identifying objectives/criteria, attributes, and alternatives.

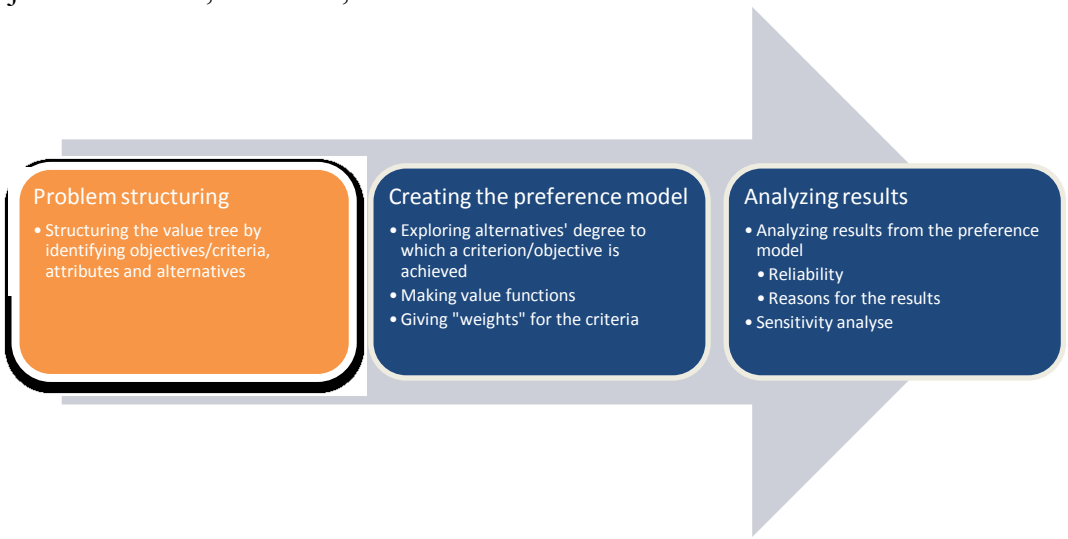


Fig. 10. **The process of MAVT – Problem structuring phase**

The problem structuring implemented in this work rests strongly on the value focused thinking that was introduced in Chapter 2.4.1. Benefits of the theory were notable compared to the alternative focused thinking. Keeney, for example, noted that decision making based on one's objectives is widely considered and validated with decision maker's fundamental values. In the alternatively focused decision making, instead, thinking is often too narrow and does not support decision maker's fundamental values. Another thing that shows a lot of objective's role in decision making is that all the decision making gurus are listing objectives in their schemes, and achieving the objectives is simply a reason for being interested in any decision. In short, it cannot be overemphasized how important identifying, structuring, analyzing, and understanding one's objectives is when making the decisions that matter. (Keeney 1992)

The next section starts with a specific description about the research logic of the work that clarifies the research method and shows thus how the preference model is planned to be created. After presenting the research method, a short overview of the

context of property portfolio management follows. The aim of the definition is to describe the research environment of the thesis and give some background to the criteria mapping. After the description of research environment follows the empirical study that seeks to identify the objectives, criteria, and attributes of real estate portfolio management. In this part of the section, the results from the interviews are adduced and analysed. As a conclusion, a value tree for decision making in real estate portfolio management will be introduced.

3.1 Research Design

The fundamental aim of the thesis is to create a preference model for property portfolio management. The generation of the model is implemented as a constructive research where the existing theories of MCDA are applied into the environment of real estate portfolio management. The research logic of the thesis is illustrated in Figure 11 where it is shown step by step how the preference model is going to be constructed.

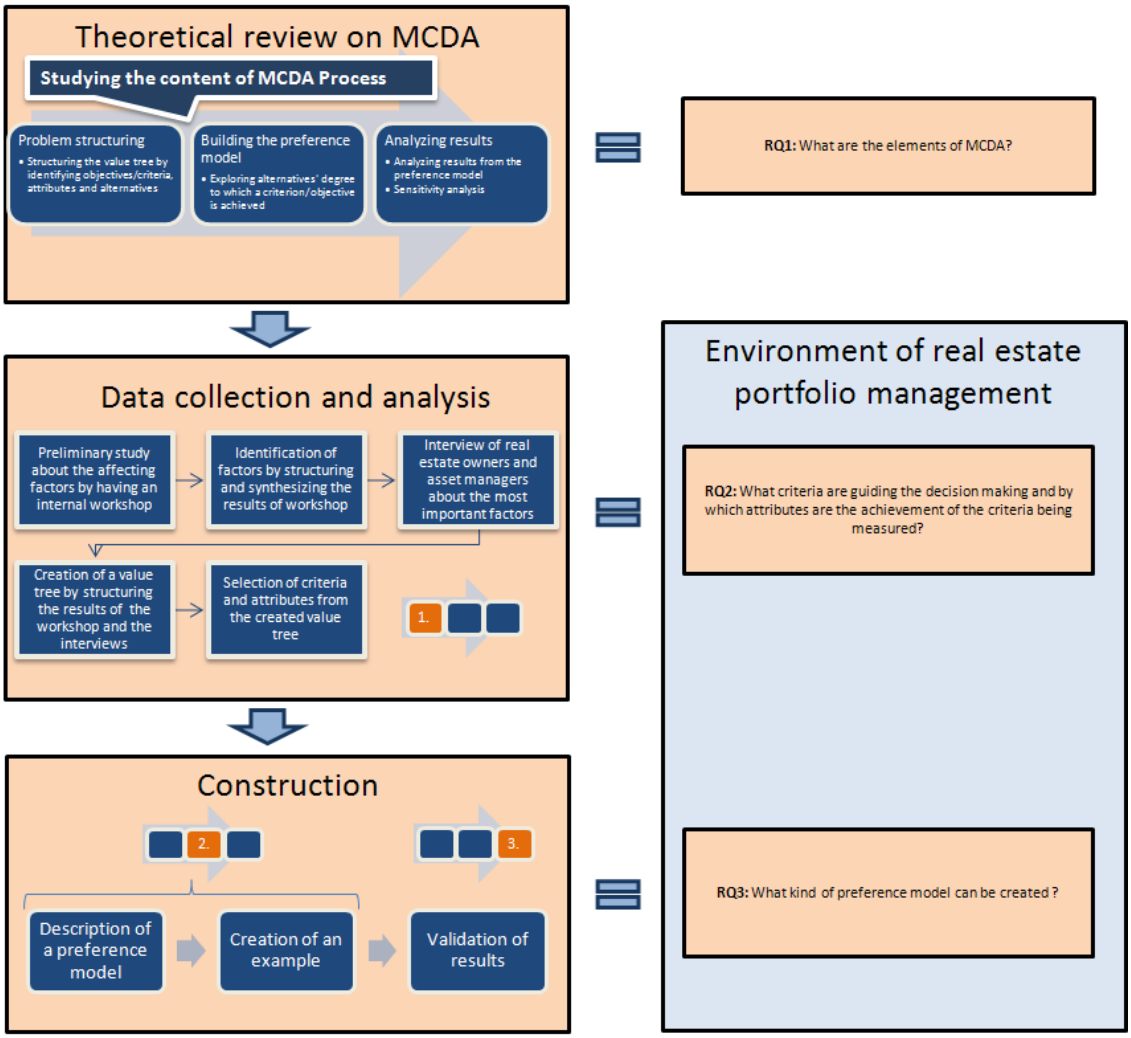


Fig. 11. **The research logic of the thesis**

For a start, the bases of MCDA are presented by defining the phases of MAVT process. This was done in Chapter 2, which sought to answer the research question 1 by describing the content of the problem, the structuring, model creation, and result analysis. The identification was implemented with the theoretical review by studying the written articles and literature on the subject. As a primary reference, the works from

Ralph Keeney were used because those were seen as the most directly relevant to the scope of the thesis. The results of the review worked as a basis for the empirical study by giving a picture about the possibilities and the constraints of the multi criteria methods. Furthermore, the latter phases of the study, data collection and analysis, and the construction, follow the identified MAVT process as shown in Figure 14.

After the theoretical review follows the data collection and analysis in Chapter 3 that match with the content of the problem structuring of MAVT process. Chapter 3 answers to research question 2 by identifying the guiding criteria for the decision making and the attributes by which the achievement of the criteria is measured. The way the previous objects were achieved included several steps. Firstly, all the affecting factors were listed in Pöyry Finland Ltd's internal workshop where the features were generated by using the tools found in the theories. The tools used in brainstorming are presented more specifically in Chapter 3.3. The workshop included, in addition to the thesis maker, three participants who represented know-how about the maintenance, management, and renovation of the real estates. All of them are familiar with the real estate portfolio management actions, and the theories of MAVT were presented for them before the workshop. The orientation to the theories and the facilitation during the workshop was done by the thesis maker. This preliminary study worked as a preparation for the latter interviews because it defined the options of the enquiry where the question "Which of the identified factors are the most significant ones?" will be asked. Furthermore, the results of the brainstorming were used in the latter creation of the value tree.

The results of the workshop will not be a list of unambiguous factors since they are required for the creation of the enquiries. Therefore, the data from the list needs to be structured and synthesized so that the real purpose of the factor can be seen and the factors with the same aim can be deleted. This makes the creation of the enquiries easier and increases the reliability of the interviews. In practise, structuring and synthesizing is made by considering the fundamental purposes of the factors and deleting the intersecting ones.

The data about the most important factors and the indicators, by which the achievement of the criteria is measured, was collected with interviews that were implemented partly as phone interviews and partly as face to face meetings. As interviewees we had eight real estate owners and asset managers who were all familiar with the portfolio management actions, and most of them are professionals in this field. The information source about MCDA for interviewees is presented in the interview questionnaire created by the thesis maker (Appendix 1). The interview questionnaire is based on the previous steps and hence the definitions made earlier formed the content of the interview questions. In other words, the questions about the criteria and the attributes include the factors defined previously. The aim of the interview is to prioritize the factors that guide the decision making of real estate portfolio management. Prioritizing is needed because all of the affecting factors cannot be included in the model in order to keep it as simple as possible. As a result of the interviews, also some attribute suggestions are gained by which the achievement of the criteria is measured. These are again crucial features that make the model creation possible in the first place. As a whole, the results of the interviews work as a material for constructing the value tree and the latter model creation.

The value tree demonstrates the whole decision environment of property portfolio management by presenting a network of fundamental objectives and means-ends objectives. The tree was created by structuring the data received from the workshop and the interviews, and the methods presented in the written theories were used for supporting the process. The value tree was created because it helps to see the decision

situation as a whole and hence makes the creation of the preference model easier. Furthermore, by illustrating the factors in a logical network it verifies the understanding about the affecting features.

The final criteria and attributes were selected from the options defined during the analysis. The selection was done by using the new understanding about the decision situation created by the workshop, the interviews, and the value tree. Defining the most remarkable criteria and the attributes for them is necessary for preference model construction.

The last section of the study, the construction, includes the remaining phases of MAVT process: the model creation, and the result analysis. The construction applied the information got from the previous sections by creating a preference model for decision making. The idea of the construction was to describe the model creation process, present an example model, and validate the model creation process.

The description of the model creation process means a specific presentation about what kind of steps the process includes, what kind of input information is needed, who are the suppliers of the information, what is the output of the process, and who is the customer. The process is illustrated in SIPOC diagram that includes all the features just presented. The description of the process was done so that it can be well understood how the construction of the model happens in practise and what kind of value it produces.

An example model for real estate portfolio management was created to demonstrate (to) the operation of the described process and to make the idea behind the preference model more understandable. In practise, the example was constructed by following the described process and using hypothetic values as an input data.

The model for property portfolio management was evaluated by five real estate owners and asset managers who estimate how well the model answers to their preferences and would the model work in practice. The evaluations were implemented with e-mail enquiries which shortly presented the model creation process and asked a couple of questions concerning the functionality of the model. The specific content of the e-mail enquiries is presented in Chapter 4.3. Enquiries were done so that the validity of the model could be discovered.

3.2 An overview to Property Portfolio Management

Term “property” has a wide variation of meanings that depend on the context. It means for example the buildings we live in and the offices and plants in which we work. The word can also have different definitions in different countries. This work, however, is based on Finnish definition of the word property. Property, also known as real estate, is defined as follows: Property is a restricted part of the ground including permanent buildings and appliances which include all the roads and other infrastructure constructions inside the fixed area. (Kiinteistösanasto 1984)

Property management is a continuing process through the whole life cycle of the real estate, and it aims to produce income for the owners, fulfill the set objectives, and sustain or increase the value of the investment property (Fig. 12). Alternatively, property management extends all the actions that are done to manage, supervise, and operate the real estate. One major factor affecting the management of properties is the differrent purposes of use of a real estate that are categorized into four different types, namely commercial, residential, industrial, and a real estate for special purposes. All of these types have their own specialities when considering the property management, e.g. is the building for living or for heavy industry. (Kyle *et al.* 1999)

When concerning the property management, this thesis focuses on the portfolio management. That means, in short, managing a number of asset classes held for investment purposes. A portfolio itself is simply defined as a list of investments. (Hishamuddin 2006) In this case there are three different classes into which properties are sorted, namely keep, develop, and sell. To make the outlines of the work more clear, this study seeks to apply MCDA to the portfolio management of the existing stock of real estates. In other words, the acquisition of the new property assets is out of the scope of this study although it is one function of portfolio management.

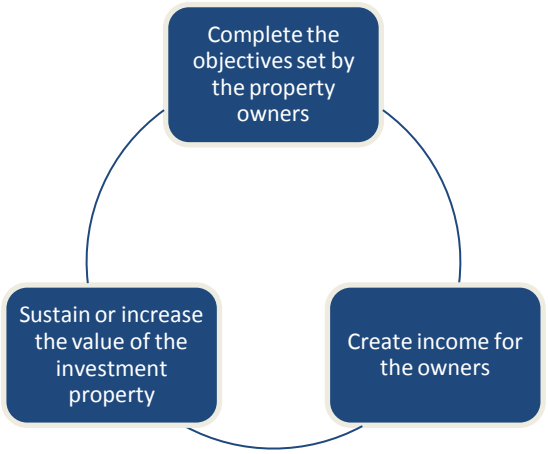


Fig. 12. **The main functions of property management (Kyle *et al.* 1999).**

There are two kinds of property owners: ones who own and use a real estate for their own benefits and ones who own properties only as an investment (Kyle *et al.* 1999). The latter ones, that is, the real estate owners whose main business is property investment, are in the scope of this study. Completing the objectives set by the property owners was one of the major functions of property management, and therefore understanding owner's objectives is a crucial task in property management (Kyle *et al.* 1999). Furthermore, goals set by the property owners are the main criteria when sorting real estates into different portfolios. These objectives are surveyed and structured in the next chapter.

Managing the real estate portfolio is not an easy task and finding a precise framework for real estate portfolio creation is challenging (Hishamuddin 2006). These difficulties arise from characteristics of property management. Business of properties is, for example, more and more influenced by government control that gives limitations and commitments regarding the functions of property management (Kyle *et al.* 1999). Moreover, property as an investment asset is one of the main ones, having many special features compared to shares and bonds. These are the characteristics of the assets such as fixed location, heterogeneity, high unit value, and illiquidity. These valuations are often used for market information rather than prices. (Hoesli & Macgregor 2000) These distinctive features provide different requirements for the criteria when sorting real estates into portfolios. The investor who can understand the complex set of real estate characteristics is more likely to make successful decisions (Phyrr *et al.* 1989)

Because of the complicated nature of portfolio managements, it can be noted that the application of MCDA could bring more understanding into the decision situation. Additionally, real estate's portfolio management is simply a sorting problem, and as presented in Table 3, sorting problems are one of the situations where MCDA may be useful.

3.3 Surveying the Guiding Factors of Real Estate Portfolio Management

According to the previous chapter, the real estate portfolio management **is** simply defined as a management operation that seeks to master a number of asset classes held for investment purposes. The decision problem in this case arises from the sorting operation where real estates are sorted into different asset classes, namely keep, develop, and sell. Hence the meaning of the problem structuring is to generate objectives, criteria, and attributes for the sorting.

The sorting of real estates can be approached from two direction. The one is observing properties from the perspective of portfolio level and the other is analyzing real estates one by one on the property level. The first one of these approaches has more importance because optimizing the ensemble of the properties is more important than optimizing the characteristics of single real estates. However, this thesis will take a closer look only on the property level analysis because of the limited extent of the work. Thus, this chapter seeks to find real estate specific criteria that can be used in decision making in real estate portfolio management. It is important to notice that the results of the property level analysis do not order the class of the real estate but they tell, by observing real estate specific factors, what is in decision maker's interest when sorting. In the portfolio level analysis, the joint effect of several properties, the risk management, and strategic alignments are taken into account. The theories of observing the joint effect of several properties were introduced in Chapter 2.5.

In addition to previous outlining, the empirical study of the work concentrates on the endogenous factors and will not take a stand on the exogenous features and their effect on decision making. The endogenous factors mean internal characteristics of the real estate such as technical quality or the location of a property. From property owners' viewpoint, this thesis focuses on the owners who own office- and business properties only as an investment.

In this chapter, the results from the interviews were adduced, i.e. the questions such as what are the overall objectives of portfolio management and which factors are the means for achieving these objectives were answered. In practice, objective and criteria generation was conducted in two phases. First, a preliminary survey was conducted where all the affecting factors were identified with real estate management professionals. Second, from the already identified factors the most important ones were chosen by interviewing real estate owners and asset managers. In this chapter, terms objective and criterion are replaced by the context of the factor, because the presented factors are not yet identified as a fundamental object or a criterion.

3.3.1 Preliminary Study about the All Affecting Factors

The problem structuring started with a preliminary study that aimed to produce alternatives for the latter interviews of real estate owners and asset managers. The preliminary study was made because as noted in the theories, noticing stakeholders and their opinions on the problem structuring is essential. Furthermore, study worked as an introduction to the environment of real estate portfolio management and aided in the preparation of the interviews.

Factors presented in Table 6 are the results of the preliminary survey that was realized in Pöyry Finland Ltd.'s internal workshop meeting. The list below describes a group of those factors that have an effect on the decision making in real estate

management. The workshop included professionals from different real estate management operations and it was facilitated by the thesis worker.

Identifying the factors was made by applying methods called "Wish list" and "Perspective approach" that were presented in Keeney's work. Wish list simply answers the question "what would I like to achieve in this situation?", and the perspective approach pushes thoughts further by varying perspectives. (Keeney 1992) These methods were used simultaneously by asking "what would I like to achieve in this situation from this perspective?". Table 6 shows the used perspectives and the identified factors inside them.

Table 6. Criteria for real estate portfolio management

Finance
• Attractive location
• Current rental agreement (duration, terms & price)
• Quality of current tenant
• Availability of a new tenant
• Supply of similar real estates on the market
• Real estate's market price
• Risk management
Physical
• Possibilities for enlargements
• Quality level of indoor condition
• Space solutions inside the property
• Possibility to easily change space solutions inside the property
• Technical quality of a property
• Legal limitations
Sustainable development
• Environmental protection
• Energy efficiency
• Available energy systems & production types
• Enviromental risks
• Harmful matters in the ground

It can be noticed that most of the factors created from the financial perspective are related to demand or competition in the markets. This is not surprising, because the demand to supply ratio defines the price of the product or service. Another criterion from the financial viewpoint is the quality of current tenant and rental agreement that strives for risk management of continuous income. In total, financial factors for real estate portfolio management seek to maximize the overall incomes from the investment assets. Overall incomes mean, in this case, incomes received from rent return and sales profit.

Factors created from the physical perspective emphasize real estate's technical quality such as structures, HVAC, and indoor conditions. Furthermore, one highlighted factor is the flexibility of a property to transform from one space solution to another. The flexibility of a property means that there is a possibility to enlarge the real estate and transform indoor space solutions. One limiting fact for the flexibility of a property is legal restrictions, and therefore legal limitations are included in the physical factors. The reasons why these factors were emphasized can be found in customer needs, the useful life of property, and maintenance and repairing requirements. The technical quality and flexibility of property, for example, are clearly features for meeting customer needs and making the useful life of real estate longer. Additionally, minimising the requirement for maintenance and repairing can be better achieved by maximizing the technical quality of property.

Sustainable development includes factors such as energy systems and production types, environmental risks, energy efficiency, and environmental protection. Some of these factors such as available energy systems and production types and energy efficiency aim at energy friendliness and meeting customers' needs. Environmental risks were found to be means for risk management of continuous income and environmental protection by enabling the enlargements of real estates. Limitations caused by the environmental issues can prevent the enlargements of properties and hence they are means for real estate's flexibility.

3.3.2 Studying the Most Significant Factors

The preliminary study tried to identify all the affecting factors without stating which one of these has the most importance. Hence decision makers' preferences were not concerned in the internal workshop. The preferences were identified by interviewing real estate owners and asset managers. The interviewees were big national and international players who either own real estates by themselves or work as an asset managers.

The interviews sought to find out the factors that have the biggest weights when sorting real estates into different classes. In practice, interviewees were asked to choose six factors from the list or name the factors they considered important for the decision making in real estate portfolio management. Interviewees were asked to select specifically six factors because in relation to the number of options, six was a suitable number for finding out the most remarkable factors without closing something significant out of the results.

The list of options in the interview questionnaire was mostly based on the results of the preliminary study. Some of the factors that were identified in the preliminary study were crossing, and there are also some factors that needed to be presented in a different form in order to be relevant options for the top six factors of the decision making. Therefore, factors adduced in Table 6 were modified for the interviews, and the list of the new factors can be seen in the interview questionnaire that is enclosed (Appendix 1).

A chart below presents how the votes were distributed between different factors (Fig. 13.). The percentages in the chart describe how many of the interviewees thought that the factor in question is among the six most important ones. The interviews were not focused on certain strategies of portfolio management although it strongly affects the decision making if e.g. a developer and a long term investor have totally different perspectives on managing portfolios. The outlining was based on an assumption that a strategy does not have an effect on the criteria in itself but on the weights of the criteria. In other words, it was assumed that despite the strategies, all the property owners have the same criteria but they just weigh the criteria differently. Furthermore, the results of this survey aimed at being a general opinion about the most significant factors, and therefore more specific outlining was not done. Thus, the interviewees gave their answers mostly from the general perspective.

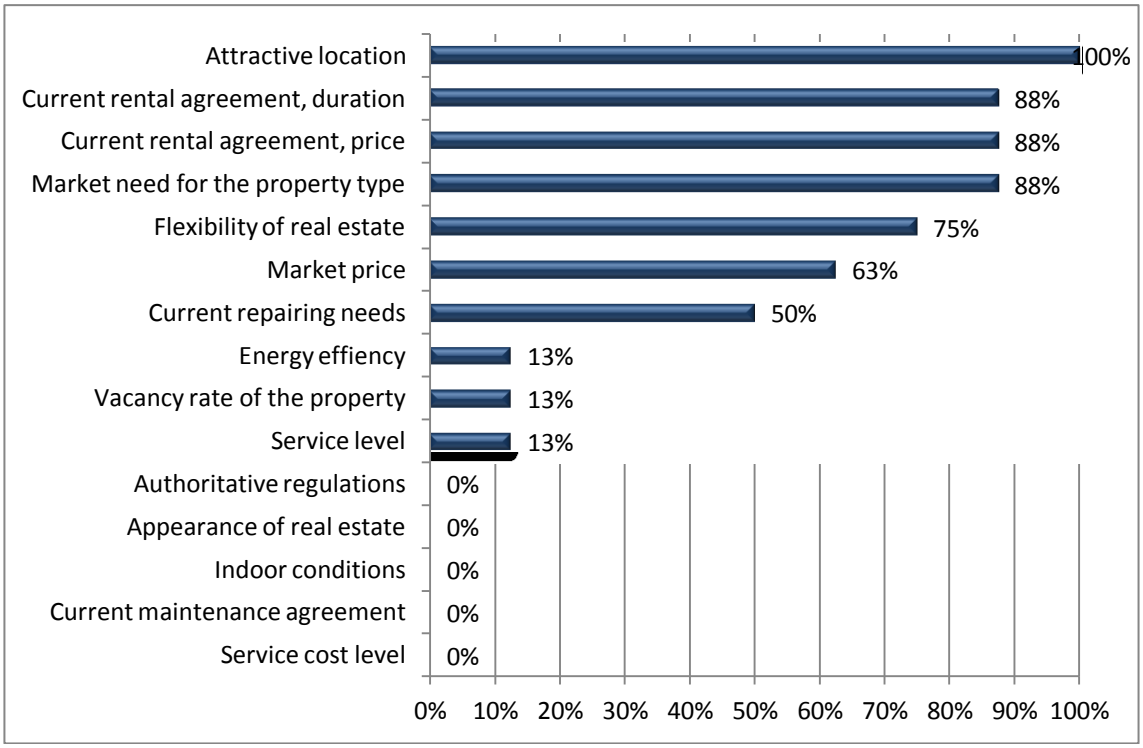


Fig. 13. **Distribution of the answers in interview question 1**

The dispersion of the votes was minor as Figure 15 shows. The top six factors received 83% of all the possible selections and 94% of the votes centered in the seven most important factors. The results of the priorities verified the understanding about the features that are guiding the decision making.

As expected, 100% of the interviewees argued that "Attractive location" is a remarkable criterion because it is fixed in nature, but at the same time its characteristics of continual and operational transformation were related to infrastructure and markets. Hence, the characteristics of this factor cannot be affected easily and the direction of the development is hard to predict. "Market need" is partly crossing with the "Attractive location" because they both illustrate an areal demand. Therefore, "Market need" was also found important and it received votes from 88% of the interviewees. Another criterion for describing the areal demand was "Market price" which in itself is not remarkable but it describes the demand well when it is made proportional to other markets' prices. Although it received quite big percentages from the interviewees, it was found to be a consequence of all the other criteria, and therefore many interviewees did not see it as a relevant option.

The next two factors were related to current rental agreement and were also in the favor of 88% of the interviewees. Selections of these factors were justified by their target which is to describe the cash flow which is the culmination of the whole portfolio management process. The rental agreement issues effect of course only on the income side of the cash flow, and outcomes are reliant on other factors such as repairing needs and energy efficiency. Factors on the outcome side of the cash flow did not get as much percentages as income side factors because they were found to be easier affected.

The flexibility of a real estate and a current repairing need got 75% and 50% of the votes. This is parallel with the assumption that the lesser a criterion can be affected by a real estate owner the more significant factor it is. Although the flexibility of a building was rated quit high, it was also considered uncommon that the way of using a real estate would be radically changed. That is one reason why it did not get more percentages. The current repairing need, instead, was seen as a remarkable risk in the future because

it could raise the operation cost significantly. However, as already implicated, this is a factor that can be affected and predicted easily.

The energy efficiency of the building got many notices but the common message was that it is not getting enough importance from the users today, and therefore it got only 13 percent. The rest of the criteria that have not been mentioned yet got only a few votes which were generally found as unimportant factors. The reason why these factors did not get votes results from the fact that they do not have effect on the decision making unless they are in the extremes. This means that, for example, the appearance of a building affects only if the building at stake is extremely beautiful or ugly.

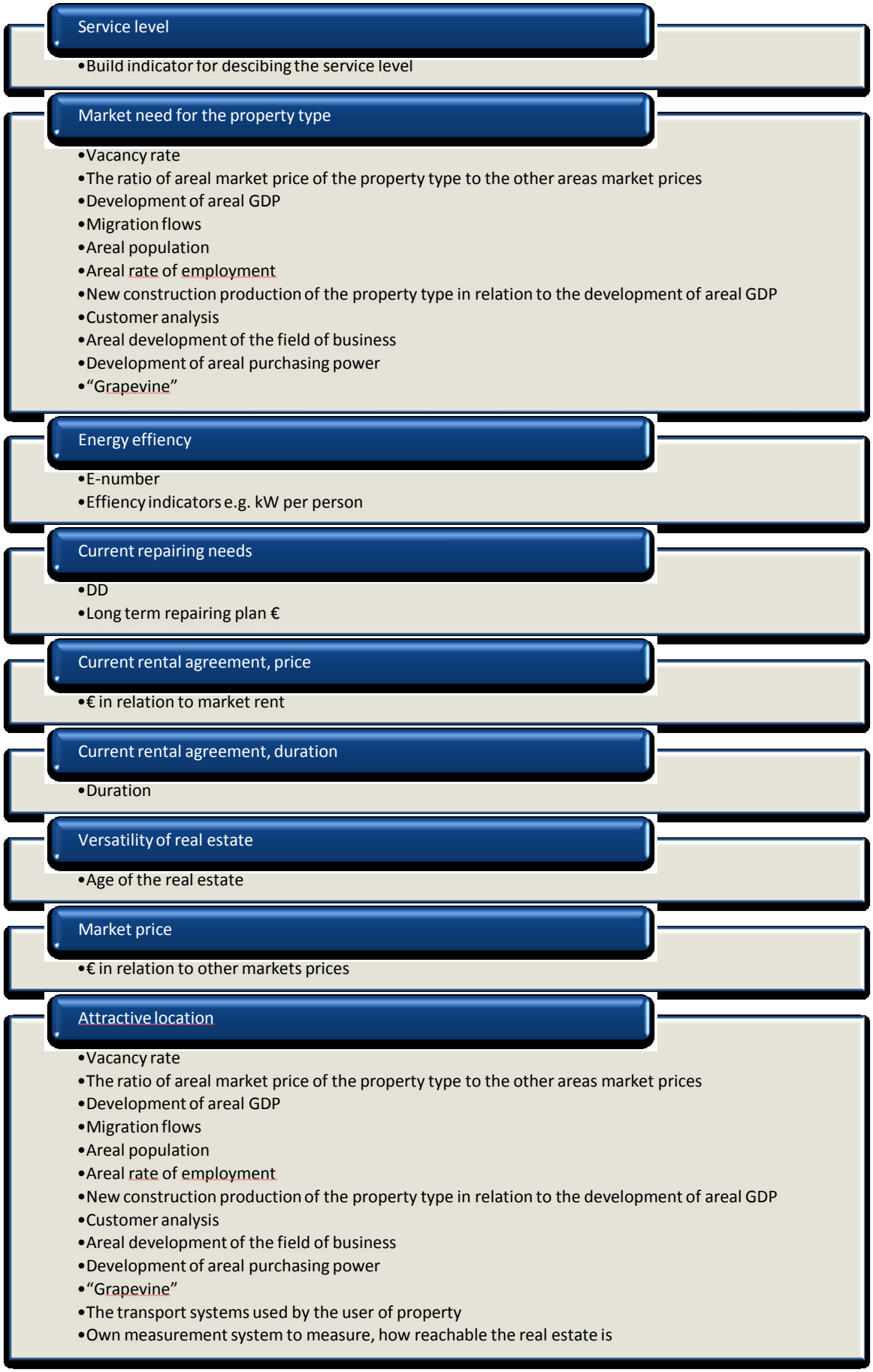
In general, it was argued that the importance of the factors can be property specific and moreover reliant with the time. In some areas, for example, the versatility of a real estate is a more significant factor than in some other area. Furthermore, the requirements for the service level of a property are different in central areas and other locations because in central areas, there are plenty of external services nearby that lowers the requirements for property's service level. The reliance on time can be noticed for example when the common economic situation is weak, because this leads to the minimization of risks even more than before, and thus real estate owners start to give more importance to the factors such as repairing need.

3.4 Attribute Suggestions

Next step of the problem structuring of MAVT process is the generation of the attributes that were used to measure alternative's degree to which objective is achieved. Alternatively, it is an indicator for measuring how good some property is in relation to certain criteria. The work sought to identify attributes only for those factors that interviewees weighted with most importance, because measuring factors with no significance would not produce value to the decision making. Hence, in the results are shown attributes only for those factors that got votes in the first interview question.

The attributes just like the preferences in the previous chapter were identified by interviewing real estate owners and asset managers. The interviewees were asked to describe properties from the perspective of certain criterion that belonged to the following classes: keep, sell, and develop (Appendix 1). The aim of this question was to make real estate owners and asset managers think about those indicators that describe the achievement of certain criteria. The results of this question are listed in Table 7 where the attributes are grouped under the factors they are measuring.

Table 7. The results of interview questions 2 and 3



As mentioned in the previous chapter, factors "Attractive location" and "Market need" are partly crossing each other and for that reason, they are also the ones that have the

biggest number of common attributes. These indicators seek to describe current demand in the area and to predict the future demand and areal development. Attributes for areal development seek to measure on the one hand how the economics generally evolves and on the other hand how the customers' field of business is changing. There are also some attributes under the attractive location that cannot be found under the market need, and these attributes indicate how reachable a certain real estate is. In practice, reachable real estate means a property with good communications and parking areas.

In the last chapter it was also noted that "Market price" is not in itself remarkable but when it is proportioned to the other markets prices it will be a good indicator of areal demand. Hence, interviewees suggested that the current market price commensurate with other market prices would be an appropriate attribute for this factor.

The factors of current rental agreement have in itself the natural attributes money and time. However, interviewees emphasized that these do not intrinsically tell anything to a real estate owner from the portfolio management viewpoint. Thus, these natural attributes need to be thought in commensurate with something. For example the rental price in proportion to the market price would describe more about the current situation. Interviewees also noted that the factors of current rental agreement are just a part of a more critical factor, namely cash flow, and argued that it would be more relevant to measure the whole cash flow than to observe only some parts of it.

The rental agreement factors were the income side of the cash flow, while the energy efficiency and repairing needs were a part of the outcome side. Hence, these factors should also be concerned as a part of the cash flow calculation. The way these factors are measured is quite easy because there already are build attributes for these such as the E-number and the long term repairing plan. Previous indicators describe the performance of the factors in question extremely well. For the repairing needs there are also attributes such as due diligence reports that illustrate not only the financial side but also the technical estimations of the condition of the building. However, the due diligence report cannot in itself be an attribute but the data inside it can be used to build one. In addition to already presented energy efficiency attributes, in the interviews some efficiency indicators came up that not only measure the absolute energy consumption but also relate the consumption to the output of a real estate.

The flexibility of a building was one of the most challenging factors to measure, and for that reason it was hard to find an explicit indicator for it. However, one characteristic that often came up with this factor was the age of buildings because it was generally argued that the younger the building the more flexible it would be. This measure has weaknesses of course but it is nonetheless very simple and broadly estimates the achievement of flexibility. Other option to describe the flexibility of properties would be measuring different technical characteristics. Nevertheless, the flexibility of a building is not reliant on one technical feature, and thus the joint effect of different characteristics would be taken into account with build attribute. However, interviewees did not suggest the build attributes because those might be too complicated and require much of resources.

Last one of the factors that has not been mentioned yet is the service level that is very hard to measure just like the flexibility of the building. The only suggestion that was received for this factor was a build attribute that would take the joint effect of several different characteristics into account. Relevant features to be taken into consideration would be e.g. communication, the level of equipment, indoor services, and parking areas.

3.5 Creating a Value Tree

As a result of the preliminary study and interviews, a list of the factors that have effect on the decision making was created and the factors on that list that have the greatest importance to the portfolio management were identified. Furthermore, indicators for the factors with most weight were identified to measure real estate's degree of achievement from the perspective of the factor in question. This chapter seeks to analyse these results and lays the ground for the latter model creation.

The results showed in previous chapters are only the raw data from the brainstorming and interviews, thus the list of factors or the distribution of preferences or the indicators in themselves do not give a clear picture about the fundamental objectives of portfolio management. The identified factors in question are more like a mixed group of objectives, goals, and constraints, and it does not make a difference between means objectives and fundamental objectives. Therefore, generated criteria need to be structured to improve our understanding about the values that matter. They would also lead to the better value model and enhance the quality of value-focused thinking. (Keeney 1992) Problem structuring made in this chapter followed the theories presented in Chapter 2.4.1 and was implemented by the thesis worker.

At the beginning of the problem structuring phase the fundamental objectives and the means objectives are identified and networks are created. A network of the fundamental objectives is called a fundamental objectives hierarchy that indicates the set of objectives above which the attributes are defined. A means-end objectives network instead includes the objectives that relate the alternatives to their consequences. To make the role of fundamental and means objectives more clear, Keeney notes that "Value judgments are required to construct fundamental objective hierarchies, and judgments about facts are required to construct means-end networks."

Structuring was started with an identification of the fundamental objective for the decision problem by considering the following question "What do real estate owners want to achieve with portfolio management?". In investment decisions of this kind, an obvious answer to the question is to maximize total incomes, or, to be precise, maximize the expected value of total incomes. In addition to the first one, two more questions were stated to get a deeper understanding about the objective and the values: What kind of real estate is favorable in relation to the objective in question? What aspects of the objective in question are important?

These questions were answered multiple times because as mentioned earlier, structuring is an iterative process that helps to find the missing objectives in the network. Moreover, the already identified factors from Table 2, the distribution of preferences from Figure 15, and the list of attributes from Figure 16 were used as an assistance. The final answer to the favorable real estate question, after all, was that real estate produces on the one hand maximal rental incomes now and in the future and on the other hand, maximal sales profit in case of selling. When opening these objectives it was discovered that important aspects for producing rental incomes are a rental price, a utilization level, and operational costs. When maximizing the sales price, ensuring the liquidity and minimizing the acquisition price are significant aspects of sales profit. The previous structuring produces a fundamental objective hierarchy that is presented in Figure 16.

The acquisition of new properties does not belong to the outlines of the work because this thesis aims at focusing on the existing property portfolio and therefore it is highlighted with the orange color in Figure 14. The decision of dealing with only already existing properties was justified by the assumption that the attributes for

minimizing acquisition would not be property specific but be more related with interest rates and market cycles.

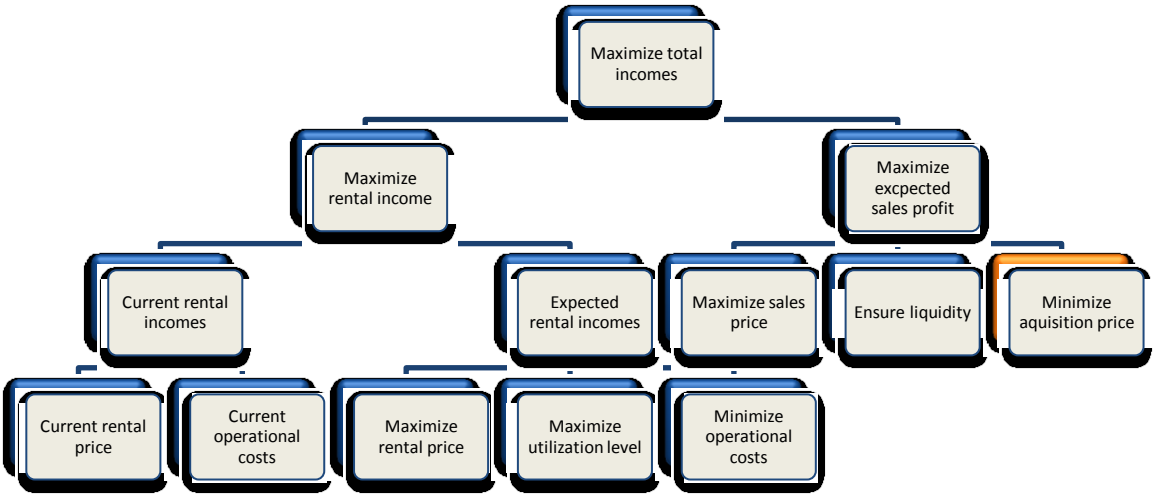


Fig. 14. **Fundamental objective hierarchy for real estate portfolio management**

The fundamental objective hierarchy could have been structured more to "lower" objectives. However, fewer objectives make it simpler to get a picture about the decision as a whole and reduce the analysis required (Keeney 1992). From the figure above it can be noticed that the objectives are divided into two main branches that seek to maximize rental incomes and sales profit. From this point onwards, the structuring continues with means objectives. This means considering how the higher level objectives can be better achieved.

In this interface, value judgments change to fact ones, thus, the structuring from this point onwards does not relate to a decision maker's values anymore but to the facts that connects means objectives with their consequences. The list of the affecting factors that were identified in the preliminary study was used to help the structuring by sorting the factors according to their influence, either on the current and future rental incomes or on the sales profits. Structuring can be done from top to down or from bottom to up. In this case, the both ways were used by choosing a factor from Table 2 and asking the following questions: How can this be better achieved and why is this important?. With this way we could discover which criteria are placed above and which below the criterion in question. During the structuring process of means-end network all the missing factors were filled again by having multiple iteration cycles. When identifying the means objectives, the fundamental objective of total incomes was kept all the time in the background so that every means objective was serving the fundamental objective.

This analysis aimed firstly to recognize the overall objective of the real estate portfolio management and secondly to identify a group of interpreters that explain the factors of the decision making. These objects and interpreters were connected according to their interaction mechanism and as a result a network was constructed that is illustrated in Figure 19 where a dash line separates the fundamental objective hierarchy and the means-end network. Again, the structuring could be further continued. However, the network created so far already gives a clear picture about the effecting factors behind the fundamental objectives. In other words, Figure 19 describes the decision environment of real estate portfolio management. Hence, in the figure all the

objects and the criteria of the decision making can be seen. In addition, some of the attributes are already in the figure and the rest of those would come out if the structuring was to be continued to the lower levels.

The results from the decision makers' preferences can also be seen from the network where they are presented with colors that are explained in Figure 15. Some of the boxes such as the technical state of the real estate and the energy efficiency are filled with a gradient color because these factors are segregating the real estate owners. In other words, some of the owners keep these factors in high importance and others give them much lower significance. When structuring the means-ends network there were strong and weak interactions between the different factors. These two types of interactions were separated in the value tree by marking the strong ones with the solid line and the weak ones with the dash line (Fig. 15., Fig. 16.).

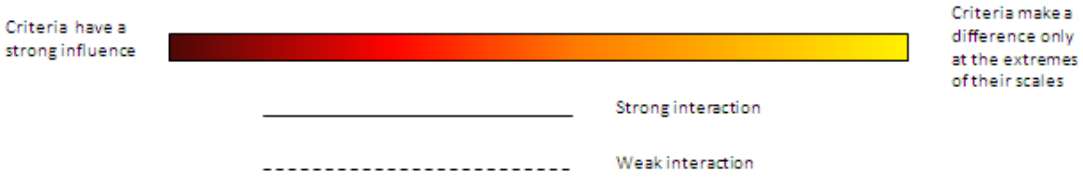


Fig. 15. **Explanations for the value tree signs**

3.5.1 Selecting the Most Important Criteria

As it can be noticed from the value tree it includes plenty of factors and taking all these into account when making decisions is not functional because as told in the theories the number of criteria defines the complicity of the model. Furthermore, it has been argued that user friendliness and the ease of adoption are essential characteristics when considering accepting the approach (Archer & Ghasemzadeh 1999) (Cooper et al. 2001). Therefore, there is a need to synthesize factors so that decision making would be guided by as few criteria as possible. Hence decision making should focus only on the most important factors that are the dark coloured "cells" in the value tree.

The criteria selection is evaluated by using the table of criteria's desired requirements (Tab. 5.). All of the characteristics presented in the list come true but only in ideal cases. Therefore, the criteria that fulfilled the desired features sufficiently well were selected.

Five factors with high importance are in the extremes of the network, namely macro location, micro location, current rental agreement, technical state, and the versatility of the real estate (Fig. 17.). These five factors synthesize all those things that were kept remarkable in the empirical studies. Macro location means the development of the macro environment *i.e.* how the demand to supply ratio is evolving. Micro location instead is more about how reachable the real estate is, in other words, how long it takes to arrive to the property and what transportation types are available.

The third and fourth criteria are directly linked to the cash flow of the property, the current rental agreement correlating positively with it and the technical state of the property correlating negatively with it. These two factors cannot be criteria by themselves because they do not fulfill the requirements for criteria stated in Table 5. For example, current rental agreement and the technical state of the property do not directly describe the consequences of interest. That is why these two factors have been noticed

only in terms of their most relevant aspects. The fundamental objective of the decision making was to maximize the financial benefits and thus reflecting on this the most remarkable aspect in the current rental agreement would be the price and repairing needs in the technical state of the property. Hence these two were selected as third and fourth criteria.

The last factor “the versatility of the property” is also conflicting with the requirements presented in Table 5, and therefore it has been modified to meet these desired properties. The main idea behind the versatility of the real estate is that building would be capable of adapting the future customer needs, in other words it could be developed so that the attractiveness of the property remains or increases. Thus the fifth criterion is stated as property’s ability to develop which means the amount of financial benefits that is likely to be received from the development operations. Financial benefits are received as a rise of the rental price and appreciation of the property.

These five factors synthesize the information form the value tree and help to see the most significant factors of the decision making. The thesis was of course focused only on the endogenous factors and does not take a stand on the portfolio level factors or the property’s exogenous factors. In other words, according to analysis of the work, these three features of the real estates are meaningful when sorting real estates from the perspective of endogenous factors. Hence, real estate owners can justify their decision of sorting by their interest on the strength of these master criteria.

Synthesizing the information as thoroughly as here has weaknesses also because by selecting only the most important factors, many features are left outside the decision making. For instance, energy efficiency issues are not taken into account in these five criteria. However, to keep the model as simple as possible, the factors that do not have a remarkable effect on the decision making are not noticed. In general by focusing on the most remarkable factors, the model will not only be easy to use but also comprehensive in regard to factors' importance.

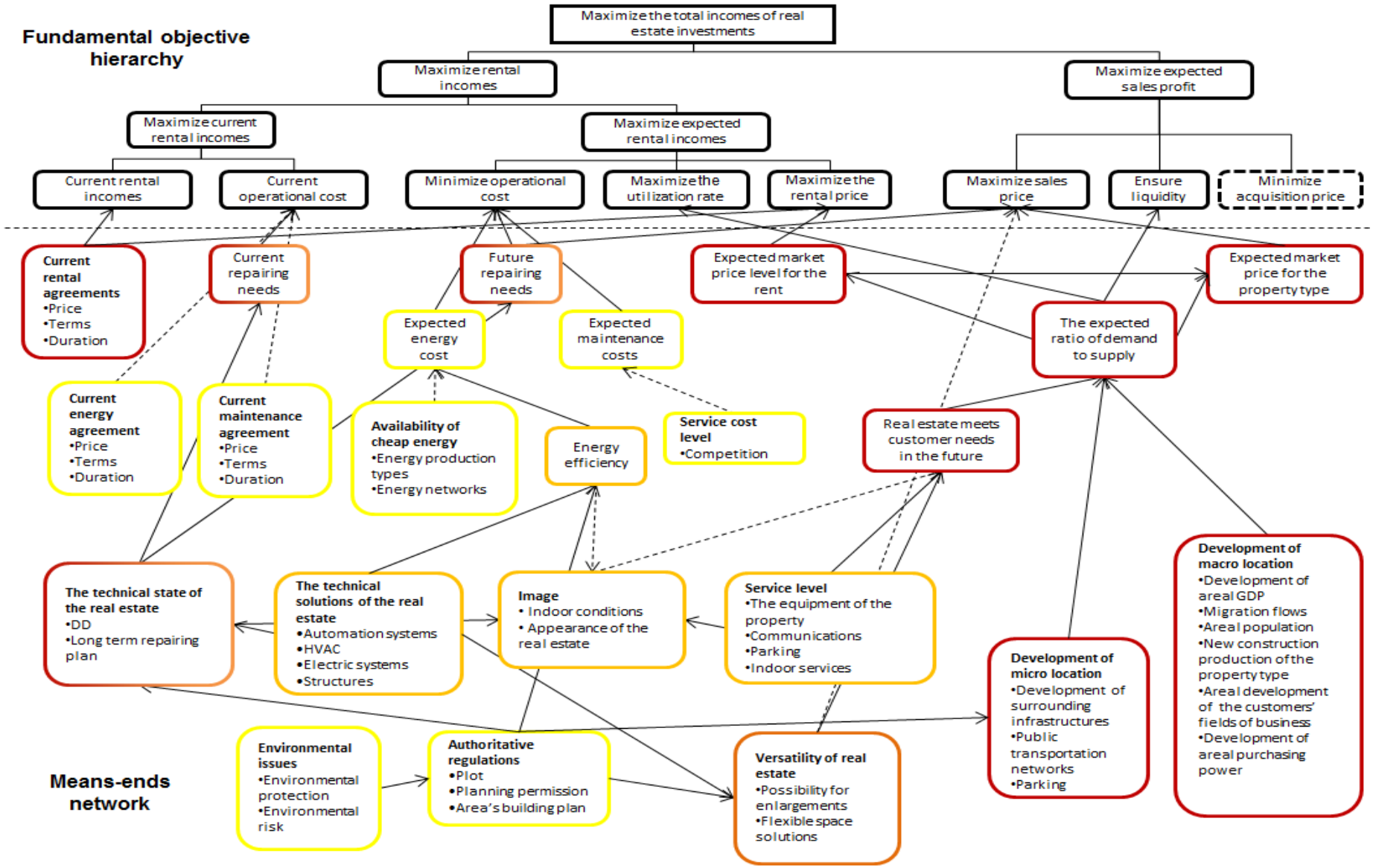


Fig. 16. **Value tree for real estate portfolio management**

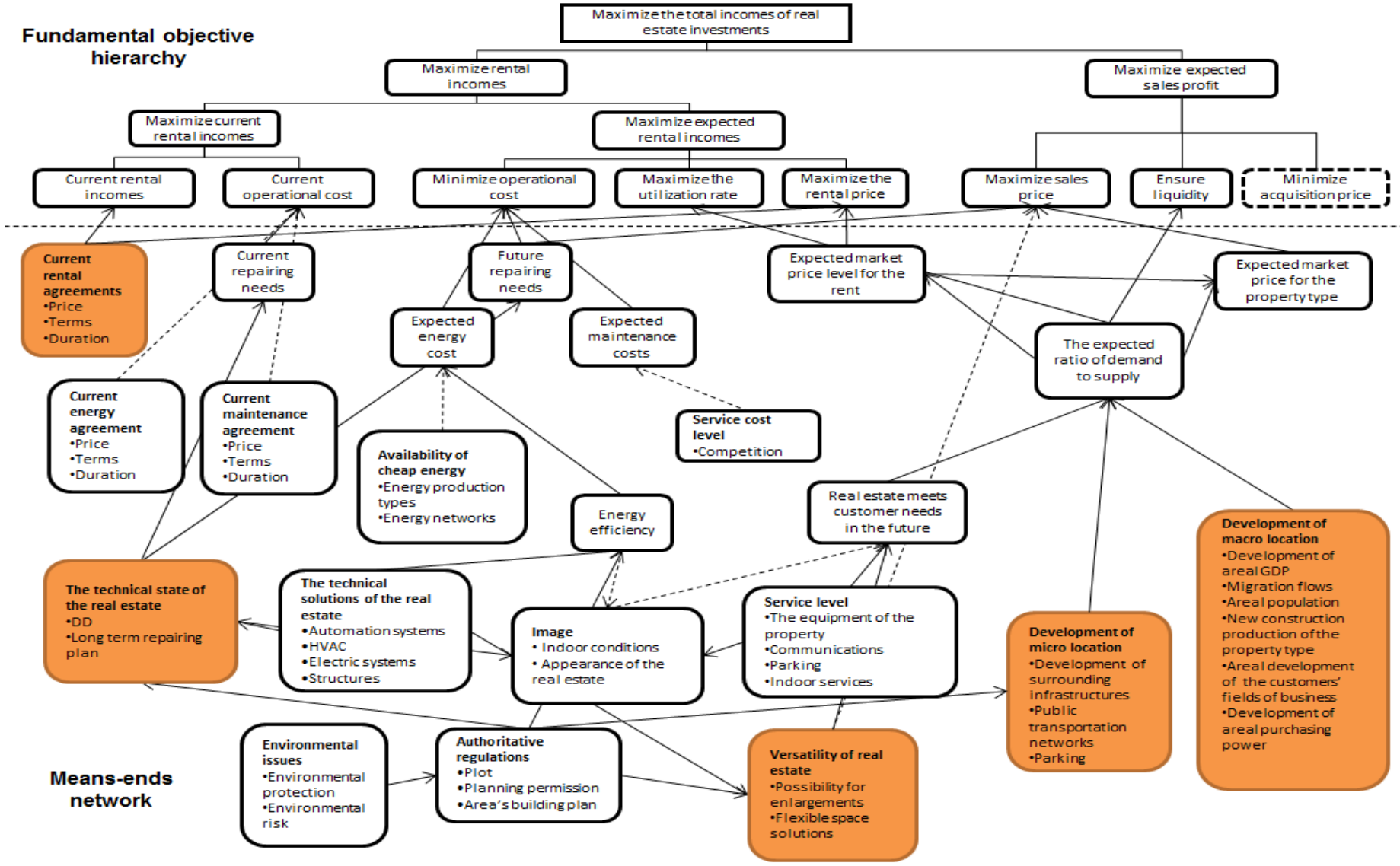


Fig. 17. **The selected criteria for real estate portfolio management**

3.5.2 Recreation of Attributes

The way the achievement of criteria can be measured is proposed in Table 8. These attributes are mostly founded on the results of the empirical studies but there is, nonetheless, also attributes that are created by the thesis maker because all of these criteria were not involved in the interviews. In other words, from the empirical results that are presented in Table 7, the relevant attributes for the recreated criteria were selected, and totally new attributes were created for those criteria that did not have any appropriate indicators in the list. In the following paragraphs, the idea behind the selected attributes will be explained, and it will be observed how it was ended at the certain indicators.

The attributes under the location criteria try to measure areal development from the macro level perspective, and from the micro level perspective the attributes are more about how reachable the property is. The areal development attributes seek to measure on the one hand how the economics generally evolves and on the other hand how the customers' field of business is changing. Reachable real estate instead means a property with good communications and this is measured by surveying users' habit on how they arrive to the real estate in question. Another proposed attribute was a build attribute that would measure time and the mode of transportation from the areal center to the property in question.

In addition to the attributes identified in the interview, one comprehensive attribute for the areal development could be developed from the PESTLE analysis that concerns the development of macro-environmental factors. PESTLE is an abbreviation for Political, Economic, Sociological, Technological, Legal, and Environmental, and the analysis will categorize the information according to these six subjects. (Oxford University Press 2009) Although the analysis can help to take the macro environmental factors extensively into account, it could nevertheless be too heavy for this purpose because it can include a great number of factors that do not have effect on the decision making, and on the other hand, the target was to keep the model as simple as possible. However, it would be useful to study about the possibilities offered by the PESTLE.

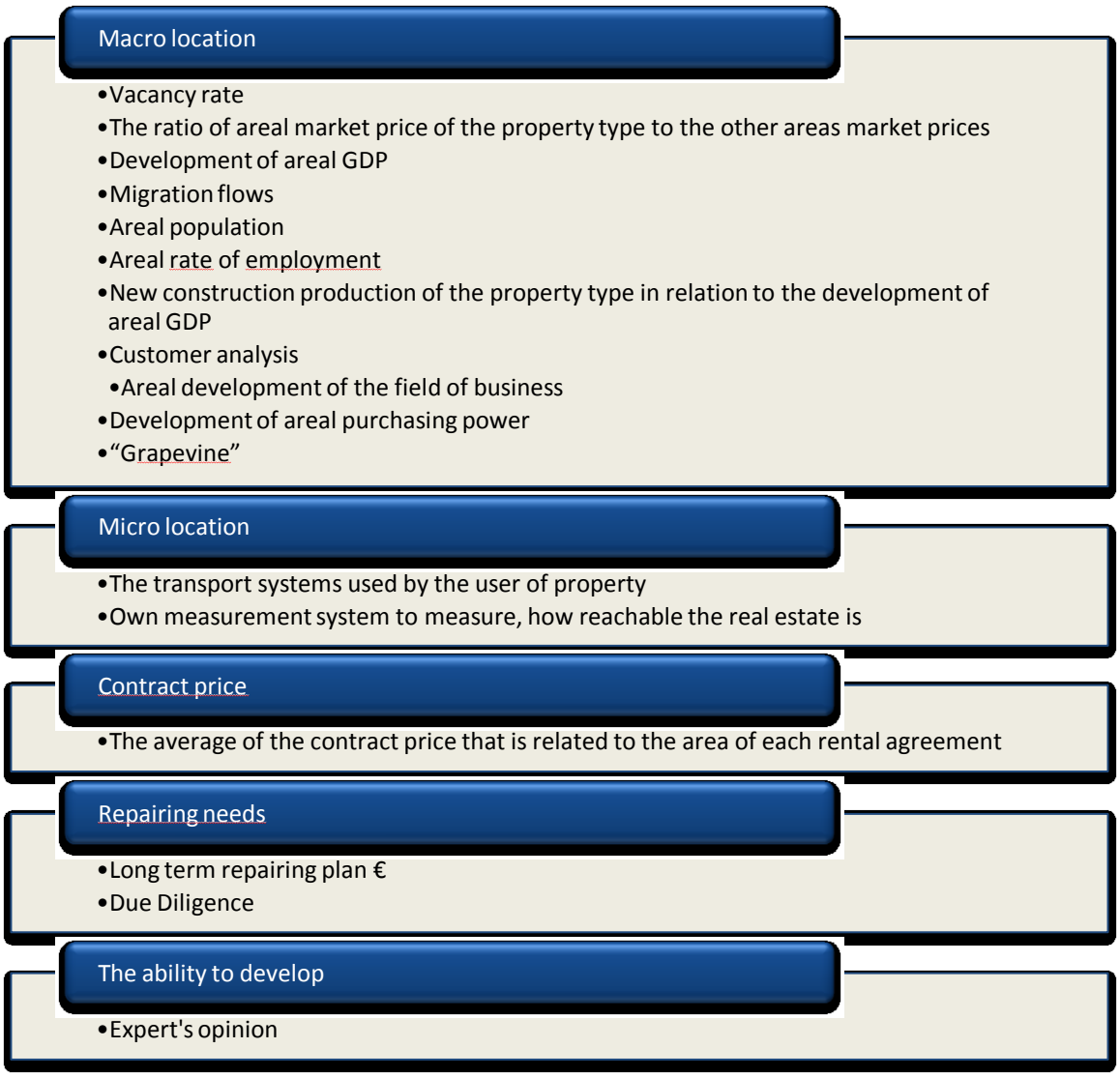
The third criterion, "contract price", has a natural attribute that is of course euro. Whereas business and office properties have usually multiple tenants, it is more relevant to calculate the average of the contract price that is related to the area of each rental agreement. This attribute will give a realistic picture about the incomes of the real estate by using the information that is easily available.

The negative side of the cash flow was taken into account by noticing the repairing need that represents the most important feature of the outcomes. For measuring the repairing need, there are fortunately some already created attributes that are commonly used among real estate owners. One of these attributes is due diligence which can be used for example for calculating an index of the technical state. In this index, the average quality of all the structures and systems in the building will be noticed. Another attribute, the long term repairing plan, gives the sum of the current repairing need costs directly and thus it describes the repairing outcomes of the property unambiguously.

An appropriate attribute for the property's ability to develop is hard to identify, because there does not exist a natural indicator for the capability of the building to produce financial benefits with the development operations. Furthermore, building an attribute would be too complicated. Therefore it was seen that the best option to measure the achievement of the criterion in question would be expert opinion because that is a simple and fast way to get a good estimation about the property's performance.

Value functions for these attributes were not created in this study because deciding the scores for the measurement results is reliant on investors' strategy. Hence the creation of value functions would require more focused outlining of the work and more empirical data of the preferences of a certain investor with certain strategy.

Table 8. Attributes for the criteria



3.6 Synthesizing the Results of Problem Structuring

The meaning of this chapter is to highlight the main results of the empirical study and create a base for the latter construction of the results. Chapter concerns, in other words, broadly about the main notices from the factor generation, preference identification, attribute creation, and analysis.

Results from the interviews verify the understanding that the permanent characteristics of properties are the most important factors, while characteristics that can be affected did not get so much significance. This is based on an assumption that factors that cannot be influenced include much more risks than the factors that can be changed or impacted. This assumption can be justified by the thought that the factors that can be influenced are capable of adapting to the future change and others are not. Hence, it is

better to favor properties that have good permanent features because those cannot be changed or affected in some other way. The factors of the property that are not fixed have more importance during the keeping period or in the selling phase, because these factors are potential objects of development.

Identification of the attributes was very challenging for many of the factors because in some cases, there were no natural attributes and building an indicator would have been too complicated. Therefore, many of the generated attributes were proxy attributes that are not directly the issues that matter, but they indirectly describe the achievement of some objective. A good example of this is a vacancy rate that is not the thing that really matters but it illustrates well what the areal demand is. On the whole, there did not exist many natural attributes in the portfolio management environment, and hence the identified attributes were mostly either build ones or proxy ones.

The decisions could be evaluated and judged by the criteria defined in the value tree; however, too many factors were found complicated and therefore the factors were compressed into five criteria, namely macro location, micro location, contract price, repairing needs, and an ability to develop. In these factors, all those things were synthesized that were considered remarkable in the decision making of property portfolio management founded on the empirical studies. The contest of these criteria was presented in Chapter 3.5, and the relevant attributes for these are listed in Table 8. When observing the real estates' location there were two approaches; macro location that seeks to describe the macro environmental development, and micro location that was more about how reachable the real estate is. Incomes and outcomes are described with the contract price and repairing need that represent the most important features of the property's cash flow. The last feature, "the ability to develop", means the capability of a building to produce financial benefits with development operations.

The selected features do not stand for all the factors in the value tree because there are many factors that do not have any effect on the decision making unless they are in their extremes. Additionally, if some factor is in its extremes, the situation is usually well known and can be taken into account when sorting real estates into different classes.

4 The Construction of the Thesis

The aim of this section is to describe how MAVT methods are applied to the environment of property portfolio management. The conclusions are based on the results of the empirical study and the comments from Pöyry Finland Ltd's professionals are used for support. In other words, the section in question puts the results from the empirical studies into practice by defining the creation of the preference model in the environment of real estate portfolio management. The construction is implemented by first illustrating the process of the model creation, and then creating an example model for sorting properties. Moreover, it is presented how the model created in this work links to the whole sorting process of real estates.

The process described in this section is not tailored for any particular decision situation but it gives readiness of the model creation for a wide variation of investor profiles and real estate portfolios. A specific model for certain situation in portfolio management was not constructed because it was seen more relevant to present the process of creating the model in general rather than making one single model for some situation. Additionally, the creation of the preference model would require more empirical data about the decision maker's strategy, preferences, and profile in general, whereas the plain description of the process can be done with the existing information.

As noted, the actual preference model will not be created and hence the verification of the process cannot be made by testing the created model as if it was presented in the theories. Therefore, the evaluation of the process is made by the real estate owners and asset managers who reviewed if the preference model got as a result from the process met the actual desires of a real estate investor. Owners' and asset managers' evaluations are presented in the last chapter of this section.

4.1 Creating the Preference Model for Real Estate Portfolio Management

This chapter seeks to explicitly present the process of preference model creation for the property level analysis, otherwise it illustrates how the alternatives' degree to which an objective is achieved can be explored (Fig. 18.). The description of the property level analysis is based on the results of the empirical studies and goes along with the process shown in the theories. Thus, it uses the identified criteria and attributes in problem structuring to describe the actions introduced in Section 2 such as score generation for the attribute's performance value, weight creation for the criteria, and calculation of the weighted summation. The aim of the process is to produce a light and simple model so that using it would be founded easy, in other words, one kind of rule of thumb.

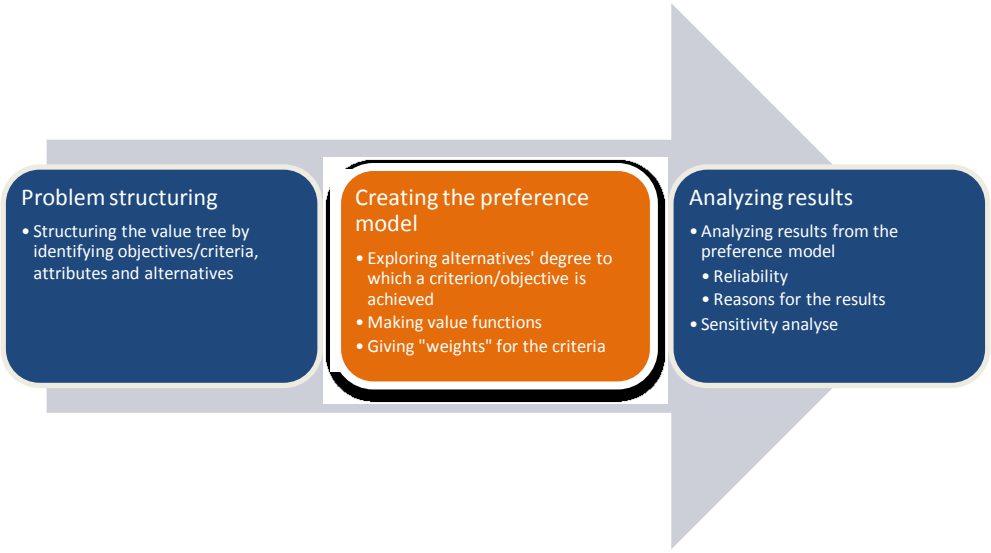


Fig. 18. **The process of MAVT – Creating the preference model**

As an assistance in the process description, SIPOC diagram is used that structures the information by splitting it into five factors, namely supplier, input, process, output, and customer. Moreover, the process factor is divided into the smaller steps so that the single actions can be seen. (Yang & Trewn 2004) SIPOC diagram was selected to illustrate the process because it emphasizes the input information and the data suppliers, among other things. These two features are important to be defined so that as good as possible a picture about how the model creation is done in practice will be received. The created SIPOC diagram is presented in Figure 19 where the identified suppliers, inputs, process, outputs, and customers are shown.

The process suppliers are the quarters that supply the needed input information for the process whereas the required information results from the attributes. Alternatively, things that are measured define the need for the data. Hence by identifying the attributes it will also be stated what kind of information will be needed and moreover, based on the information requirements, the question who are the process suppliers will be answered.

Although the attributes and the criteria have already been identified in the analysis in the previous chapter, there is a need to decrease the number of attributes to keep the created model as simple as possible by choosing the most relevant indicators from Table 8. The fundamental objective of the decision making in the real estate portfolio management was all about financial benefits, and therefore the selection of the attributes should be done based on the financial points of view. Because of the previous statement, the selection of the indicators presented in Table 9 is justified mostly by their manner to measure alternatives' degree of achieving the objectives from the economic perspective.

For example, the attributes for the criteria “contract price” and “repairing need” executes directly the presented idea by measuring the incomes and outcomes. The attributes for “macro location” and “ability to develop” instead, do not directly measure the incomes or outcomes but they take a stand to these indirectly. The attribute for “macro location”, for example, notices the financial viewpoints by observing the development of areal GDP, and the indicator for the “ability to develop” focuses only on the financial benefits of the development operations. It was hard to find an attribute for the micro location that would measure how reachable the property is from the financial perspective, and therefore the selection of a certain attribute is justified only because the transportation time and the variation of transportation type from the areal center were seen as the most determining factors.

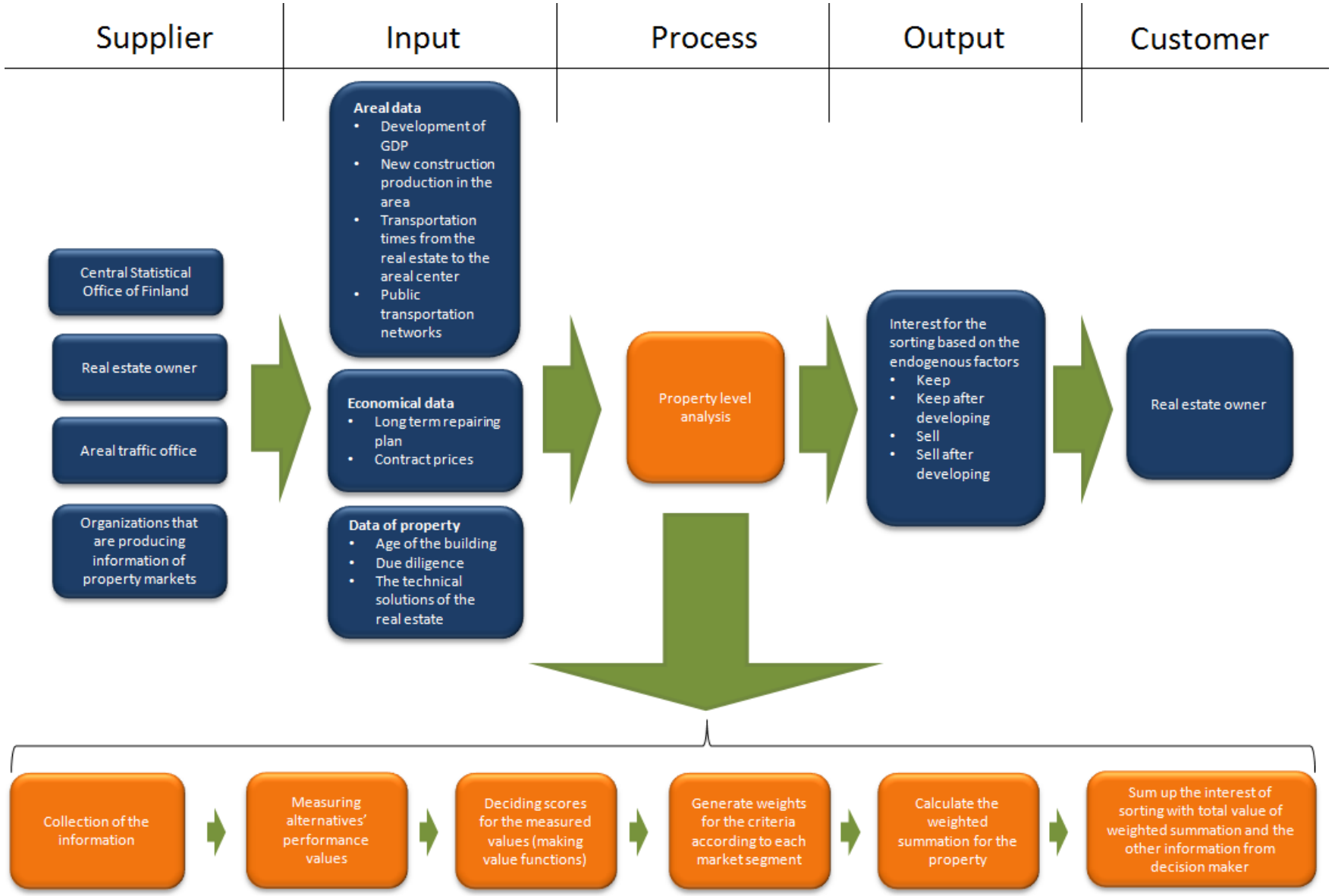


Fig. 19. **The process of sorting real estates described with SIPOC model**

The collection of the selected attributes for the criteria are presented in the list below where the information needs such as the financial key rates of the area and the property, travelling times, and technical information about the building can be concluded (Tab. 9.). The possible suppliers of the required information would be the Central Statistical Office of Finland, the real estate owner, the areal traffic office, and the organizations that produce information about the property markets. The identified suppliers and information needs are presented more specifically in Figure 19. After these two columns follows the process in itself that is described by example in order to demonstrate the model creation in practice (Fig. 20.)

Table 9. The attributes for measuring alternatives' degree of achieving the objectives

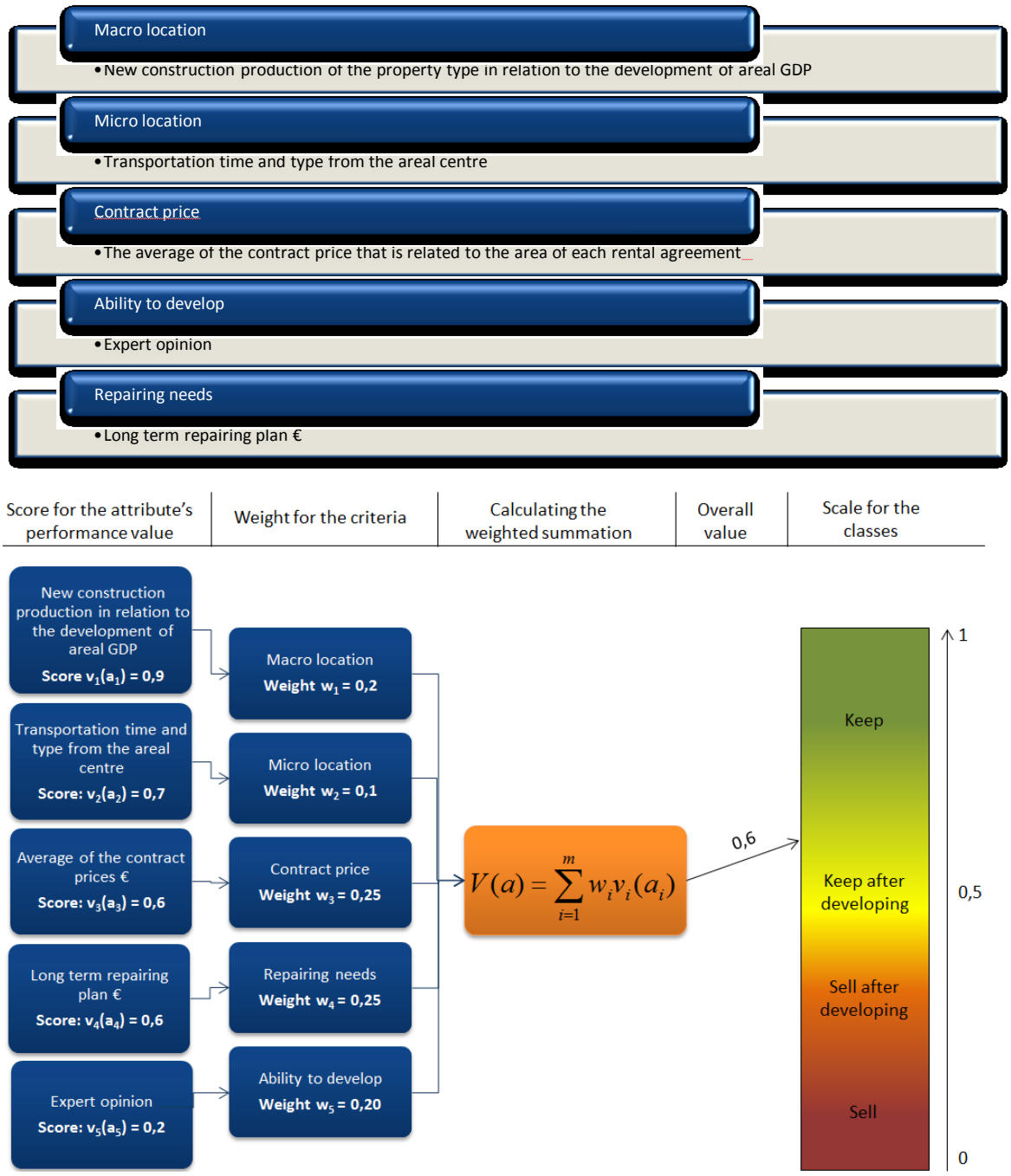


Fig. 20. **An example model for sorting real estates**

The process starts with the collection of the needed information and continues with the measurement of the attributes' performance values (a_i). In the example, hypothetical values from them are used because the real data was not available. Moreover, using the actual data would require focusing on a certain case investor whereas (in) this thesis was wanted to be kept on the general level.

When all the required information is gathered and the results of the measurement are received, the next step is giving scores ($v_i(a_i)$) for the attributes' result. As noted in Chapter 2.4.2, there are two ways to decide a score for the alternative's performance value. In a case where there is no natural measure for the attribute, the scores can be given directly e.g. relying on professional evaluations. Another option is to create a value function that describes the correlation between the alternative's measured performance value and the decision maker's received value from the alternative. The specific scores for the results of the measurements are not stated in this thesis because it would require more empirical research about how the decision makers value certain results. Furthermore, decision makers' views about what scores would be relevant to which measurement result, are differing. Therefore, stating specific value functions would again require focusing on only one real estate owner and hence the hypothetical values were used in the example.

The criteria weighting where the decision maker's preferences are put into practice follows after the score generation. The empirical research did not take a stand on the weights of the criteria because they are reliant *e.g.* on time, strategy, and property itself. Therefore it is impossible to create universal weights for the preference model of property portfolio management. In practice the weighting can be made *e.g.* with the SWING method that was introduced in the written theory, or as in this example where a logical deduction path was created to aid weight creation. Figure 20 presents the built path that was made generally from the perspective of a long term investor. Terms "OK" and "NOK" mean that the performance value of certain attribute was either on an extremely good level or on an extremely poor level. The weights (w_i) themselves were concluded from the created path by testing which weights execute the statements made in Figure 21. For instance, which weights would put the property into the "keep" class if the macro and micro location were on the "OK" level, and the contract price and repairing needs were on the "OK" level, and the ability to develop was on the "NOK" level?

As said in Table 3, the sorting can be made into classes such as "definitely acceptable", "possibly acceptable but needing more information", and "definitely unacceptable". The same kind of classification is done traditionally in the property portfolio management where the classes are "keep", "development" and "sell". However, as shown in Figure 20 and 21, four different classes for the properties are illustrated. The difference between these two presentations is that the latter one splits the development class into two different classes, namely "keep after developing" and "sell after developing".

The class is divided because during the work it was noticed that there are commonly two types of properties that are located in the development class; the ones that will be kept after the development and the ones that will be sold after the development. Thus, sorting properties into three different classes is not decent in this case, and therefore the development class has been split into the properties that will be kept and properties that will be sold.

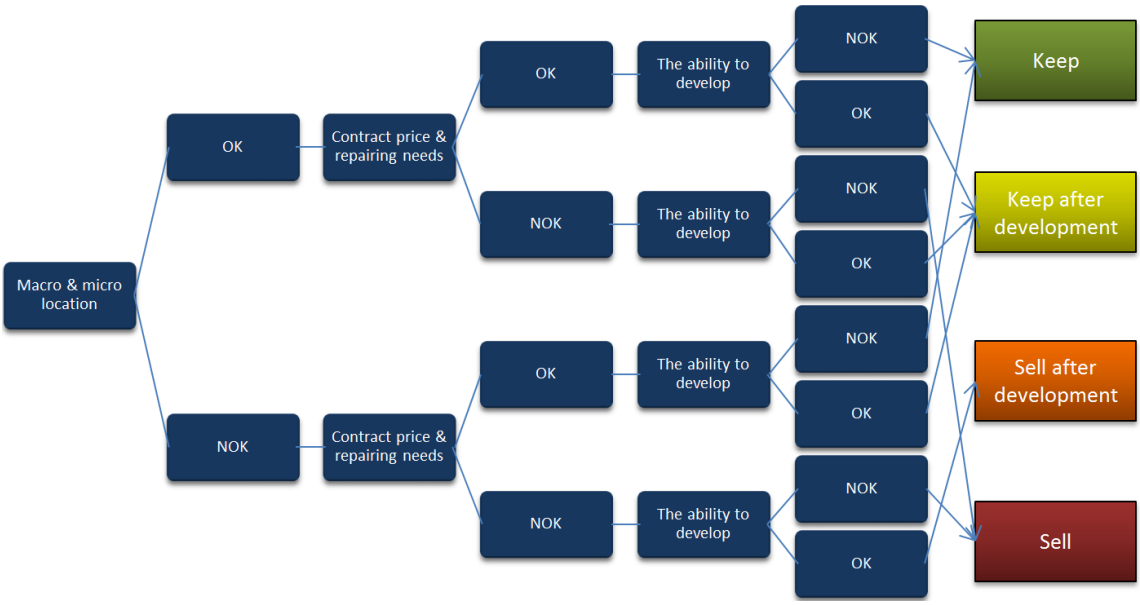


Fig. 21. **The logical deduction path of the weights**

The sorting of the properties was desired to implement by reflecting the overall value against the linear scale, meaning that the overall value of the property would correlate linearly with the sorting suggestion. The problem is, however, that the weights cannot be identified so that they would execute the logic in Figure 21 and at the same time produce linear overall values. This challenge arises more with the properties that should be sorted into the development classes unlike when sorting real estates into classes "Sell" and "Keep" for which the weights can be set so that the overall values are linear and the presented logic is fulfilled. Thus, the weights can be set so that the buildings with a low overall value would go to the "sell" class, and the properties with a high value would be included in the "keep" class. The weights that would execute the presented logic on the development classes viewpoints and at the same time produce linear overall values, are unfeasible to find. The logic illustrated in Figure 21 is as a whole impossible to execute only with weights, and therefore the model needs reasoning rules that guide the sorting along with the overall value. To identify the appropriate rules, it is necessary to take a closer look at the properties that are sorted into the development classes.

The conflict between the class and the overall value of the property arises for example in situation where every indicator is in the "green zone". In this situation, the property does not go into the "keep" class unlike the overall value would suggest but into the "keep after developing" class (Fig. 21.). This result from the performance value called "ability to develop" that measures how capable the building is producing financial benefits with the development operations. As shown in Figure 20, the criterion "ability to develop" is the determining factor when deciding on whether or not the property will be located in the development classes. This logic is based on the assumption that the need for the development of the real estate arises for one reason only, and that is financial benefits. No one of the investors in focus of the study would develop a real estate without the expectation of future profits. In other words, if there is a possibility to receive financial benefits by improving the property, the fundamental objective of the decision maker is mandating the development of the building. Hence, when the performance value of "ability to develop" is on the green zone, it is possible to get more financial benefits through development operations, and the properties would go into the "keep after development" class.

According to the previous reasoning, the model would work more properly by adding a rule to it that would judge solely according to whether or not the building will be developed based on the performance value of "ability to develop". In other words, when the score of the criterion in question is on “OK” level, it goes into one of the two development classes depending on the overall value. When the score is on the “NOK” level, the property will be sorted into the “sell” class or the “keep” class, according to its’ overall value. In Figure 22 it is explained more specifically what kind of properties should be included in certain classes.

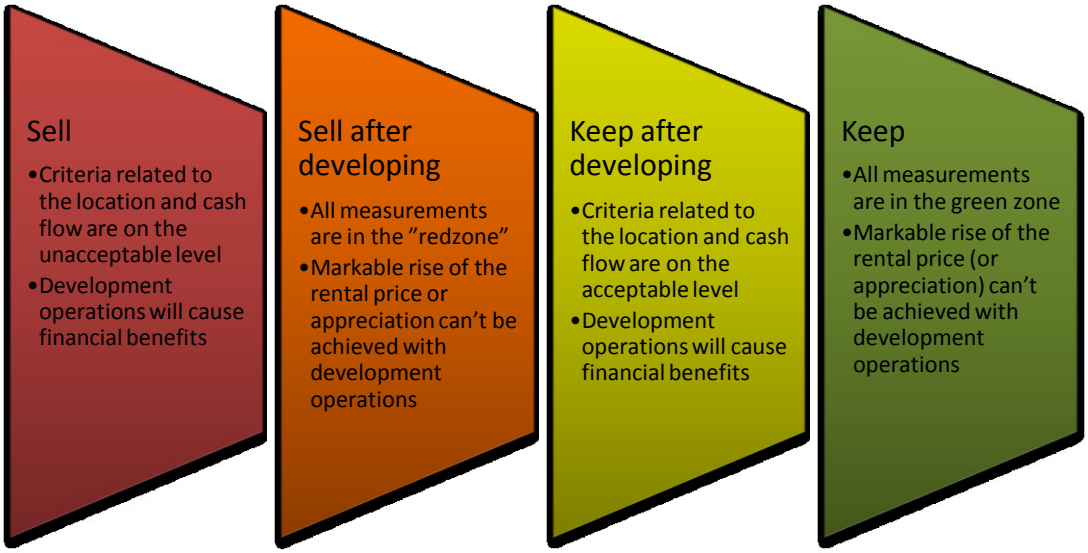


Fig. 22. **Asset classes for real estate portfolio management**

Now when the weights and the score are decided, the weighted summation that was presented in Chapter 2.4.2 can be calculated (Fig. 20.). In its’ simplicity, the formula just calculates the sum of the products of scores and weights. As a result from the hypothetic scores for the attributes’ performance values and created weights of the criteria, an overall value of 0,6 was received. Moreover, the performance value of “ability to develop” was on the “NOK” level. Thus, according to the overall value and the set reasoning rules, the output of the process is to sort the property into the “keep”.

It is, however, important to remember that the interest of sorting is not based only on the results of the model but that the other information that had not been taken into account with the preference model is also affecting. As it was underlined in the theories, the model in itself does not make the decision but it works as an aid for the decision maker who makes the final solution. Hence these two information flows figure the interest of real estate owner. The output of this process, in other words, is the interest of sorting, and the customer is of course the real estate owner itself. To get the big picture, the results of the property level analysis will be collected into the portfolio level analysis where all the properties will be observed as a coherent whole and where the information will be reflected against the strategic alignments.

This example showed only one option of model creation and sought only to demonstrate the model creation. The weights set in the example would not be valid in practice because these did not take the strategy, occasion, and property specific factors into account. In practice, the weights that take the effects of strategy and occasion into account can be set for the whole property portfolio, but noticing the property specific factors requires property specific weights. However, in order not to generate different weights for every property, the weights could be created e.g. for every market segment. This precision would take the special characteristics of area and properties sufficiently into account. The presented weight creation also has a weakness of having been

synthesized some criteria in the logical deduction path, thus with this method it is hard to say how the weights should be divided among e.g. the macro and micro location.

This thesis was outlined to concern only one part of the real estates' sorting process that is the property level analysis of endogenous features. The meaning of Figure 23 below shows how the described model links to process of sorting real estates. Hence it seeks to broadly describe the big picture of property portfolio management by illustrating the whole process of sorting real estates.

The created description of the sorting process is based on the understanding created during the work. As presented in the picture, everything starts from the vision and strategy of the real estate investor. It means that alignments made in the strategy are strictly obeyed when doing the sorting analysis. As mentioned before, the sorting of properties can be approached from two directions, namely from portfolio level or from single property level. On the portfolio level the properties are analyzed as a coherent totality, while on the property level the real estates are evaluated as single objects. Combining the strengths of both analyses, the decision of sorting the real estate into a certain class is finally made.

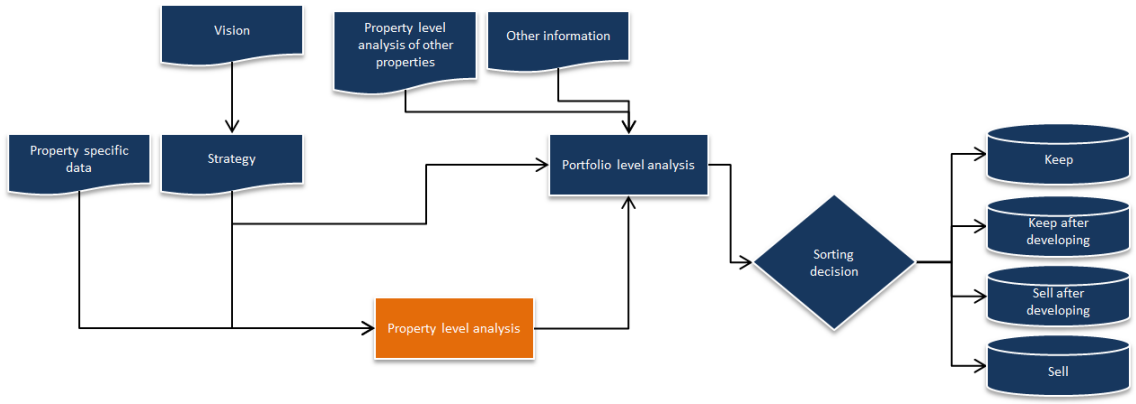


Fig. 23. **The big picture of sorting real estates**

4.2 Analyzing the Results of the Model

The meaning of this chapter is to analyze the validity of the construction of the work (Fig. 24.). The result analysis cannot be done as it was presented in the theories because in this case, the model was not tested with any data and therefore e.g. the reliability of the results could not be tested. However, to test the validity of the described model, the construction was evaluated by real estate owners and asset managers. The people who estimated the construction of the work were the same who were interviewed in the empirical study.

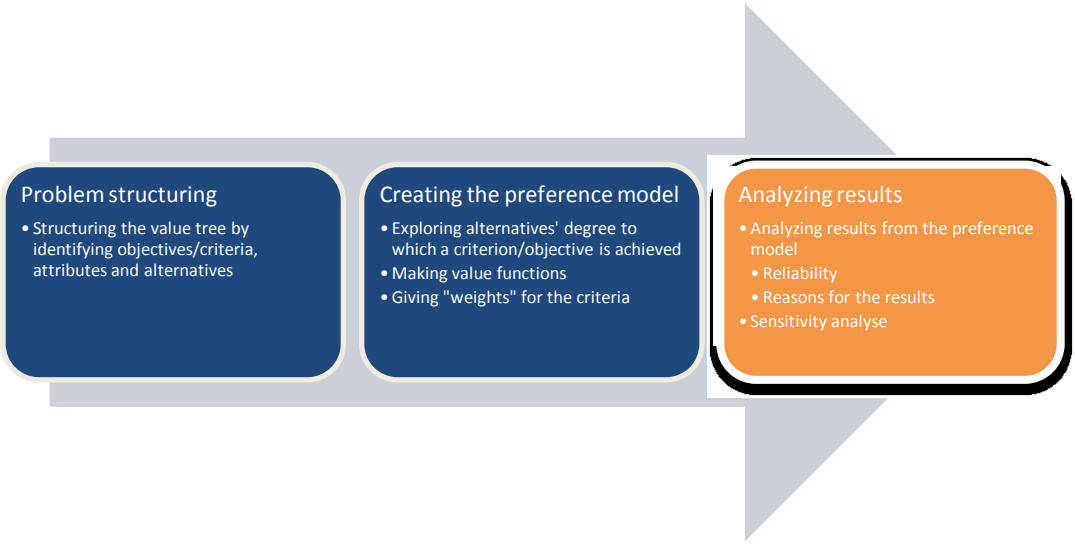


Fig. 24. **MAVT process – Analyzing results**

The assessors were asked to evaluate how well the sorting model, received as a result from the described process, would answer their preferences. In general, how much did they see the use of MAVT could produce value for the decision making of the property portfolio? Moreover, it was asked how they would do the criteria weighting.

The answers got from the assessors were encouraging. All of them saw that the use of the model, received as a result of the process, can produce value for the decision making of property portfolio management. Furthermore, the investors and asset managers were in steps with the statement made in the construction and with the theories according to which the model should be used only as an aid for the decision making. The feedback on the criteria was mostly positive while the attributes received some developmental suggestions. One assessor would reconsider the attribute of the micro location and argued that the most important aspects of the micro location are the property's role, demand, and competitiveness inside the macro location. Moreover, the attribute of micro location was criticized because, unlike it was assumed in this work, the areal center is not, in every case, the center of communications. The indicator for the contract price received some comments that suggested that it would be more appropriate to relate the contract price with the market price or with the type of the room. It was also argued that the expected costs of the repairing need do not give the right picture about the situation but it should be related with the expected profits.

Weighting the criteria was seen so case-specific that setting fixed weights for the criteria could not be done. In principle the assessors saw, however, that the weighting done in the constructions was mainly workable. Some of the assessors would highlight the role of the location criteria more.

4.3 Synthesizing the Construction of the Thesis

The construction made in this study sought to create a process description for the model construction in the environment of property portfolio management. The aim of the created model would be to assist decision making when sorting real estates into different classes. Another requirement for the model is that it should be user friendly and easy to adopt. These requirements and the results received from the empirical studies guided the creation of the model construction process.

The process description was made by using SIPOC diagram where the suppliers, input information, process, output, and the customers are separated. As a conclusion,

Figure 19 was created where e.g. the input of the process and the suppliers of it are presented. In the figure still presented are the actions inside the process such as score generation for the attribute's performance value, weight creation for the criteria, and calculation of the weighted summation. These actions were observed closer by constructing an example model to demonstrate the model creation in practice.

The criteria and attributes used in the example were mainly shaped in the analysis of the empirical data. Only the selections of certain attributes were not done before the construction phase. The final criteria and attributes can be seen in Figure 27 where the example weights for the criteria as a result of the logical deduction path are also presented. From the value function point of view, the example uses only hypothetical numbers to describe the scores for the attributes' performance values, because the generation of the scores as the proper creation of weights would require a case investor.

As a whole, it was concluded that creating a universal model for sorting real estates is not possible because of the unique nature of the weights and value functions. Therefore it would be more appropriate to execute the model constructing process with the case investor. The process described in this chapter should, however, give readiness to create a preference model for the investors that were in the focus of this work. The preference model formed as a result of the process will propose an interest of sorting based on the endogenous property specific features. However, the model should be used only as an assistance in decision making so that the decision maker would use it to support his decisions.

As a conclusion of the result analysis, it was seen that the described process can produce value for the decision making in property portfolio management. However, the reconsideration of the attributes of micro location, contract price, and repairing need was suggested because of the attributes' too narrow viewpoint on the criteria. The weights for the criteria were not suggested because they were seen so case-specific. Instead, the weights set in the example were considered workable in principle.

5 Conclusion

The thesis works as a good preliminary study about the possibilities of MCDA methods in the environment of property portfolio management. During the work a general picture was formed about the factors that are affecting the portfolio management of properties. Furthermore, some of the ways how the achievement of these factors can be measured were identified. Finally, as a conclusion of these features, a value tree was created that was used for describing the process of preference model creation. This chapter considers the contribution of the work, validity and reliability of the study, and the subjects of further research.

5.1 The Contribution of the Work

In this study the existing theories of MCDA were applied into the environment of real estate portfolio management by describing a process for the creation of a preference model. The preference model that will be received as a result from the described process is meant for sorting properties into different classes. Additionally, it was tested on which level the model would answer the preferences of real estate owners and does the whole MAVT process create value for real estate portfolio management.

As a conclusion of the written theories, the MAVT process was defined that seeks to model the preferences of a decision maker. The phases of the process were the problem structuring, model creation, and result analysis. The problem structuring identifies decision maker's objectives, alternatives, and the connections between the factors. In model creation phase, instead, the alternatives are ranked in relation to decision makers' preferences by constructing a model so that the decision alternatives can be compared in a systematic and transparent manner. Finally, in the result analysis the reliability of the results is tested and the reasons for certain results are identified.

Results from the interviews verify the understanding that the permanent characteristics of properties are the most important factors, while the features that can be affected did not get much of importance. As a result of the analysis, five criteria were formed by which the sorting of real estates is evaluated. The criteria were: a macro location that seeks to describe the macro environmental development, a micro location that takes a stand on how reachable the real estate is, a contract price that presented the income side of the cash flow, a repairing need that was included because it has a high effect on the outcomes, and the ability to develop which means the capability of a building to produce financial benefits with the development operations. Selected features did not stand on all the factors in the value tree because there is a great number of factors that do not have any effect on the decision making until they are in their extremes.

Identification of the attributes was challenging for many of the factors because in some cases, there were no natural attributes and building an indicator would have been too complicated. The final selection of the attributes was based on the empirical study and the analysis made in this work. Attributes under the location criteria try to measure areal development from the macro level perspective, and from the micro level point of view the attributes are more about how reachable the property is. A suggested attribute for the "contract price" was the average of the rental prices that are proportioned to the area of each rental agreement. For measuring the repairing needs, there are attributes that are already used commonly, namely due diligence and the long term repairing plan. An appropriate attribute for the property's ability to develop is hard to identify, and therefore it was seen that best option to measure the achievement of the criterion in question would be expert opinion.

The construction of the study sought to create a process description for the model creation in the environment of property portfolio management. The model, got as a result of the process was required to be user-friendly and easy to adopt. These requirements and the results received from the empirical studies guided the creation of the model constructing process. The process description was made by using SIPOC diagram where the suppliers, input information, process, output, and the customers are separated. Thus, the construction phase described on the general level what kind of information is needed and who are the information suppliers. Moreover, it was presented what kind of actions are included in the process in itself, and what is the output and who the customers are in the process. The steps of the process were observed closer by creating an example model to demonstrate the model construction in practice. The process described in the construction phase should give readiness to create a preference model for the investors who were in the focus of this work. The preference model built as a result of the process will propose an interest of sorting based on the endogenous property specific features. However, the model should only be used as an assistance in decision making so that a decision maker would use it to support his decisions.

As a conclusion of the result analysis, it was seen that the described process can produce value for the decision making of property portfolio management. The reconsideration of the attributes of micro location, contract price, and repairing need were, however, suggested because of their too narrow viewpoint to the criteria. The weights for the criteria were not suggested because they were seen so case-specific. Meanwhile, the weights set in the example were considered workable in principle.

5.2 Critical Evaluation of the Study

The research strategy of the thesis could have been chosen differently, because as mentioned earlier, the result analysis would have been more appropriate if a case study was used to build a preference model. The result analysis made in this work was based on real estate owners' and asset managers' intuition about the possibility of the described process to produce a model that would reflect their preferences. With real data the question was whether the received results would make the recognized criteria and attributes work in practice, and would the illustrated process produce a preference model that properly describes the desires of the owner. Hence, creating a MAVT model for a certain real estate owner would maybe tell more about the workability of the model.

The results of the interviews included some divergences that appeared as single votes for certain factors. It was assumed that interviewees who have a strong strategy on

a background will give answers that differ from others'. Answers did not, nevertheless, differ from the common line totally but there was usually one differing choice, and that was caused by the effect of strategy. In addition to the validity of the interview results, the interviewees were mostly from the financial field, and therefore the economic points of view were maybe highlighted in their answers. Hence by interviewing people from the technical field would possibly give differing answers; for instance the basic characteristics of real estate might get more attention. After all, it is assumed that the fundamental objectives would be the same in spite of the interviewees' backgrounds.

The interview questionnaire included three questions where the first concerned the criteria of decision making, and the last two concerned the attributes by which the achievement of the criteria is measured. The option list for the first question was not totally valid because some of the factors were still intersecting although the factors had been synthesized so that the features would not be crossing each other. The answers for the last two questions varied a lot because of the semi-structured shape of the questions. Furthermore, many interviewees could not give answers for every in the questions. The meaning of the question was, nevertheless, to give only suggestions for the attributes. Thus the variation and the missing answers did not reduce the internal validity of the study.

The theoretical section gave an image that by following MAVT process and using the described tools and methods, an ideal preference model will be received. However, it is not so simple because it depends on the context how well (does) the presented features fit in the decision situation and what kind of a preference model can be created. The point is that the model presented in the theories would be reality only in an ideal situation while in practice, the shape of the model depends on the context. Therefore, this viewpoint would be appropriate to turn out when presenting the theoretical findings. Otherwise, it might be assumed that the construction of the study is not a proper preference model.

The created MAVT model cannot be generalized to the environment of property portfolio management because as written in the theories, there does not exist only one value tree for some decision situation but the created value tree is always constructed from its creators' perspective. Hence, the described process should give readiness to create a preference model only to the decision situation that was in the focus of this work. In the decision situation in question the model is just one model among others that is influenced by the views of the thesis maker and the interviewees.

The reliability of the study suffered from the narrow sample because only eight people were interviewed. On the other hand, trends could be seen clearly from that narrow sample already, and thus the bigger amount of interviewees would not necessarily change the results.

5.3 Need for Further Research

During the work, many new questions have arisen concerning MCDA in property portfolio management. This chapter aims to synthesize these thoughts by suggesting some subjects for further research.

This thesis was outlined to the private real estate owners who own property only as an investment. Hence it would be different to build the value tree for public owners or for investors who are not only the owners but also the users of the properties. In these cases, the fundamental objectives of the property owners would not be concentrated only on profits but also, for instance, on the property's standard of service or in case of

the public owner, on social responsibilities. Therefore, it would be interesting to see how the value tree would change if the real estate owner profile was changed.

Another interesting subject for future research would be the other parts of the sorting process, because this thesis concerned only the property level analysis of endogenous factors. Thus, to get a more extensive model for sorting real estates, it is necessary to study also the exogenous factors and thereafter the portfolio level analysis. In addition, studying the generation of strategy and surveying how the alignments stated in it are executed in the sorting analyses would increase our understanding about the portfolio management. After these studies, a model could be created that not only generates an interest for the sorting according to the property specific endogenous factors, but also gives recommendations for the sorting based on all affecting factors.

The role of the strategy and owner's profile could be concerned also from the other viewpoint, just like the strategy has an effect on the criteria within the outlines of this work. This is interesting issue because in this work, an assumption was made according to which criteria are not reliant on the strategy or investor's profile but these issues are mainly taken into account on the weights of the criteria. In other words, it was assumed that criteria by which alternatives are evaluated can be the same in different strategies but the way how these criteria are weighted is totally different. The duration of the current rental agreement and current repairing need, for example, are differently weighted from the developer’s and long-term investor’s point of view. Hence it would be informative to study whether all the investors inside the outlines of this work have the same criteria for decision making, or are the differences in the strategies noticed only with weights and value functions.

This study focused mainly on the problem structuring phase of the MAVT process. Thus, it would be relevant to study how the preference model can be created as a whole and test the work ability of the created model by using an existent property owner and actual data. The creation of a real model would take a stand on the operations that were not the focus of this thesis. For example, the work did not concern much of the creation of value functions or how the weighting methods work in practice. For instance, weighting the criteria is challenging because it is reliant on the location and time or in some cases, weights can even be property specific. Thus, this subject requires closer thoughts about how the weight creation can be made efficiently, but at the same time, how the specific characteristics of some area or even some property can be taken into account with weights. Examples for weight eliciting can be found in RPM methodology introduced by Liesiö *et al.* 2006 where it is noted that the weights do not need to be fixed with exact numbers but they can be limited e.g. with priorities, ranges, and the relations between the weights. These thoughts have been well approved in distinct applications (Könnölä *et al.* 2006a, 2006b; Lindstedt *et al.* 2006; Mild 2006a, 2006b).

In addition to the weights and value functions, the attributes of the criteria would be a remarkable subject for further research. The empirical results of the work gave only suggestions about the possible attributes, and therefore a wider study about the good indicators would be important. Moreover, some attributes were described only verbally and the exact structure of these attributes was not described. Hence it would be reasonable to take a closer look on these indicators and study what the appropriate content of the attribute would be.

As a whole, it can be noted that the best possible model for sorting a real estate for a certain real estate owner and a certain real estate portfolio can be created by going through the whole process of MAVT. With this it is ensured that the created model answers as ably as possible to the situation in question and that the owner's preferences are properly modeled. Moreover, it would also guarantee the best learning and increase understanding about the decision maker's values and objectives. That was one of the

best outcomes of using MAVT methods. Thus, it would be important to have a case example where the preference model could be created and tested.

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Appendix 1

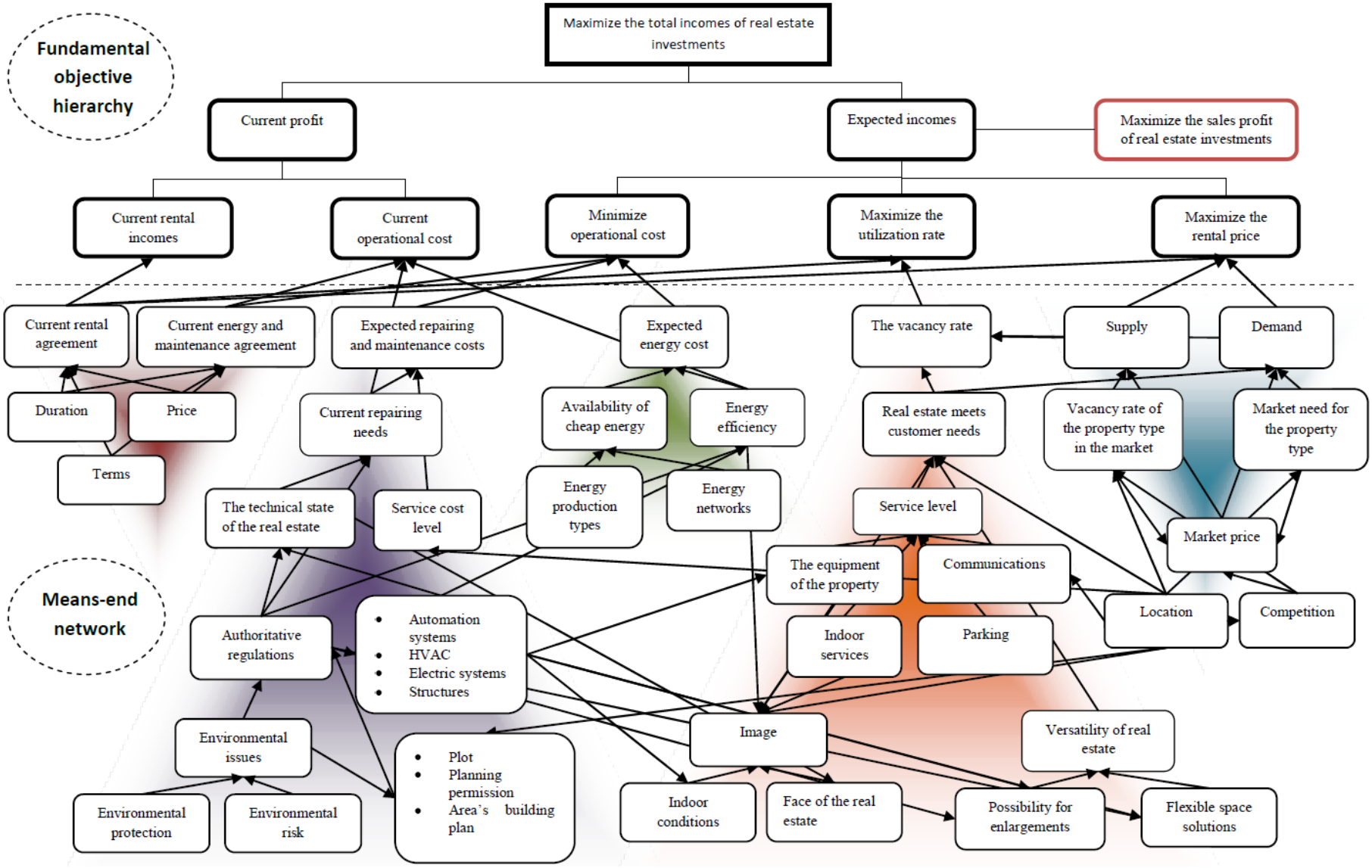
Haastattelulomake – Kiinteistöjen salkuttaminen

Tämä haastattelu tehdään osana Pöyry Finland Oy:lle ja Oulun Yliopiston tuotantotalouden osastolle suoritettavaa diplomityötä, jonka tarkoituksena on testata monikriteeristen päätösongelmateorioiden (Multi-Criteria Decision Analysis - MCDA) soveltuvuutta kiinteistöjen salkuttamisen ympäristöön. Kiinteistöjen salkuttamisella tarkoitetaan tässä yhteydessä kiinteistökannan jaottelua kolmeen eri salkkuun: pidetään, kehitetään ja myydään.

Multi Criteria Decision Analysis (MCDA tunnetaan myös MCDM Multi Criteria Decision Making) on oppi metodeista ja lähestymistavoista, joissa eri vaihtoehtojen paremmuutta arvioidaan suhteessa päätöksentekijän asettamiin tavoitteisiin. Teorioiden käsittelemien päätösongelmien luonteeseen kuuluvat useat ristiriitaiset ja yhteismitattomat kriteerit, jotka tekevät päätöksenteosta erittäin haasteellista. Kriteereillä tarkoitetaan niitä tekijöitä joiden perusteella vaihtoehdon hyvyyttä arvioidaan suhteessa päätöksentekijän tavoitteisiin. MCDA:n tuoma arvo päätöksentekoon syntyy sen jäsennellystä ja selkeästä tavasta käsitellä päätösongelmaa, minkä johdosta päätöksentekijä tulee paremmin tietoiseksi itse päätösongelmasta sekä omista ja muiden sidosryhmien arvoista ja tavoitteista.

Kiinteistöjen salkuttamiseen vaikuttavia tavoitteita, arvoja ja kriteereitä on diplomityössä kartoitettu ja jäsennelty seuraavalla sivulla esiintyvän kuvan mukaisesti. Katkoviivan erottama kuvio jakautuu tavoitehierarkiaan (Fundamental objective hierarchy) ja keinotavoitteiden verkostoon (Means-end network). Tavoitehierarkian tarkoituksena on kuvata kiinteistöjen salkuttamisen päätöksenteon perimmäiset tavoitteet perustuen päätöksentekijän arvoihin. Keinotavoitteiden verkosto puolestaan pyrkii kuvaamaan tarkemmin ne tekijät jotka vaikuttavat ”ylemmän tason” tavoitteen toteutumiseen ja perustuu näin ollen faktoihin.

Haastatteluiden tarkoituksena on vahvistaa käsitystä kiinteistöjen salkuttamisen päätöksentekoa ohjaavista kriteereistä ja tuoda esiin mahdollisesti puuttumaan jääneet tekijät. Haastatteluiden avulla pyritään lisäksi kartoittamaan kriteereiden toteutumista arvioivat mittarit. Haastatteluista saadut tulokset tullaan esittelemään työssä pitäen haastateltavat anonyymeinä.


Fundamental objective hierarchy
Maximize the total incomes of real estate investments
Current profit
Expected incomes
Maximize the sales profit of real estate investments
Current rental incomes
Current operational cost
Minimize operational cost
Maximize the utilization rate
Maximize the rental price
Current rental agreement
Current energy and maintenance agreement
Expected repairing and maintenance costs
Expected energy cost
The vacancy rate
Supply
Demand
Duration
Price
Terms
Current repairing needs
Availability of cheap energy
Energy efficiency
Real estate meets customer needs
Vacancy rate of the property type in the market
Market need for the property type
Means-end network
The technical state of the real estate
Service cost level
Energy production types
Energy networks
Service level
Market price
The equipment of the property
Communications
Location
Competition
Authoritative regulations
Automation systems
HVAC
Electric systems
Structures
Indoor services
Parking
Environmental issues
Image
Versatility of real estate
Plot
Planning permission
Area's building plan
Environmental protection
Environmental risk
Indoor conditions
Face of the real estate
Possibility for enlargements
Flexible space solutions

Haastattelukysymykset

Kiinteistöjen salkuttamisen kriteerit

Tämän kysymyksen tarkoituksena on tuoda esiin ne tekijät (kriteerit), joiden perusteella ensisijaisesti arvioidaan vaihtoehdon hyvyyttä päätöksentekijän tavoitteisiin nähden. Halutaan siis selvittää mitkä tekijät ohjaavat kiinteistöjen sijoittumista eri salkkuihin.

1. Mitkä kuusi tekijää seuraavista nostaisit tärkeimpien asioiden joukkoon arvioitaessa kohteen sijoittamista ”pidetään” salkkuun?

    - ☐ Kiinteistön palvelutaso (varustelutaso, palvelut kiinteistössä, kulkuyhteydet…)
    - ☐ Alueella vapaana olevien samantyyppisten kiinteistöjen määrä
    - ☐ Alueella oleva tarve ko. kiinteistölle
    - ☐ Kiinteistön energiatehokkuus
    - ☐ Tämän hetken korjaustarpeet kiinteistössä
    - ☐ Tällä hetkellä voimassa olevan vuokrasopimuksen hinta
    - ☐ Tällä hetkellä voimassa olevan vuokrasopimuksen kesto
    - ☐ Kiinteistön muuntautumiskyky
    - ☐ Alueella vallitseva markkinahinta ko. kiinteistötyypille
    - ☐ Kunnossapitopalveluiden hintataso alueella
    - ☐ Tämän hetkinen kunnossapitosopimus kohteessa
    - ☐ Sijainnin houkuttelevuus käyttäjille
    - ☐ Kiinteistön sisäolosuhteet
    - ☐ Kiinteistön ulkonäkö
    - ☐ Viranomaismääräykset kohteessa
    - ☐ Jokin muu kriteeri

Kriteereiden toteutumista mittaavat tekijät

Toisen kysymyksen tarkoituksena on pyrkiä etsimään kohdassa 1 valituille kriteereille niiden toteutumista kuvaavat mittarit. Halutaan toisin sanoen saada selville millaisten tekijöiden suhteen voidaan arvioida tietyn kriteerin toteutumisen astetta.

2. Miten kuvailisit kiinteistöjä eri salkuissa kohdassa 1 valitsemiesi tärkeimpien kriteereiden suhteen?

Kriteerit	Pidetään	Kehitetään	Myydään
Kiinteistön palvelutaso (varustelutaso, palvelut kiinteistössä, kulkuyhteydet…)			
Alueella vapaana olevien samantyyppisten kiinteistöjen määrä			
Alueella oleva tarve ko. kiinteistölle			
Kiinteistön energiatehokkuus			
Tämän hetken korjaustarpeet kiinteistössä			
Tällä hetkellä voimassa olevan vuokrasopimuksen hinta			
Tällä hetkellä voimassa olevan vuokrasopimuksen kesto			
Kiinteistön muuntautumiskyky			
Alueella vallitseva markkinahinta ko. kiinteistötyypille			
Kunnossapitopalveluiden hintataso alueella			
Tämän hetkinen kunnossapitosopimus kohteessa			
Sijainnin houkuttelevuus käyttäjille			
Kiinteistön sisäolosuhteet			
Kiinteistön ulkonäkö			
Viranomaismääräykset kohteessa			
Jokin muu kriteeri			

Kolmannella kysymyksellä pyritään selkeyttämään kohdassa kaksi löydettyjen mittareiden mitta-asteikkoa, hakemalla asteikon ääripäitä. Toisin sanoen millaisia ovat kohdassa yksi valittujen kriteereiden toteutumista kuvaavien mittareiden ääripäät.

3. Miten kuvailisit ”myydään” ja ”pidetään” salkkujen ääripäihin sijoittuvia kiinteistöjä kohdassa 1 valitsemiesi tärkeimpien kriteereiden suhteen?

Kriteerit	Pidetään	Myydään
Kiinteistön palvelutaso (varustelutaso, palvelut kiinteistössä, kulkuyhteydet…)		
Alueella vapaana olevien samantyyppisten kiinteistöjen määrä		
Alueella oleva tarve ko. kiinteistölle		
Kiinteistön energiatehokkuus		
Tämän hetken korjaustarpeet kiinteistössä		
Tällä hetkellä voimassa olevan vuokrasopimuksen hinta		
Tällä hetkellä voimassa olevan vuokrasopimuksen kesto		
Kiinteistön muuntautumiskyky		
Alueella vallitseva markkinahinta ko. kiinteistötyypille		
Kunnossapitopalveluiden hintataso alueella		
Tämän hetkinen kunnossapitosopimus kohteessa		
Sijainnin houkuttelevuus käyttäjille		
Kiinteistön sisäolosuhteet		
Kiinteistön ulkonäkö		
Viranomaismääräykset kohteessa		
Jokin muu kriteeri		