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A METHOD FOR STRATEGIC TECHNICAL LIFE CYCLE MANAGEMENT OF REAL ESTATES

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ABSTRACT

This research study focuses on the strategic technical life cycle management (TLCM) of real estate. In the early phases of the study it became clear that very often the performance of TLCM was not perceived as satisfactory: there were problems in the purchasing and provision of technical services, TLCM was not performed according to real estate specific needs and objective-setting for building characteristics did not serve cost-effective ownership.

The study focuses on four research questions. The first research question is: What is the status of TLCM processes in the real estate sector? The underlying theories, key concepts, methods and tools in the real estate sector as well as practices related to the domain of TLCM are studied, along with the performance of TLCM as perceived by stakeholders. The initial aim was to establish whether there is a solid foundation of appropriate theories, key concepts and methods for TLCM, and was approached through a literature review and interview studies. Another aim of this preliminary phase was to define the appropriate scientific approach for the study and refine the further research questions. At the beginning of the study, it was not clear if there even was a theoretical background and therefore both hermeneutic and constructive approaches were possible depending on the results obtained in elaborating the first research question.

According to the preliminary studies, there was no solid foundation of appropriate theories and key concepts for TLCM. There was no satisfactory method for performing TLCM, and one needed to be developed. Therefore the second research question asked: by what means can we successfully develop and deploy such a method? This research was carried out using the constructive approach to develop and test a new method for TLCM. The third research question focused on the method itself: What are the characteristics and capabilities required of such a method? This was approached by interview studies and literature reviews through which it was possible to identify the initial factors critical for success. After the new construct was developed and being tested, a fourth research question was asked: Does the method work? Is it practical, usable and useful? The thesis describes the research process phase by phase, as well as the results of five real life case studies which were chosen to test the method in different situations for which it was designed. When evaluating the TLCM Method, 21 users as well as 15 experts in the field were interviewed. Questionnaires were used as well.

The net result of this research has been the construction of a practical, generic and novel TLCM Method for analyzing the technical risks and potential of buildings as well as costs for achieving the primary objectives from the perspective of cost-effective ownership. The Method begins with a detailed analysis, and then describes a process for developing a technical life cycle strategy according to decisions made during the analysis. The concept of TLC-manager was also defined and described.

Finally, the thesis presents the results and the practical and theoretical contribution of the TLCM-Method and evaluates the validity and reliability of the research. The study demonstrates that the TLCM Method facilitates objective-setting related to the technical objectives of real estates, and also facilitates the purchasing and provision of technical services. Using the TLCM Method improves the cost-effectiveness and quality of TLCM, and improves risk management. According to the interview data, the need for such a new, practical method was obvious. The TLCM Method was perceived as systematic, logical and generic. It also proved to be useful and usable in all situations for which it was constructed, and is also applicable in other environments. Several real estate owners and technical service providers in Finland are currently using the TLCM Method in practice.

Key words: technical life cycle, life cycle management, strategic property management, investment analysis

FOREWORD

This thesis focuses on business development needs related to the strategic technical life cycle management of real estates in the real estate and construction businesses. The initial problem was that the strategic management of technical life cycles of real estates seemed not to be a common practice. According to many real estate managers and technical service providers, there were many unsatisfactory issues related to the purchase or provision of technical services, and buildings were not performing well over their technical life cycles. Too often, technical management seemed not to be goal-oriented, and there were plenty of technical problems. In this research, a new method for the strategic technical life cycle management of real estates is constructed and tested in case studies. For me, the most interesting challenge was to take an academic approach to solving a practical problem.

I was given the opportunity to start this dissertation at the Helsinki University of Technology, Department of Industrial Management, as part of TEKES's Rembrandt research program (2000-2004). The main work was done in Germany, where I also studied at the European Business School (EBS), a private university of real estate economics and management. I have found this international view of real estate management issues very fruitful and rewarding, and I thank my teachers and fellow students there.

I owe many thanks to my dissertation director, professor Eero Eloranta, for his valuable support throughout my research. In the finishing stage of this research Dr Brian Atkin and professor Lauri Koskela provided many constructive and inspiring remarks, and I thank them for their valuable contribution to my work. I am also very grateful to Dr Nely Keinänen who checked the language of this thesis.

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PART ONE

1 Introduction

This chapter discusses the background of the study, and also explains the researcher's personal motivation for doing it. In addition, we present the scope and restrictions of the study and also introduce its general structure.

1.1 Background and motivation of the study

Property management is an interdisciplinary and multidimensional line of business in the national economy. Investors invest their capital for the long term on long-lasting objects, and consequently have profit expectations and requirements. In order to fulfill the prerequisites of business, properties must enable investors to realize their profit expectations and/or provide facilities for the owner's core requirements. The management of a given property creates a strategy which takes into account profit expectations and the investments necessary to maintain it. Owners must balance costs and profit expectations or other benefits. In addition, owners must ensure the continuity of returns, the maintenance of property values, and factors relating to changes in either of these (Aho, 1993). Like owners, the end users of a property also define a strategy (Kaleva, 1998). And indeed, an increasingly important component of property management is responding to the rapidly changing requirements of end users (Bottom et al., 1998).

In Finland, services supporting a property and its users are often bought from external service providers. Some of these services are related to daily requirements, such as cleaning, daily maintenance and catering services. The main group using and benefiting from these services is the property's end user. Other, less frequent services focus on the property itself, its development, maintenance, and other work necessary to maintain its market value. These services are often related to a property's physical characteristics, such as functionality, aesthetics, technical and functional quality or durability or are provided to eliminate problems standing in the way of realizing the desired benefits. The main party benefiting from these services is the owner of the property.

If a property's technical services are systematically bought on a long-term basis, this is referred to as long-term (technical) planning (LTP). In recent years, there has indeed been much discussion among property managers about long-term technical planning and life cycle development. The objective is to create, increase and maintain properties that are healthy, safe, pleasant, ecological, durable and cost-effective. Some methods have been developed to achieve these optimal characteristics in newly-built buildings, such as multi-optimization of the construction life cycle or methods for choosing the moisture physical design level in new construction projects according to environmental or internal moisture loading (Sarja et al., 1999b; Sarja, 2000; anon., 2001b; Lehtinen et al., 2000, 2001). This sets increasing requirements on builders and designers to optimize a building's structural and technical solutions and systems to meet the requirements of users and owners.

As the proportion of finished building stock grows in comparison to the number of buildings being planned or under construction, the main focus of the real estate and building sector is also shifting from new construction projects to maintaining, developing and renovating existing buildings (Balaras et al., 2000). Possible rapid changes in the business core of a building's owners and users can also create changes in their space needs, so the significance of strategic long-term planning increases. At the same time, people are increasingly demanding that the quality of workspaces be a significant aspect of work atmosphere and personnel policies.

When we look at the situation primarily from the perspective of the real estate owner, another important consideration is costs (Flanagan et al., 1989). On one hand, requirements about a building's characteristics are subjective, based on the user's needs and preferences, but on the other hand, they are also absolute and measurable (Benda et al., 2000). It is absolutely essential to have some characteristics, while others are less significant. Ensuring the existence of some characteristics requires increased investments and affects maintenance. In addition, throughout the life of a building it wears and ages in various ways: it physically deteriorates, and also ages in terms of its economic potential, functionality, technical level, social purpose, location, legality, aesthetics, and visual appeal, as well as in terms of its environmental status (Flanagan et al., 1989, p. 39). In addition, a property's technical characteristics, level of maintenance, and use affect the appearance of signs of aging and the speed with which new problems appear (e.g., Lehtinen et al., 2000, 2001 and Al-Hammad et al., 1997).

How is a real estate owner able to function, draw up strategies for business development, set goals, identify the different options which best serve his business needs, implement these solutions in practice and at the same time run a profitable business in the rather exceptional business environment of real estate? In this dissertation, these questions are answered in terms of Technical Life Cycle Management (TLCM). The domain of the research interest could be characterized as the domain incorporating the life cycle of a building from investment analyzing to a demolition decision, taking into account both technical and economic perspectives. This dissertation studies how a real estate owner sets goals, makes decisions and plans and implements actions directed at an individual real estate which affect the physical characteristics of a building. In this study we especially focus on those characteristics that are important from the perspective of cost-effective ownership. Figure 1.1. introduces the parties of TLCM.

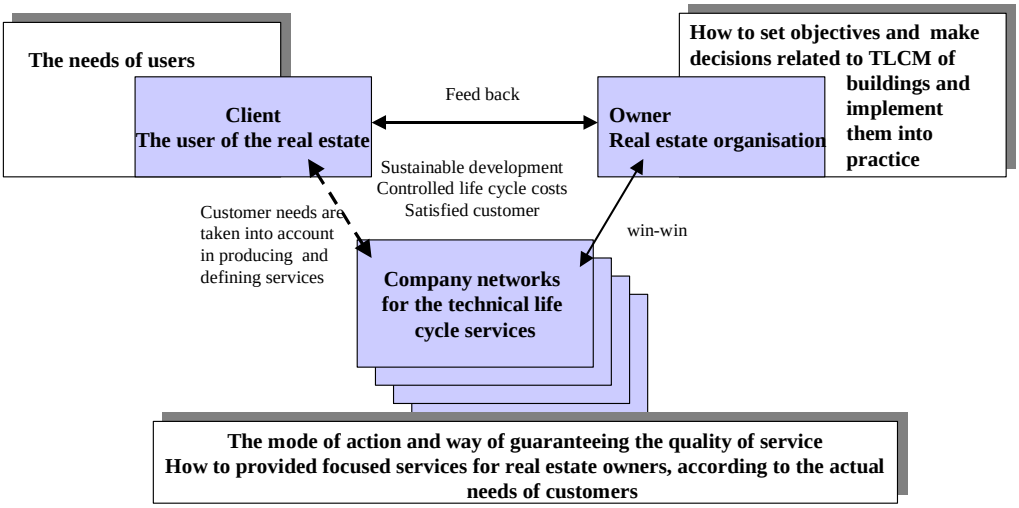

Figure 1.1 The parties of technical life cycle management.

The researcher's interest in technical life cycle management arose when she was working as a research and development manager in a company that provided technical services for real estate owners. In 1997 she conducted a study in which she interviewed different parties involved in the real estate sector, focusing on technical services, technical problems in real estate and problems related to real estate management practices. She also reviewed the literature related to the development, provision and marketing of knowledge-intensive services, as well as the development of an expert organization's know-how, structure and services. Her aim was to start a project in two technical service provider organizations, in order to develop practices, know-how, services and service-provision according to the needs of customers (real estate owner organizations). By analyzing the needs and values of potential customer organizations and numerous customer projects, she was able to formulate her *research problem*. It seemed to her that strategic planning was not a common practice related to the technical life cycles of buildings: there seemed to be many unsatisfactory issues related to the purchase or provision of technical services, and buildings were not performing well over their technical life cycles. Too often, technical management seemed not to be goal-oriented, and there were plenty of technical problems. Moreover, despite her own efforts to develop technical services and service packages according to the needs of potential customers, it was simply impossible to provide them in a cost-effective way. At the same time, many real estate managers pointed out that the provision of services, generally by service provider companies, was not done according to their needs. She also wondered how important technical questions were in the real estate business, or whether they had any real importance at all. She was also curious about how the performance of TLCM was perceived inside real estate companies.

1.2 Research problem and research questions

This dissertation studies the role and performance of technical life cycle management (TLCM) in real estate organizations. Since these days at least some technical actions are outsourced, we tried to understand how companies purchased and provided technical life cycle services for a real estate and how they included technical life cycle management as part of the strategic management of that real estate.

At the beginning of the study, the aim was to clarify the relevance of the research problem and find answers to the first research question:

RQ1 What is the status of technical life cycle management (TLCM) processes?

- What are the underlying theories, key concepts, methods and tools in the real estate sector?
- What are the practices of TLCM; how do they reflect the body of knowledge, if any; how is the performance of TLCM perceived by the stakeholders?
- Is there a solid foundation of appropriate theories, key concepts, methods and tools for TLCM?

The researcher did not know whether TLCM was grounded in a solid foundation, and became interested since in her own experience the purchase of technical life cycle services did not correspond to the needs that technical service providers articulated, nor to the views of the managers interviewed.

Research question one was supposed to result either in knowledge leading to a hermeneutic research trajectory which would elaborate and understand the state of affairs in the field, or a second trajectory would be triggered which identified theoretical and/or practical problems in the field. It might turn out that TLCM lacks basic theories, concepts, methods and tools for practitioners to apply, or practitioners might experience low performance in TLCM despite a

potentially solid theoretical and conceptual base, for some reason or other. If this was the case, this "second trajectory" would raise the need for a constructive, rather than hermeneutic research agenda, for developing an appropriate theoretical base, key concepts, methods and tools which could be deployed in the practitioners' community. In this phase both the hermeneutic and the constructive research agenda were possible. Therefore depending on the results obtained in elaborating RQ1, a hermeneutic RQ2a or a constructive RQ2b were addressed:

RQ2a Assuming that there is a solid foundation of appropriate theories, key concepts and tools for TLCM, how can they be successfully deployed?

RQ2b Assuming that there is a lack of a solid foundation of appropriate theories, key concepts and tools for TLCM, by which means can such a method be successfully developed and deployed?

When we began we were not sure if there was a theoretical background, and it seemed that both hermeneutic and constructive approaches were possible. We therefore divided the research into two parts: a) preliminary studies, which would enable us to decide between different scientific approaches and define further research questions; and b) the main study, which would answer the research questions identified in the preliminary studies.

There were four possible outcomes relating to the preliminary studies: first, there are no impediments to the performance of TLCM in the real estate business; second, there is a theoretical foundation, means or tools for performing TLCM, but doing so is not a priority; third, performing TLCM would be a priority, but there is no theoretical foundation, means or tools for doing so; last, performing TLCM would be a priority as there is a theoretical foundation and means to do so, but for some reason it is not done. In effect, these four possible outcomes acted as hypotheses and were duly tested. The overall objective of the preliminary studies was to find out which of the outcomes was relevant and then, according to the results, formulate the remaining research questions and define an appropriate research strategy.

For the main study, a hypothesis (or hypotheses) was not, however, formulated and used to 'drive' the research forward. Objective setting was not adopted either. In the latter case, the objective of this research would have been 'to solve the research problem' or to 'create understanding related to the research topic'. Both would have been inferior to the specific research questions. The relevance of the research problem was tackled by research questions 1 and 2, which focused on the theoretic basis for the TLCM domain as well as on theories and practices used in the real estate sector related to the TLCM domain. Relevance was also considered through analyzing the perceived performance of TLCM in practice.

According to Järvenpää et al. (1997), the research problem affects the kind of research data required. It also affects the analysis of the data. Sometimes the research problem needs to be reformulated during the research. This reformulating is quite normal in qualitative research (Järvenpää et al., 1997). The research problem was subsequently refined once the results of the preliminary studies were known and research questions 3 and 4 were formulated. A constructive approach was then adopted:

RQ3 What are the characteristics of such a method? What is it required to do?

The third question focuses on the features of the method which could possibly facilitate its use, make it more logical and useful as well as determine whether the tool is practical and usable. This evaluation was carried out by interview studies after the case studies.

RQ4 Does the method work?

- Is it useful?

- Does it facilitate the analysis of a building's technical potential and the development of technical life cycle strategies?
- If it works, would it be possible to make it easier to use and more useful?

1.3 Scope of the study

The study examines the practices and importance of Technical Life Cycle Management (TLCM) in the real estate business. Already in the beginning of the research, the domain of Technical Life Cycle Management was defined as follows: "setting goals, making decisions, planning and implementing actions directed at an individual real estate from the investment analysis phase through a demolition decision, affecting the physical characteristics of the building which are important from the perspective of cost-effective ownership." According to Halder`s definition of "life cycle," the life cycle of a building begins in land acquisition and lasts till the demolition of a building (Halder, 1999). "Technical" refers to the physical characteristics of a real estate.

In studying the importance of the research domain (TLCM) in the real estate business, we tried to consider the business as a totality. TLCM was considered a support function in the real estate business, a means of achieving the business goals of an owner organization. Thus, issues are examined from the owner's perspective.

The main motivation for doing this work was to find out first what is the status of technical life cycle management (TLCM) processes in the real estate business. Then we studied if it was possible to develop a method for facilitating TLCM processes--facilitating the purchase of technical services in real estate owner organizations and connecting technical life cycle issues and the strategic planning of TLC more tightly to overall business planning and managing in real estate owner organizations. We focused on existing buildings, and considered in more detail: a) investment analysis and situations where the development potential of existing buildings needed to be reconsidered; and b) situations where the cost-effectiveness of owning a given building needed to be reconsidered and TLCM strategies for a specific life cycle period as part of the overall strategies of a real estate business were needed.

The method was developed from the perspective of Finnish markets taking into account the quite often very high technical demands, needs and expectations related to buildings in Northern, partly arctic conditions.

1.4 Structure of the thesis

The following figure presents the structure of the thesis.

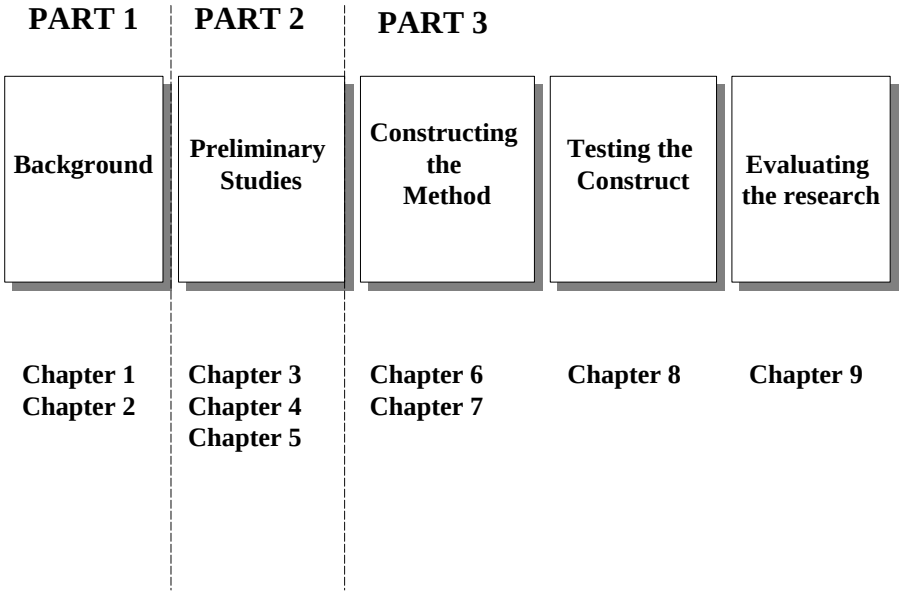

Figure 1.2 The structure of the thesis.

The thesis is composed of three parts. In part one, the research problem and questions are presented and possible research methodologies and strategies are explored. Part two presents the preliminary phase of the study whose objective was to find a suitable method for solving the problems and answering the research questions. In part three, the research strategy has been chosen according to the results of the preliminary studies and the description of the research process is presented phase by phase. Part three also presents the case studies and their results. At the end of this part, the results, the practical and theoretical contribution as well as the validity and reliability of the research, are evaluated.

More specifically, the ten chapters focus on the following:

PART ONE

Chapter 1. Introduces the research problem and its background, and the main research questions. Also presents the researcher's personal interest in the subject.

Chapter 2. Explores the potential research methods

PART TWO

Chapter 3. Identifies a methodology suitable for the preliminary studies. Presents the research questions and research design for the preliminary studies.

Chapter 4. Includes a literature review for the preliminary studies on the real estate sector and current practices in the real estate sector related to technical life cycle management, how real estate organizations are organized, responsibilities of different parties, how the strategic business is managed, how the technical issues are processed. Summarizes results of the first literature review.

Chapter 5. Presents the interview studies, summarizes results of the interview studies.

PART THREE

Chapter 6. Refines the research questions. Selects and justifies the methodology chosen for Part 3. Presents a general and then a more detailed description of the research plan for Part 3. Describes the different data collecting and analyzing methods used in the different phases of the research study, the data itself, and the data sources.

Chapter 7. Describes the construction phase, beginning with a short summary of the results of the preliminary studies, as these provided the basis for developing the method (initial success factors). Presents Literature Review 2. Discusses the life cycle phases of a real estate, in order to determine which factors are critical to the success of the method. These factors were determined through the literature reviews, market tests and criteria related to the constructive approach. Describes the process of constructing the method and the parties involved. Presents a final version of the TLCM Method.

Chapter 8. Analyzes the connections between the different modules and phases of the constructed model and existing theories. Presents the case studies, including short descriptions of the cases, the results of interviews and questionnaires, and the results of the expert panels. The construct's novelty and practical functionality is also tested in the case studies. In addition, the summary section of chapter 8, using the interview and questionnaire data, discusses and analyzes the contents, practical functionality, usability, usefulness and novelty of the method. It also analyzes the differences in interview and questionnaire answers between different cases, different parties involved and different levels of organizations.

Chapter 9. Answers the research questions and summarizes the research findings.

Evaluates the practical and theoretical contribution of this research, as well as its validity and reliability. Makes generalizations about the research outcome, and considers issues for further research.

2 Research strategies

This chapter explores the possible research methodologies and strategies. The objective was to find a suitable method for solving the problems and answering the research questions introduced in chapter 1. In addition, possible alternative approaches are compared.

Popper points out that before we are able to collect data, we must first define an interest and identify a research problem. This problem may be brought out by practical needs or scientific or pre-scientific beliefs (Popper 1957, p. 121). A research study is always based on some question or problem related to the research subject (Niiniluoto, 1999, p. 25). Research questions and problems are usually broadly formulated, and therefore the ways they are specified and structured is of crucial importance. For this reason, the explorative phase of a research project is important to its overall design, whose aim is to find and form hypothesis and guesses (Niiniluoto 1999, p. 27). How these hypotheses are initially formed has a great effect on how the entire research strategy is developed. Another important component of the overall research strategy is a detailed plan of the different phases of the research. In addition, the following issues are included in the research strategy: 1) how the data will be collected; 2) how the collected data will be described and analyzed and 3) how it will be interpreted: how the conclusions will be drawn (Niiniluoto 1999, p. 27-28).

According to Järvenpää et al., a research strategy or scientific approach is a set of norms and means for sourcing and analyzing the research data, but one approach may include several methods of measuring data. Yin (1984, in Lanning, 2001) also uses the term “strategy” when referring both to different units of analysis and the methods of analyzing them. Instead of using “strategy,” Kasanen (Kasanen et al. 1991, also in Lanning 2001) uses the term “research approach” when referring to the researcher’s basic methodological choices which grow out of their philosophical perspectives.

Within the field of business economics, Kasanen points out that international discussion on approaches to research has been related to such themes as (Kasanen et al., 1991; Kasanen et al., 1993, p. 254):

- *Quantitative* versus *qualitative* research;
- *Positivistic* (descriptive) versus *hermeneutic* (interpretive and critical research);
- Research based on *large vs. small* empirical samples.

Kasanen emphasizes that these all collude in the modernist mainstream view. Characteristic of the *positivist* tradition is its *quantitativenes*, complete with large samples and the claim to eliminate values: quantitative phenomena are studied with law-like generalizations as the ultimate aim of the whole research endeavor. Numerical data is often collected in *quantitative* research (Kasanen et al., 1993, p. 254).

Qualitative research is often defined as research in which qualitative, e.g. descriptive data, is used. Characteristic of qualitative research, according to Kasanen, is direct collection of empirical data from the field through interviews or observations. From the perspective of the positivist tradition, the central problem of these kinds of studies is the measurement of variables, which normally can be done only on a nominal or ordinal scale (Kasanen et al., 1993, p. 254).

Hermeneutic research is based on interpreting and understanding phenomena. The aim of hermeneutic research is to find relationships between phenomena and to test hypotheses related to them. Hermeneutic research may be either experimental or non-experimental. (Järvenpää et al., 1997). Kasanen points out that hermeneutic or interpretive accounting research is a rather heterogeneous group of ways of doing research. Usually interpretive

research is qualitative by nature. The most essential single characteristic of interpretive research, and the most significant difference from the positivist tradition, is its acceptance of a certain amount of subjectivity as a legitimate part of science (Kasanen et al., 1993, p. 254).

The juxtaposition of *positivist* and *hermeneutic* paradigms is obvious in literature. Quantitative evidence can reveal factors and relationships that are not evident, whereas qualitative data helps the researcher understand the rationale and the reasons for relationships revealed by the quantitative data (Eisenhardt, 1989, p 538 also in Lanning, 2001).

The ***case study*** research method is often used when a contemporary phenomenon in a real life context needs to be investigated and a better understanding of a complex phenomenon is needed. The aim is to build a theory and then test it (Lanning 2001, Eisenhardt, 1989, Yin, 1989).

Yin defines case studies as follows (Yin, 1989, p. 23):

"A case study is an empirical inquiry that:

- Investigates a contemporary phenomenon within its real life context; when
- The boundaries between phenomenon and context are not clearly evident; and in which
- Multiple sources of evidence are used."

This definition helps us to understand case studies and as well distinguishes them from other research strategies.

According to Yin (1989), the five most important components of case study research are as follows (Yin, 1989, p. 29):

- A study's questions;
- Propositions, if any => each proposition is directed at something which should be examined within the scope of the study;
- Its units of analysis => A fundamental problem of defining what the "case" is;
- The logic linking the data to the propositions; and
- The criteria for interpreting the findings

Figure 2.1 presents Yin's case study method.

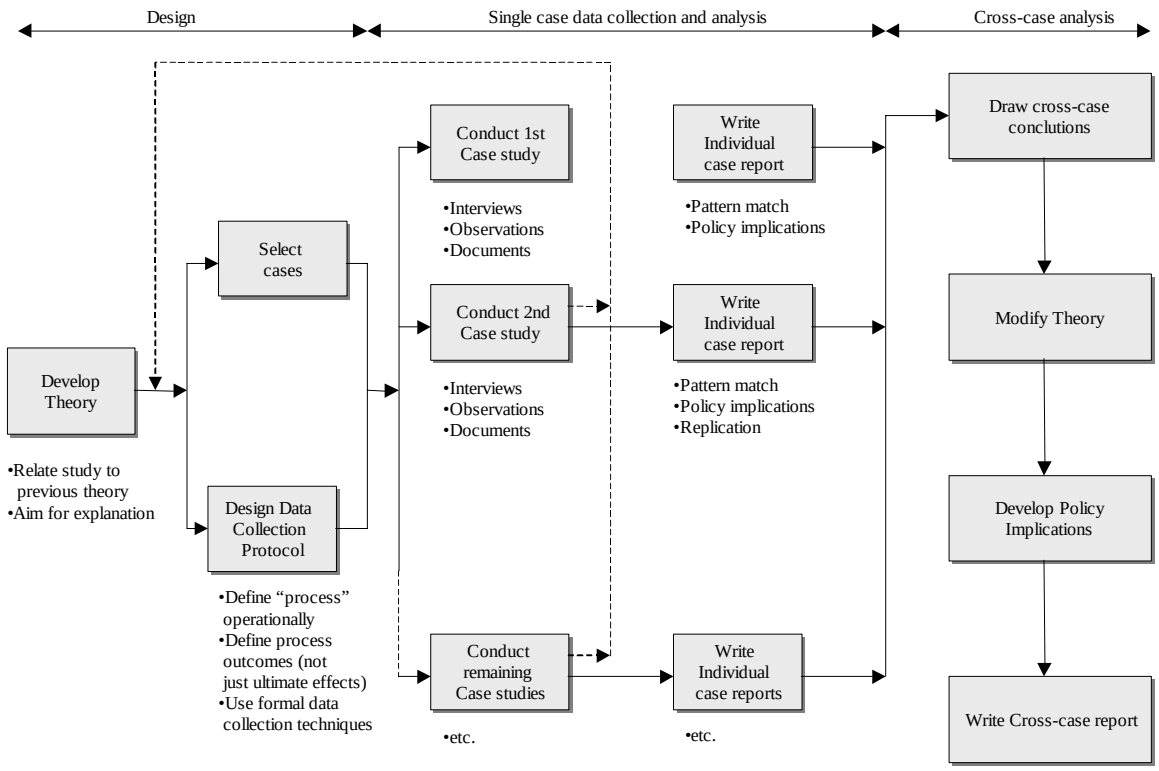

Figure 2.1 The case study method (Yin, 1989, p. 56).

A characteristic of field and case studies is the use of small samples in order to achieve a deeper and more comprehensive understanding of the studied subjects than is possible when using large samples (Kasanen et al., 1993, p. 255).

Furthermore, according to Järvenpää et al., case study research may include one or multiple cases. These cases are studied in their natural circumstances, and the data may be qualitative or quantitative. The aim of a case study is to provide a well-rounded picture of the item under study, including an understanding of all the persons involved (Järvenpää et al., 1997).

Yin presents relevant situations for different research strategies: experimental research, survey, archival analysis, history studies and case studies. He also provides suitable research questions for different strategic approaches. These questions and strategies are presented in the following table (Table 2.1).

Table 2.1. Relevant situations for different research strategies (Yin, 1989, p. 17)

STRATEGY	FORM OF RESEARCH QUESTION	REQUIRES QONTROL OVER BEHAVIORAL EVENTS	FOCUSES ON CONTEMPORARY EVENTS
Experiment	How, why	Yes	Yes
Survey	Who, what, where How many, how much	No	Yes
Archival analysis	Who, what, where How many, how much	No	Yes/No
History	How, why	No	No
Case study	How, why	No	Yes

Constructive research is typically based on case studies. According to Kasanen et al. the concept "case" may refer both to descriptive or normative research but the constructive

approach represents the normative research type, a goal-directed problem solving activity. (Kasanen et al., 1993, p. 255).

“The constructive approach can be defined as follows:

- The constructive research produces an innovative theoretically grounded solution for a relevant problem
- The usefulness and usability of a construct is showed
- The scope of applicability of the solution is considered.“

Constructive research may include both quantitative and qualitative material. Typically, the constructive approach is based on a limited number of case studies. Constructive research is not, due to its concrete objectives, descriptive, but is rather decision-oriented. It is normative research. Theoretical analysis and thinking plays an important role, leading to the innovative creation of a new entity: a construct, model, method, tool or way of acting, and a demonstration of the practical usability of the constructed solution (Kasanen et al., 1993, p. 254-256).

According to Niiniluoto, constructive research is part of design (Niiniluoto 1993 p. 9-11; also in Peura, 1996, p. 252), where the aim is to discover generally-grounded instrumental knowledge (Niiniluoto et al., 1986, p. 10 in Peura 1996 p. 252). While science studies and explains how things are, the aim of design is to determine how things should be (Hameri, 1990, p. 50; in Peura, 1996, p 252).

In figure 2.2. the position of the constructive approach among established accounting research approaches is shown. The method is applicable also in other researches related to managerial questions.

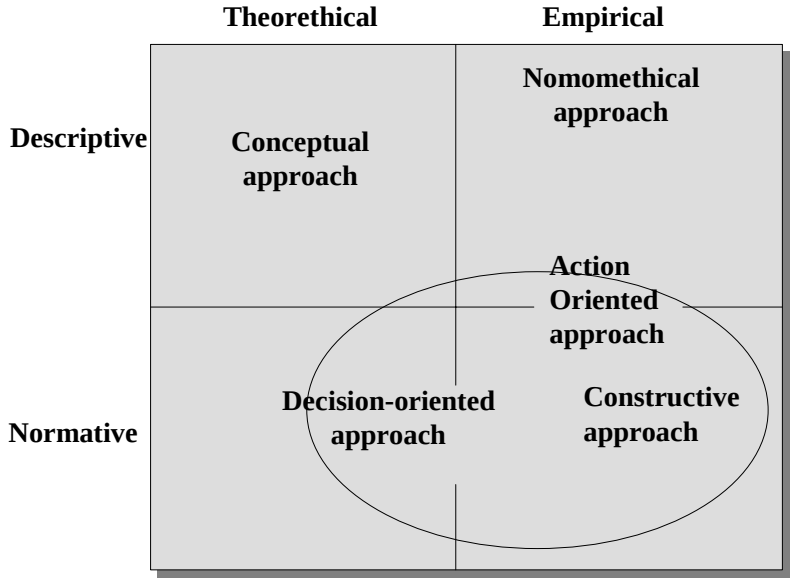

Figure 2.2. Position of the constructive approach among established accounting research approaches (Kasanen et al., 1993, p. 257).

Constructive research has a lot in common with decision-oriented research. In both, theoretical analysis and thinking have an important role leading to the creation of a new entity. However, the difference between these methods is that the decision-oriented approach uses the method of deduction while heuristic innovation is characteristic of the constructive approach. In addition, when using the constructive research strategy, it is necessary to

demonstrate empirically the practical usability of a constructed entity (Kasanen et al., 1993, p. 256).

According to Kasanen et al., in the constructive approach, the research process may be divided into phases. Their order may vary from case to case, and include the following steps (Kasanen et al., 993, p. 246) (Figure 2.3.):

- Find a practically relevant problem which also has research potential
- Obtain a general and comprehensive understanding of the topic
- Innovate, i.e. constructg a solution idea
- Demonstrate that the solution works
- Show the theoretical connections and research contribution of the solution
- Examine the scope of applicability of the solution

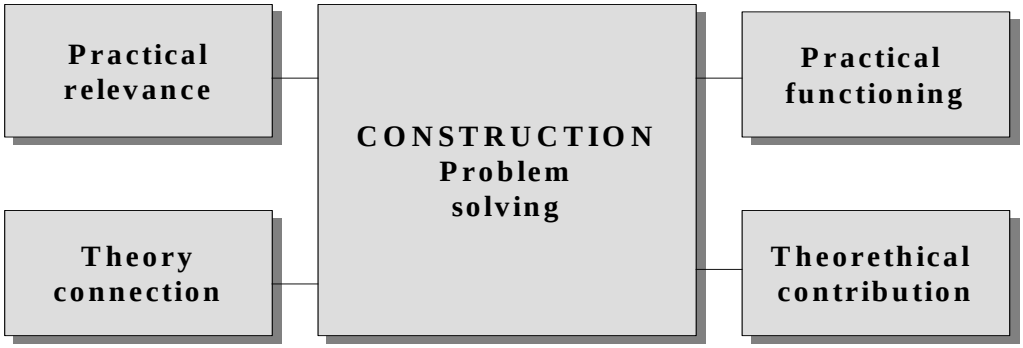

Figure 2.3. Elements of constructive research (Kasanen et al. 1993, p. 246)

Kasanen et al. points out that the constructive research method is applicable in situations where there is a need for a practical solution to an existing problem. The solution must be based on need and be connected to existing theoretical knowledge. In addition, its usefulness and usability, as well as its theoretical novelty, must be shown (Kasanen et al., 1993).

The nature of the constructive approach is purely normative. It aims to create an innovative solution to the problem, test this solution empirically, and also consider the scope of the applicability of this construct (Kasanen et al. 1991, p. 318; Kasanen et al. 1993, p. 257).

Action research is a research method in which the researcher, in addition to doing research, also uses data in order to develop the research object (Järvenpää et al. 1997). The action-oriented research approach is close to the constructive approach (Figure 3.1) in that both strategies require an empirical connection to real life. A deep understanding of organizational processes is also needed, in order to make the intended changes in an organization. In action research, however, the aim is not to create a new construct, e.g. a way of acting, whereas in the constructive approach that is the main objective.

According to Lanning (2001), the term “action research” was proposed by Levin (Levin 1946, in Lanning 2001, p. 48**)**. Action research combines generating theory with effecting changes in the social system through the way the research acts in the social system. “Action researchers demand that research should be relevant for scholars whose purpose is to advance

the current state of knowledge and for practitioners who, in turn, struggle with their problems in a system" (Lanning, 2001, p. 48). According to Susman et al. (1970; in Lanning 2001, p. 48) action research can be defined as follows:

> Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework.

Eden et al. (1996, p. 539) has listed characteristics of action research. Some of them are as follows:

1) "Action research demands an integral involvement by the researcher in intent to change the organization.

2) Action research must have some implications beyond those required for action or generation of knowledge in the domain of the project. It must be possible to envisage talking about the theories developed in relation to other situations. Thus it must be clear that the results could inform other contexts, at least in the sense of suggesting areas of consideration.

3) As well as being usable in everyday life, action research demands valuing theory, with theory elaboration and development as an explicit concern of the research process.

4) If the generality drawn out of the action research is to be expressed through the design of tools, techniques, models and method, then, this alone is not enough. The basis for their design must be explicit and shown to be related to the theories which inform the design and which, in turn, are supported or developed through action research.

5) Action research will be concerned with a system of emergent theory, in which the theory develops from a synthesis of that which emerges from the data and of that which emerges from the use in practice of the body of theory, which informed intervention and research intent.

6) Theory building as a result of action research will be incremental moving through the cycle of developing theory to action to reflection to developing theory, from the particular to the general in small steps.

7) What is important for action research is not a (false) dichotomy between pre-description and description, but recognition that description will be prescription, even if implicitly so. Thus presenters of action research should be clear about what they expect the consumer to take from and present it with a form and style appropriate to this aim.

8) For high quality action research a high degree of systematic method and order-lines is required in reflecting about, and holding on to, the research data and the emergent theoretical outcomes of each episode or cycle of involvement in the organization

9) For action research, the process of exploration of the data – rather than collection of the data in the detecting of emergent theories and development of existing theories must either be replicable or, at least capable of being explained to others.

10) The full process of action research involves a series of interconnected cycles, where writing about research outcomes at the latter stages of an action research project is an important aspect of theory exploration and development, combining the processes of explicating pre-understanding and methodological reflection to explore and develop theory formally."

Table 2.2 summarizes the characteristics of different possible strategies. Later in this research the appropriate scientific approach are chosen according to the results of preliminary studies.

Table 2.2. Characteristics of different possible strategies.

GENERAL CHARACTERISTICS	WHEN TO USE?	ENSURING AND JUDGING THE QUALITY OF THE RESEARCH
Constructive research and design science (Kasanen et al. 1991, 1993; Niiniluoto 1992, in Lanning, 2001)		
- Normative in nature - Typically includes case studies - Both quantitative and qualitative methods can be used - Both quantitative and qualitative methods can be used - Produces an innovative and theoretically grounded solution for a relevant problem - Uses a limited number of research objects	- When there is a need for an innovative and theoretically grounded solution for a relevant problem - When there is a concern about "how things ought to be in order to attain goals" – not "how things are"	- The research outcome: - Relevant, simple and easy to use - Practical relevance - Practical utility - Useful - Theoretical novelty - Link to theory - Also applicable in other environments
Case study research (Eisenhardt, 1989; Ellram, 1996; Gummersson, 1993, in Lanning, 2001; Kasanen et al. 1991, 1993; Stake, 1995, in Lanning, 2001; Yin, 1989)		
- Descriptive or normative in nature - Both quantitative and qualitative methods used - Difficult to separate analysis and interpretation from data gathering - Analysis and interpreting subjective procedures - Knowledge constructed rather than discovered or found - Generalizing on the basis of a very limited number of cases - Generalizing is not making statistical interferences from the sample but to generalize through a deep understanding of the phenomena	- When a contemporary phenomenon within its real life context needs investigation - To gain a better understanding of complex phenomena - When how and why questions are being asked about a set of events over which the investigator has little or no control - To build a theory and to test it	- Use of triangulation - Proper research design - Rigorous and accurate representation of empirical data - Finding rival explanations - The reader is offered a chance independently to judge the merits, the validity, and reliability of the analysis
Action research (Eden et al., 1996)		
- Field oriented - Researcher in addition to making research work uses the research results in developing the object - Close to the real phenomenon - Researcher's personal involvement - In full process: series of interconnected cycles with writing about research outcomes in important - Knowledge is constructed not discovered - Deep understanding of organizational processes is needed - Theory building as a result of action research	- To describe an action or a development process of an organization. - The aim is to change the action of an organization.	- The process of exploration of the data must be replicable or capable of being explained - Validity and applicability of the results: The history and context for the intervention must be included in the interpretation - Focusing on reflection and data collection processes - Triangulation

PART TWO

3 Research design of preliminary studies

As we saw above, the research question for the preliminary studies was as follows:

What is the status of technical life cycle management (TLCM) processes?

- What are the underlying theories, key concepts, methods and tools in the real estate sector?
- What are the practices of TLCM; how do they reflect the body of knowledge, if any; how is the performance of TLCM perceived by the stakeholders?
- Is there a solid foundation of appropriate theories, key concepts, methods and tools for TLCM?

Since the appropriate research strategy depends on the answers to research question 1, theoretical and practical studies on subjects related to strategic planning in real estate companies, practices related to TLCM domain, and key concepts and roles in the real estate sector were needed. Only after that was it possible to evaluate research question 1. Therefore, the study was divided into separate parts.

The first phase of the study was technically a separate explorative study at the beginning of the research project. The aim of this preliminary study was to study what is the perceived status of technical life cycle management in real estate owner organizations, to refine the research questions and find an appropriate research strategy. This first phase consists of a literature review, to develop theoretical understanding, and interview studies, to gather practical understanding of the research issue.

In the literature review, the underlying theories, key concepts, methods and tools used in the real estate sector are analyzed. In the interviews, the practices of technical life cycle management are studied: how do they reflect the body of knowledge and how is the performance of TLCM perceived by the stakeholders? Since the real estate sector is quite interdisciplinary and often at least part of the needed technical services are outsourced we concentrated on questions related to “technical life cycle management as part of the strategic management of real estates” and “purchasing and providing technical life cycle services for real estates.”

The status of technical life cycle management in real estate organizations is studied, as well as how it is commonly taken into account in business strategies. Also considered are how technical life cycle services were purchased and provided in the real estate industry, and how the performance of TLCM was perceived in real life situations. We were also interested in the theoretical basis of TLCM. At this early stage, there were four possible outcomes:

1) There are no impediments to the performance of TLCM in the real estate business.
2) There is no theoretical foundation, means or tools for performing TLCM, but doing so is not a priority.
3) Performing TLCM would be a priority, but there is no theoretical foundation, means or tools for doing so.
4) Performing TLCM would be a priority, there is a theoretical foundation and means to do so, but for some reason it is not done.

In figure 3.1 the structure of the preliminary studies is presented.

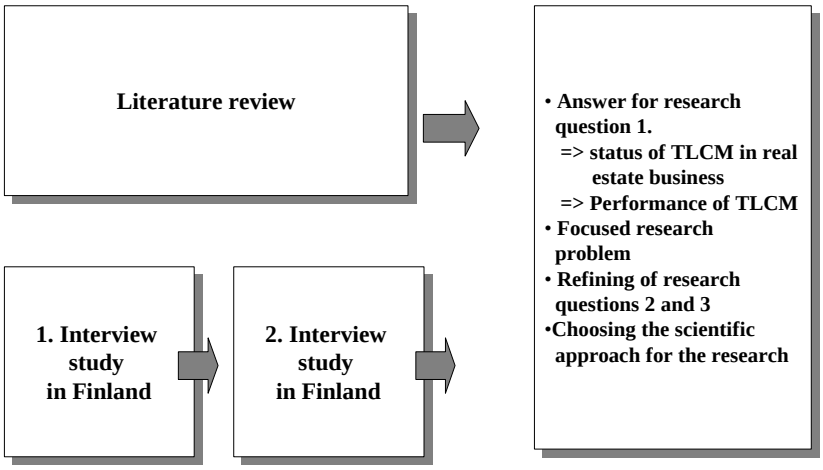

Figure 3.1. The structure of the preliminary study phase.

The preliminary study phase was the first proper phase of the research. The aim of the preliminary study phase was to understand the role of technical life cycle management in the real estate business and consider the current ways of acting in purchasing technical life cycle services, to focus the research questions and to identify the relevant research strategies.

This first phase was based on a literature survey on practices and concepts in the real estate sector related to TLCM practices. Also, the role of technical life cycle management and the strategic planning of technical life cycle actions were considered, as well as how it was perceived by different stakeholders.

Two interview studies in Finland were done related to the research topics. In the first interview study, real estate owners and users were interviewed, in order to get an owner perspective of the importance and practicalities of TLCM. The second interview was focused more on technical issues in the business. These interviews were done in order to get a practical view of the real estate business and the role of TLCM in it. The interview questions were devised according to the results of literature review 1. In addition a few interviews were carried out in Germany. The results fully supported the results of Finnish studies but they are not used and presented here since the interviews were not structured enough.

The first interview study was done in the winter of 1999-2000 in the capital area of Finland. In this study real estate managers or other decision-makers in the real estate business were interviewed.

The aim of this study was to further refine the research questions and clarify how Finnish real-estate companies or real estate departments of non-property companies:

1) Define the status of technical life cycle management in the real estate business

2) Describe how they set values and objectives in their business related to TLCM:

- Their needs for buying technical life cycle and technical life cycle management services for their real estates
- How they are organized, what critical know-how is needed in their own organizations

- How and from whom they buy technical life cycle services. How the technical life cycles of their real estates are managed

In every interview, the same questions were asked and the answers were written down as accurately as possible. This method was chosen for two reasons. On one hand, we wanted to avoid making the atmosphere too formal, keeping it suitable for a confidential discussion, so we decided not to use a tape recorder. Also, we wanted to be sure that the term “technical life cycle” was perceived in the “right” way. This was possible in face-to-face interviews where it was possible to elaborate on the terminology used. In order to ensure that the interpretations would be accurate, we not only wrote down the answers, but also checked the interpretations by sending notes to the interviewees by e-mail, and then took their comments into account. We then classified and analyzed their answers, and wrote the report.

The second interview study was done by interviewing managers and technical and building physical experts in service provider companies in the capital area of Finland. The interviews were semi-structured interviews with prepared questions. The interviewees were chosen from different organizational levels. The aim of the study was to clarify the perspective of technical experts on the importance of technical life cycle management in the real estate business and to clarify the relevance of research questions 1 and 2. The real life experience of both parties involved in technical life cycle management processes was considered very important in finding out if there is a need for improvements in the purchasing and provision of technical life cycle services. In interview study II, the questions were more focused on technical issues: the performance of technical life cycle management and practices in purchasing technical services. Some real life experiences were discussed as well. The interviews were done face-to-face. This time we also used a tape recorder, but also continued to take notes by hand. The interviews were analyzed and a short conclusion was presented to the interviewees.

The interview studies were done as hermeneutic semi-structured qualitative interview-studies aimed at collecting practical knowledge related to practices in the real estate business.

4 Literature review

The main objective of this literature review was to study the theoretical backgrounds of the research issue and answer the first research question: what is the status of technical life cycle management processes in the real estate business? What are the underlying theories, key concepts, methods and tools in the real estate sector? What are the practices of TLCM; how do they reflect the body of knowledge, if any; how is the performance of TLCM perceived by the stakeholders? Is there a solid foundation of appropriate theories, key concepts, methods and tools for TLCM?

In order to answer these questions, we must first clarify how real estate owner organizations are organized, how they conceptualize and how they manage their core business: define objectives, make decisions and implement them in practice. In particular, we focus on questions regarding the domain of technical life cycle management (TLCM), which we defined in chapter 1. Is TLCM considered part of real estate management, is it connected to other business areas, and is the strategic planning of issues related to technical life cycle management adequate in practice according to the literature.

In this thesis "IA" refers to "internet articles" used in the literature reviews. For these downloaded articles, the page numbers of the published articles are not available and therefore page numbers used here refer to the page numbers of the downloaded article, not to the page numbers of the publication.

4.1 Roles, concepts and responsibilities of different practioners in the real estate sector

The real estate sector is interdisciplinary. Different parties are involved in different aspects of it and have different interests according to the role they play in the real estate business. The whole business is based on buildings and on the people who use these buildings. The real estate owner is an investor who is interested in both the building and the users. According to Halder, the real estate economy consists of different aspects of management, different institutions connected to the real estate business, and different perspectives related to different real estate types (Halder, 1999, p. 5; Schulte, 2000b, p. 109). In addition, Smith points out the importance of involving all stakeholders in making real estate decisions (Smith, 2000). In this chapter the different roles, concepts and parties with different tasks related to the real estate business are studied, and the concepts used in this thesis are defined.

Framework of the real estate economy

According to Halder (Halder, 1999, p. 5), property management includes managerial, functional and phase-specific aspects. The institutional aspects deal with the influence of institutions and are directly or indirectly concerned with development, realization or utilization. Property typological approaches are concerned with questions related to the various property types. As a research topic, properties are especially multidimensional, given these interdisciplinary aspects. Figure 4.1 presents Holder's view on the real estate economy.

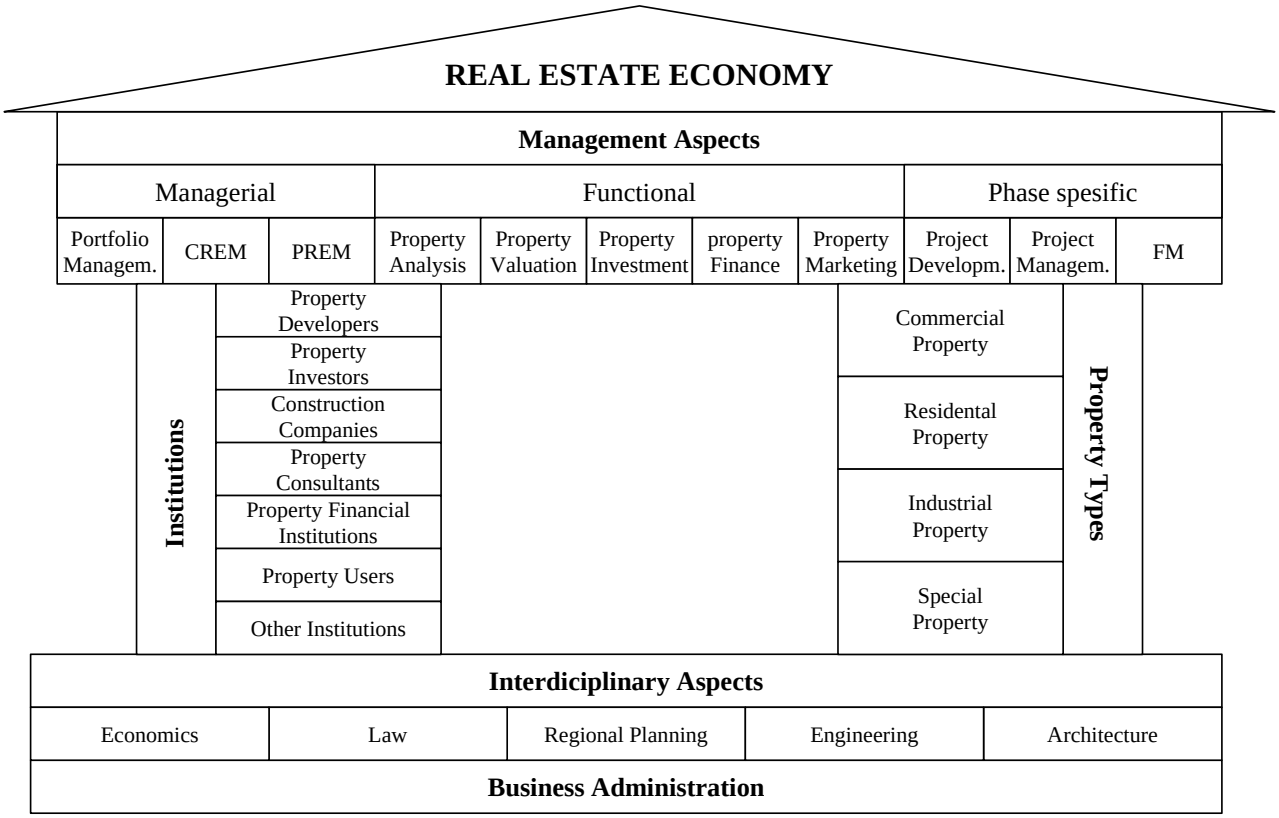

Figure 4.1. Real estate economy: Parties, institutions, interdisciplinary areas, management aspects and property types within the real estate sector (Halder, 1999, p. 5; Schulte 2000b, p. 109).

According to the RAKLI (anon., 2001a, p. 3), a real estate business is a set of actions connected to the ownership and utilization of real estates and to the provision of customer services with commercial objectives. Building management comprises the same activities but does not inevitably have commercial goals. Real estate and building management includes real estate development, building, investment in real estate, conveyance of real property, leasing, real estate administration, real estate maintenance functions and user functions.

Building management

Building management includes construction, real estate administration, real estate maintenance functions and the demolition of buildings. Building functions can be divided into new construction and repairing. Repairing can be further divided into renovation, rebuilding, restoration and rehabilitation actions. Maintenance functions include maintenance management and repairs, replacements and other maintenance actions (anon., 2001a). Repairing can be described as constructing in which the previous object is changed in a hoped-for direction. Modernization and rehabilitation is a construction project in which the

previous quality level of an existing building is markedly improved (anon. 2001a, p. 28-29). According to Aho "the building is developed in order to be more suitable for its planned use" (Aho, 1993, app. 1). Maintenance can be defined as repairing with the intent to keep the usability and "image" of an object at the existing (original) quality level by repairing and maintaining the building (anon. 2001a, p. 24; Aho, 1993, app. 1). Figure 4.2 shows these concepts.

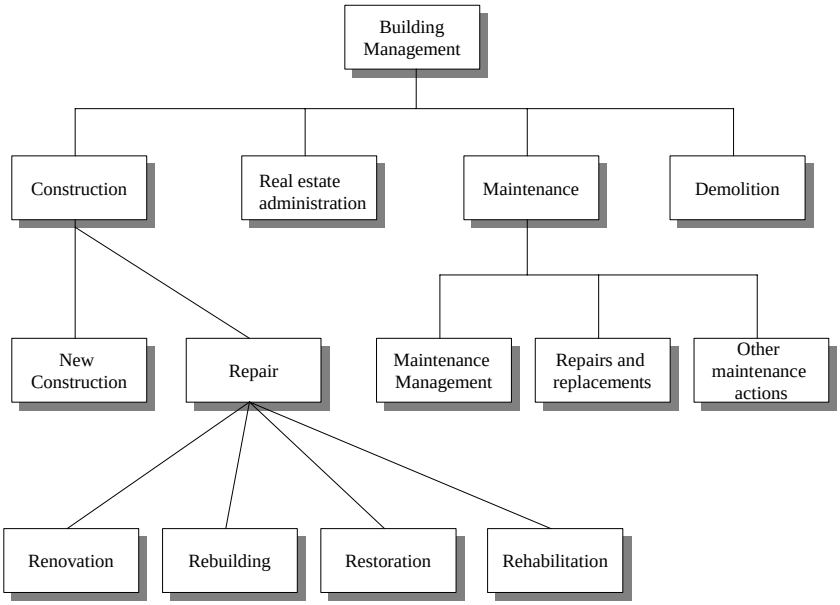

Figure 4.2. Concepts of building management and repairing (anon., 2001a).

Within the real estate management sector, important concepts and definitions are **AM, CREM, FM, and PM:**

I AM (Asset Management)
II CREM (Corporate Real Estate Management)
III FM (Facilities Management), also divided into
- Technical Facilities Management
- Commercial Facilities Management
- Infrastructural Facilities Management

IV PM (Property Management)

Sources differ in how they define these concepts, and some of these definitions are presented below. Also, the usage of concepts varies according to the owner organisation (Brown et al., 1993, p. 4). According to Ring, owner organsisations themselves can be divided into three categories (Ring et al., 1981, p. 509; see also Flanagan et al., 1989, p. 6):

1) The investor is the one who puts money into a real estate based on careful analysis, with the expectation of realizing income or profit over an extended period. He looks for both annual income and long term capital gains. According to Flanagan, the motivation can be e.g. short term profit, long term profit or satisfying public need.

2) A speculator is one who buys and sells property with the expectation of realizing quick profits due to changes in price. He is operating within a short time frame.

3) A developer improves and prepares land for use, ususally by constructing a building. His time frame is usually several years.

According to Brown, there are three primary participants with varying roles in the real estate business, with the following functions: 1) strategy (strategic planning), 2) management and control and 3) operations. In different kinds of organizations, at the strategic level these might be called Corporate Real Estate Manager, Developer or Portfolio Manager. At the management and controlling level they can be called Asset Manager, Property Manager or corporate real Estate Director or Manager, and at the operative level Property Manager or Facilities Manager (Brown et al., 1993, p. 3). The functions of these different participants according to the company type are presented in table 4.1.

A Traditional Real Estate Organization is a company whose primary purpose is owning, developing, brokering, leasing and/or managing real estate. A Traditional Corporation is a company whose primary purpose is to produce goods or services. The company owns or leases and manages real estate in order to achieve corporate production and objectives.

Table 4.1. Framework for real estate asset management according to Lapides et al. (1991 in Brown et al., 1993, p. 4)

Type of Entity/ Functions	**Traditional Real Estate organization**	**Real Estate Equity Fund**	**Real Estate Lender/ Mortgage fund**	**Traditional Corporation**
Strategy	Developer/Owner /Syndicator	Portfolio Manager	Portfolio Manager	Sr. Management/ CFO/ Treasurer/VP Finance **CRE** (Corporate Real Estate Executive)
Management and control	**AM,** Asset Manager / Supervisory Property Manager	**AM/PM**, Asset Manager/ Supervisory Property Manager	**AM,** Asset Manager	**CRE** CRE-Director/ Manager/ Executive
Operations	**PM**, Property Manager and On-Site staff --- Services	**PM**, Property Manager and On-Site Staff --- Services	Debtor	**FM** Facilities Manager/ Property Administrator Staff

In the following sections, we consider the different management activities and roles in the real estate business as defined in different sources.

4.1.1 Asset management (AM)

According to different sources, asset management or the asset manager is defined as follows:

According to Brown et al., Real Estate Asset Management is a general process of managing all aspects of real estate assets, including acquisition and disposition, devising management strategies, management of buildings and facility operations, financial management and all aspects of accounting and reporting on real estate held. The corporate real estate executive (CRE), the real estate director or manager will also be responsible for developing information, assisting or co-coordinating decisions regarding property or facility operations, devising procedures and executing policies to achieve real estate objectives (Brown et al.; 1993, p. 5).

RAKLI provides a similar definition (anon. 2001a, p. 13): AM (Asset Management) is managing real estate with the goal of creating a specific real estate portfolio by buying, selling and developing individual properties or parts thereof, and by supervising and controlling their cost-effectiveness.

Then (Then et al., 1992) emphasizes the all-inclusiveness of AM, saying that it represents the whole area of the real estate business, including financial management, facilities management and maintenance management activities.

4.1.2 Corporate Real Estate Management (CREM) and Facilities management (FM)

A definition of Corporate Real Estate Management and Facilities Management according to Balck is presented in picture 4.3

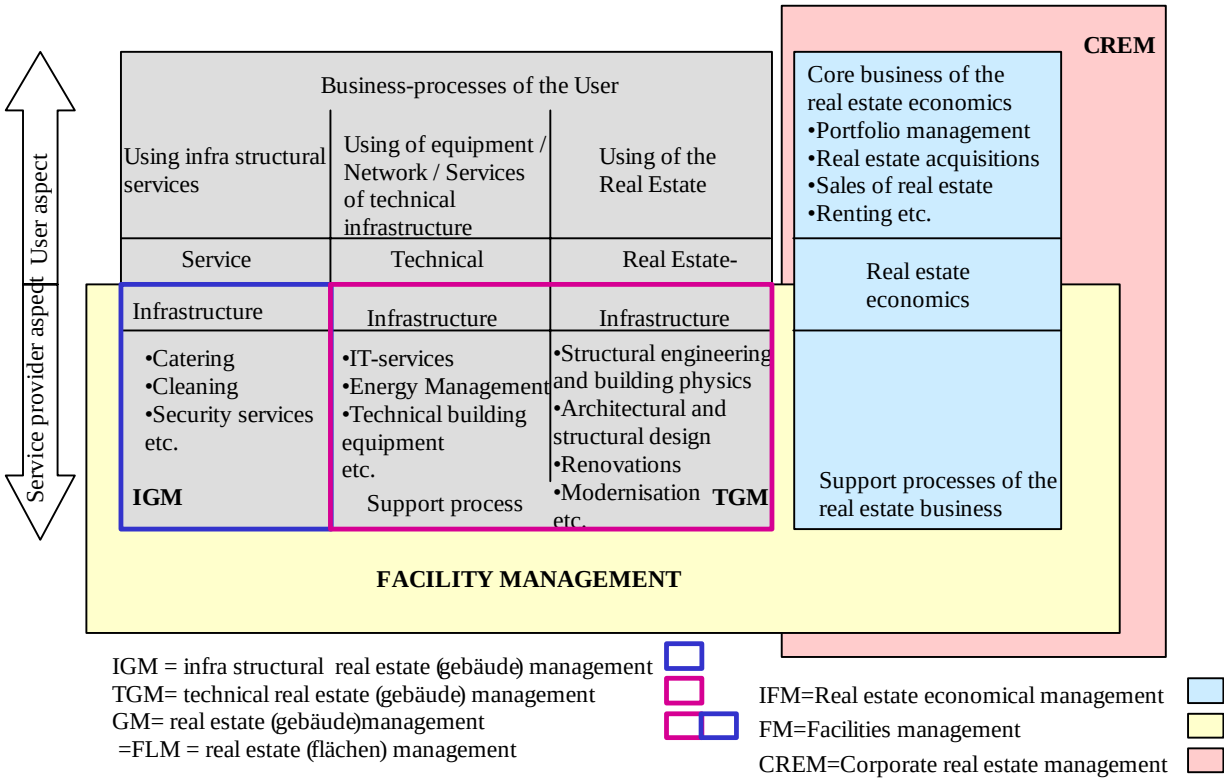

Figure 4.3 Real estate management, facilities management and corporate real estate management according to DIN 32736 (Balck, 2000).

Technical management is part of “Technical gebäude” management, which is itself part of facilities management, including structural engineering, architectural planning, renovation planning and modernization planning. Corporate real estate management consists of support processes of the real estate business as well as the “core business” of real estate economics: portfolio management, acquisitions planning, sales, renting, investment planning and decision making.

Schulte presents the difference between CREM and FM in picture 4.4. Corporate Real Estate Management is more focused on buildings and the real estate business itself whereas Facilities Management on people and processes.

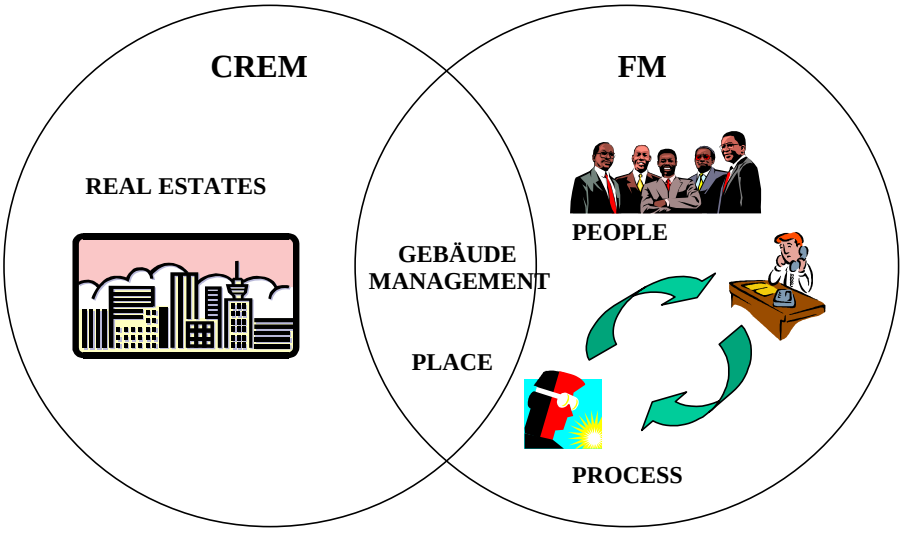

Figure 4.4. CREM, FM and "Gebäudemanagement" according to Schulte (Schulte, 2000a, p. 39)

4.1.2.1 Corporate Real Estate (CRE) management (CREM)

According to Bon, Corporate Real Estate Management (CREM) can be defined as follows (Bon et al., 1999, 1994): "An organization that occupies space is in the real estate business, as well, and needs to manage it properly. CREM covers the entire range of activities concerning building and land holdings held by an organization, starting with investment and finance, through construction and facilities planning management, to reuse and disposition of property."

Bon points out the importance of an owner's ability to maintain his or her properties, remarking that many functions which were outsourced in the early 1990s were brought back into the fold between 1993-94. Design management, construction management, facilities management and maintenance management were provided internally rather than outsourced, and if one of these was kept in-house, others were likely to be kept as well (Bon et al. 1999). Bon emphasizes how important it is to take care of the real property, noting further that it is important to manage real estate from the perspective of the building (Bon, 1989, in Toure, 1999).

Schäfers (Schäfers, 1997, in Schulte 2000a, p. 38) points out that this definition describes the procedure of a traditional corporation: "…in the middle, there is a special process, that according to the strategic objectives of the company, contributes the company's continuous competitiveness by systematic planning, managing and controlling all the needed real estate specific activities."

According to the RAKLI (anon., 2001a, p. 14) "CREM" can be defined as follows: Corporate Real Estate Management is a field of management whose goal is to integrate real estate assets and their use so that together they become part of a firm's most important resources which produce added value for the core business. The aim of strategic corporate real estate management is to ensure that the perspectives of corporate real estate, the management of an

individual real estate and facilities management are integrated into strategies and processes of the core business (anon. 2001, p. 14).

According to the definitions CREM is a part of the real estate management of traditional corporation.

4.1.2.2 Facilities Management (FM)

According to Brown et al., “Facilities Management is the general function of co-coordinating the needs of people, equipment and operational activities into the physical workplace. When performed by an in-house corporate organization, it usually refers to performing those activities dealing with the acquisition and disposition, physical upkeep, record keeping and reporting tasks for corporate-owned real estate. While the corporate real estate executive has historically supported the strategic planning effort in a very important advisory, proactive role, he or she is increasingly becoming an essential participant in the strategic planning process.” FM reports to the corporate real estate executive (Brown et al., 1993, p. 5).

Facilities Planning is the “process of developing general and precise information about real estate assets for the purpose of assisting facility decision making, developing policies and procedures for facilities operations, construction planning, cost estimating and value engineering and conducting other activities to provide efficient asset management” (Brown et al., 1993, p. 5).

Generally it could be said that FM services are mainly directed at the user of the real estate. Barrett defines FM as follows: “FM is an integrated approach for maintaining, improving and adapting the buildings of an organization in order to create an environment that strongly supports the primary objectives of that organization…and contributes to achieving the organization’s strategic goals” (Barrett, 1995,p. xi). And also: "An oft-cited definition of facilities management is provided by Barrett and Baldry (2003) who see it as 'an integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organisation in order to create an environment that strongly supports the primary objectives of that organisation.' They continue by reminding us that 'the breadth and scope of facilities management are not constrained by the physical characteristics of buildings. For many organisations the effectiveness and behaviour patterns of the workforce and the effectiveness of their information technology and communication systems are of considerable importance and the profession of facilities management continues to evolve to reflect this.' Whatever is adopted as a definition, either in this book or by practitioners communicating with their clients and customers, it should stress the importance of integrative, interdependent disciplines whose overall purpose is to support an organisation in the pursuit of its (business) objectives." (Based on an interview with B. L. Atkin, October 2004)

According to Schulte (Schulte, 2000a, p. 37: Seifert, F., a.a.O., p. 23), FM can be defined as follows: FM involves all the processes needed for customer-oriented service, taking into account the needs of the core business of the customer. The FM process is not only composed of services connected to the building, however, but also involves development of all the facilitating services needed by the customer.

The RAKLI provides the following definition (anon.2001): Facilities Management (FM) is management of real estate whose goal is to be responsible for acquisitions and developing of business premises as well as user and facilities services.

According to Then et al., facilities management can be seen as a management discipline that might be the career destination of professionals from relevant technical or administrative fields. The strategic role of the facilities manager demands specific knowledge and skills. “The focus of facilities management skills and techniques should be in such an area that

contributes to the overall management of a business by relating accommodation and support infrastructure issues to business, financial and personnel criteria. In figure 4.5 the multi-skill nature of facilities management is presented" (Then et al., 1992, p. 18).

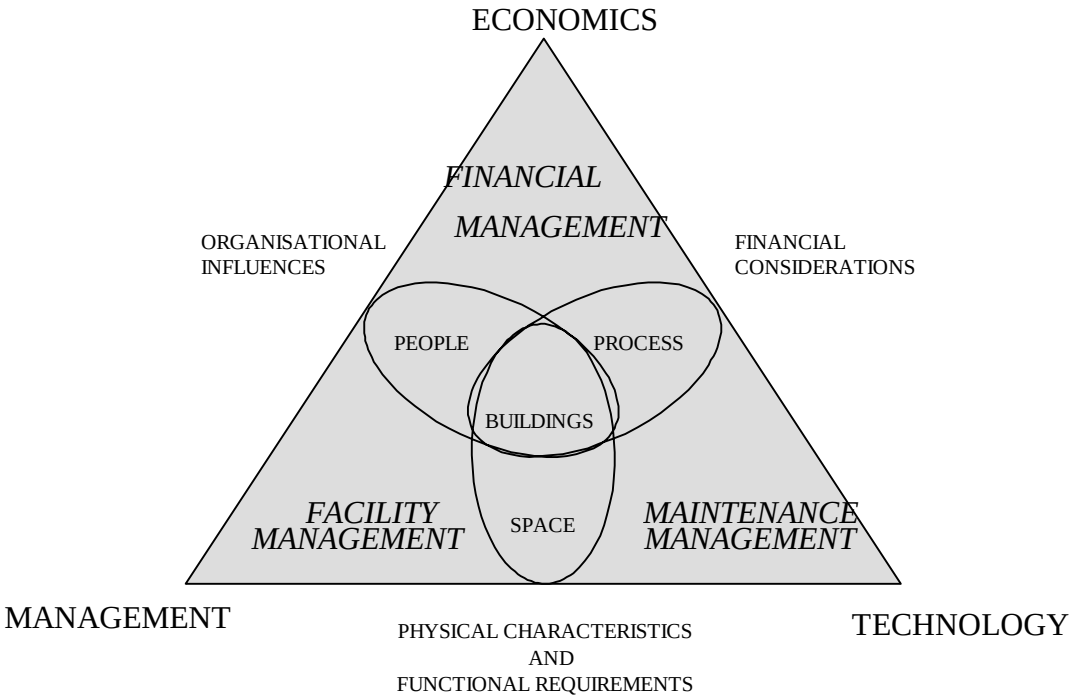

Figure 4.5. Scope of built asset management according to Then et al. (1992, p. 18).

Facilities management tasks can be classified as in table 4.2. In the table, every item represents a category of decisions that have to be made at various management levels, along with the skills required to make and implement them or to asses their effectiveness and performance. Management fuctions are divided into three levels: strategic, tactical and operational. In addition, the table presents responsibilities, management roles and project tasks.

Table 4.2: Classification of facilities management tasks (Then et al., 1992, p 19).

Functions	Executive responsibilities	Management roles	Project tasks
Strategic	Mission statement Business plan	Investment appraisal Real estate decisions Premises strategy Facility master planning IT strategy	Strategic studies Estate utilization Corporate standards FM operational structure Corporate brief
Tactical	Corporate structure Procurement policy	Setting standards Planning change Resource Management Budget management Database control	Guide-line documents Project program FM-job description Prototypical budgets Database structure
Operational	Service delivery Quality control	Managing shared facilities Building operations implementation Audits Emergencies	Maintenance procurement Refurbishment / fit out Inventories Post occupancy audits Furniture procurement

Halder divides Facilities Management into two levels: strategic FM and operative FM. The strategic level includes the entire life cycle of the property from development via construction and use to demolition. The operative level only includes the use of the property and is therefore often called property management, PM. Figure 4.6 shows Halder's definitions of these two levels (Halder, 1999, p. 48; Pierschke in Schulte, 2000b, p. 279).

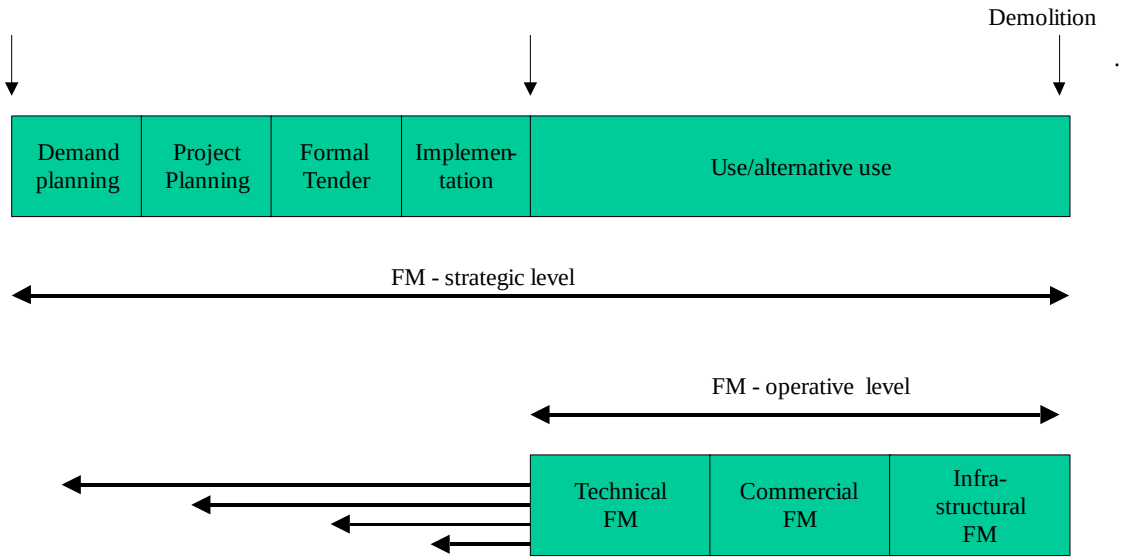

Figure 4.6. Strategic and operative FM (modified from Halder 1999, p. 48; Pierschke in Schulte, 2000b, p. 279).

According to Halder (Halder, 1999, p. 5), the performance areas of operative Facilities Management are Technical Facilities Management, Commercial Facilities Management and Infrastructural Facilities Management. All three parts of operative facilities managements are included in the concept of integrated Facilities management, whose parts are shown in Figure 4.7.

Along with Technical Facilities Management, the significance of plants and systems as a strategic performance potential is increasing, with simultaneously growing demands concerning functionality and flexibility. Also, energy management and increasing the intelligence of plants and systems require a qualitative improvement in operational planning. At the moment, the operation of plants and systems, as well as energy management, are generally provided internally, while maintenance alterations and refurbishment are mostly outsourced. Nowadays, Commercial Facilities Management services, such as property management, cost management, maintenance controlling and insurance, are mostly provided internally. It is significant that for properties there is a growing demand for revenue and shareholder value while at the same time a need to optimize the use of space (Halder, 1999, p. 57-58).

Figure 4.7 shows Halder's description of the different levels or parts of facilities management.

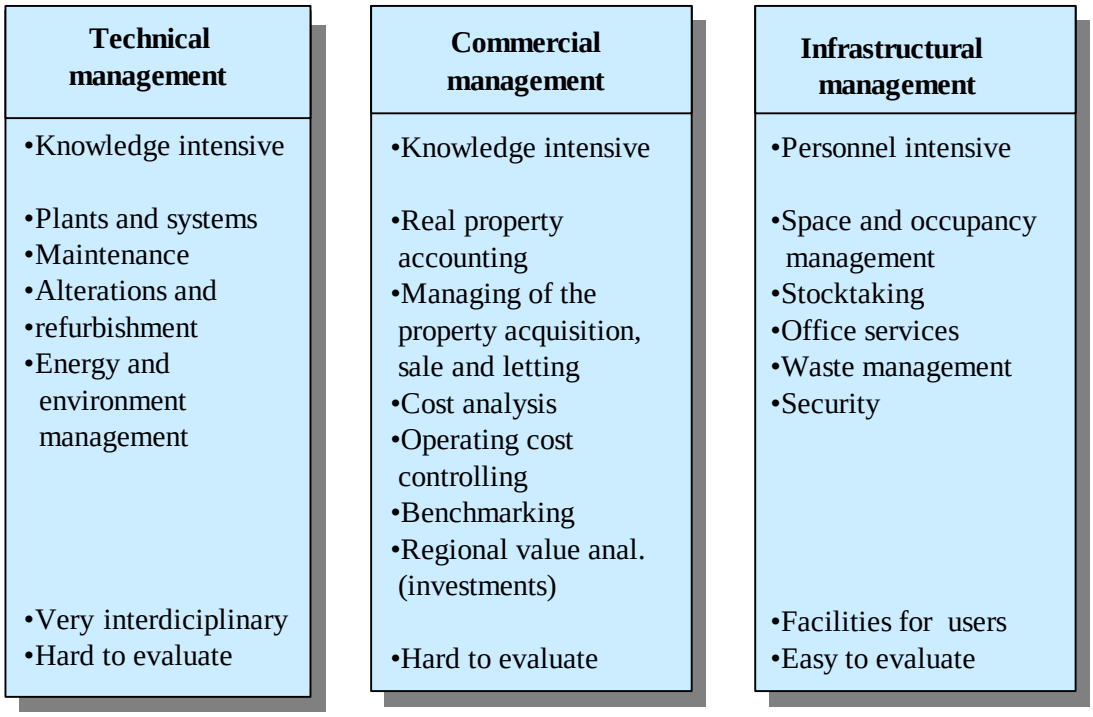

Figure 4.7. Technical, Commercial and Infrastructural facilities management according to Halder (Modified figure from Halder, 1999, 51-63).

4.1.3 Property management (PM)

The function of the Property Manager (PM), in the context of maintenance, is to maintain the building at an appropriate and acceptable standard at a reasonable cost and with the minimum of inconvenience to the occupier. During the economic life of a building, the total amount spent on maintenance is likely to be significant when compared with the initial capital cost (Scarret, 1995).

RAKLI's definition of Property Management (anon. 2001a, p. 13) emphasizes the owner's perspective: PM (Property Management) is the management of real estate with the goal of being responsible for the usability and development of a given real estate, or parts thereof, taking into consideration the benefits to and needs of the owner.

According to Brown et al. (Brown et al., 1993, p. 5), Property Management Administration is a general description of overseeing the day-to-day tasks required for real estate assets to function properly, including administrative management, marketing management and physical management.

Jaffe emphasizes that the role of the property manager is very important, especially when the holding periods are expected to be long. According to him property managers are more familiar with the physical plant than anyone else. They have detailed knowledge about the property and can therefore provide important inputs related to rehabilitation decisions and maintenance strategies. In addition they usually have valuable technical cost information which can be used in design maintenance programs. He also points out that effective property management is one of the key factors to successful real estate investing (Jaffe et al., 1986).

4.1.4 Roles and responsibilities in the real estate business

In the literature, the titles of the key players in the real estate business vary according to the type of real estate owner organization. Also the roles and the responsibilities related to the roles vary. Nevertheless there are roles in all strategic, tactical and operative levels in these organizations. In this thesis, the terms **strategic, management and control (tactical) and operative managers** mainly refer to strategic planning and managing (CREM, portfolio manager or owner), tactical, account and financial managing (asset manager, AM or PM) and operative manager, which depending on the organization can be FM or PM (see table 4.1).

In many real estate companies, decision-making related to technical issues is delegated to strategic, management and control (tactical) and operative levels (Brown et al., 1993). The asset manager (AM) or corporate real estate manager (CREM, in traditional companies) is responsible for managing all aspects of real estate assets including financial management, facilities management, and maintenance management in a cost effective way. The role is partly strategic and also tactical relating to management and control functions (Brown et al., 1993, Then et al., 1992, anon., 2001a). The terms CREM and FM (facilities manager) are mainly used when the owner is a traditional corporation. FM services are mainly directed at the user of the real estate. In some definitions, the FM is responsible for acquisitions and development of business premises. The role is considered mainly operative but in some definitions the FM also has strategic responsibilities (Barret, 1995; Brown et al., 1993; Then et al., 1992, Halder, 1999). The function of property manager (PM) is usually considered operative. S/he is responsible for day-to-day tasks that should be carried out taking into account benefits and needs of the owner. In some definitions, the PM is responsible for maintenance strategies while in other definitions strategic planning of maintenance is a task of the asset manager (AM) (Scarret, 1995; Brown et al., 1993; Jaffe et al., 1986; anon 2001a).

In our domain of TLCM, we consider strategic (objective setting and decision making), tactical (objective setting and decision making) and operative (implementing) real estate management from the perspective of technical management issues. In the following sections, we study the focus areas of strategic real estate business, strategic business planning and implementing of real estate strategies in order to find out if the domain of TLCM is considered part of real estate management and connected to other business areas.

4.2 Strategic focus areas in the real estate business

According to Porter, strategic planning can be defined as follows: “Developing a competitive strategy is developing a broad formula for how a business is going to compete, what its goals should be and what points will be needed to carry out those goals” (Porter 1980, p. xvi).

The competitive strategy is a combination of the ends (goals) the firm is striving to achieve and the means by which the firm is trying to get there. Some firms prefer to talk about goals, while others use words like “mission” or “objectives.” In any case, “goals” includes how the business is going to compete and its objectives for profitability, growth, market share, social responsiveness, and so on, as well as the means by which these goals shall be achieved. For example, strategies can be defined for labour, marketing, finance and control, purchasing, research and development, etc. Goals are in the middle of Porter’s wheel of competitive strategy, and include a broad definition of how the company wants to compete as well as its specific economic and non-economic objectives. The spokes of the wheel are the key operating polices in that functional area with which the company is trying to achieve the goals. In addition, at the broadest level, formulating competitive strategy involves both factors that are internal to the company and factors external to a company, as in Figure 4.8 (Porter 1980, p. xvi-xvii).

Figure 4.8 Porter's wheel of competitive stratgy (Porter, 1980, p. xvi-xvii).

The strategic planning process includes the following steps: 1) corporate mission statement "what business are we in?"; 2) core marketing strategy: market penetraton, market development, product development and diversification; 3) strategic direction and 4) market positioning (Christopher et al., 1987, p. 6). Figure 4.9. shows the organisation levels involved in strategic planning according to Christopher et al. (Christopher et al., 1987, p. 3).

According to Chakravarthy (Chakravarthy et al., 1991, pp. 2-7) the different organisational levels are responsible for different strategies: the chief executive manager and top management is responsible for corporate level strategies; divisional managers for business family strategies and business unit managers for business strategies. Functional managers, such as R&D and marketing managers, are responsible for the planning of functional strategies. There are five distinct steps in the strategy process. The first three steps involve the strategic planning system while the final two steps cover the role of monitoring, control, etc. The first step of the process is to set objectives, in order to determine a strategic direction for the company as a whole, as well as for all its divisions and business units. The second step is strategic programming, while the third is budgeting. The whole process of defining strategy is interactive, involving all four organisation levels.

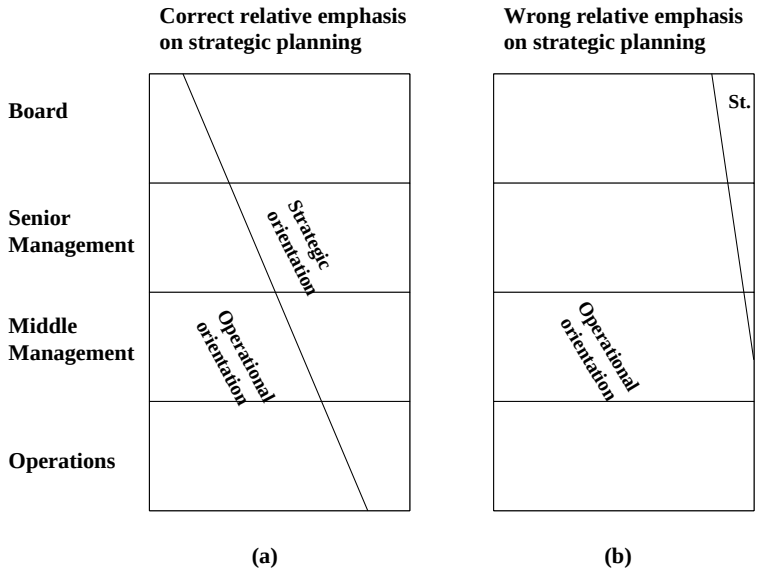

Figure 4.9 The strategy operation balance (Christopher et al. 1987, p. 82).

Christopher points out that although stategy is generally well understood as a concept, strategic thinking is nevertheless quite rare. Rather, people think only for the short term, seldom taking a longer term view and identifying different resources in a way which would anticipate market and competitor reactions (Christopher et al., 1987, p. 3).

According to Gilbert (Gilbert, lecture in EBS 2001) the main objectives of the strategic management of a real estate company are:

- Minimising the risk of incorrect decisions by controlled development of the strategy
- Controlling the whole spectrum of the business area.
- Strategically inspecting the opportunities and threats in the early stages.
- Managing the company, systemising future planning.
- Building and maintaining the success potential of the company
- Integrating isolated decisions into the main decisions
- Building a framework for operative management

Figure 4.10 presents Gilbert`s concept of strategic management (Gilbert, handout, CREM-course in EBS, 2001).

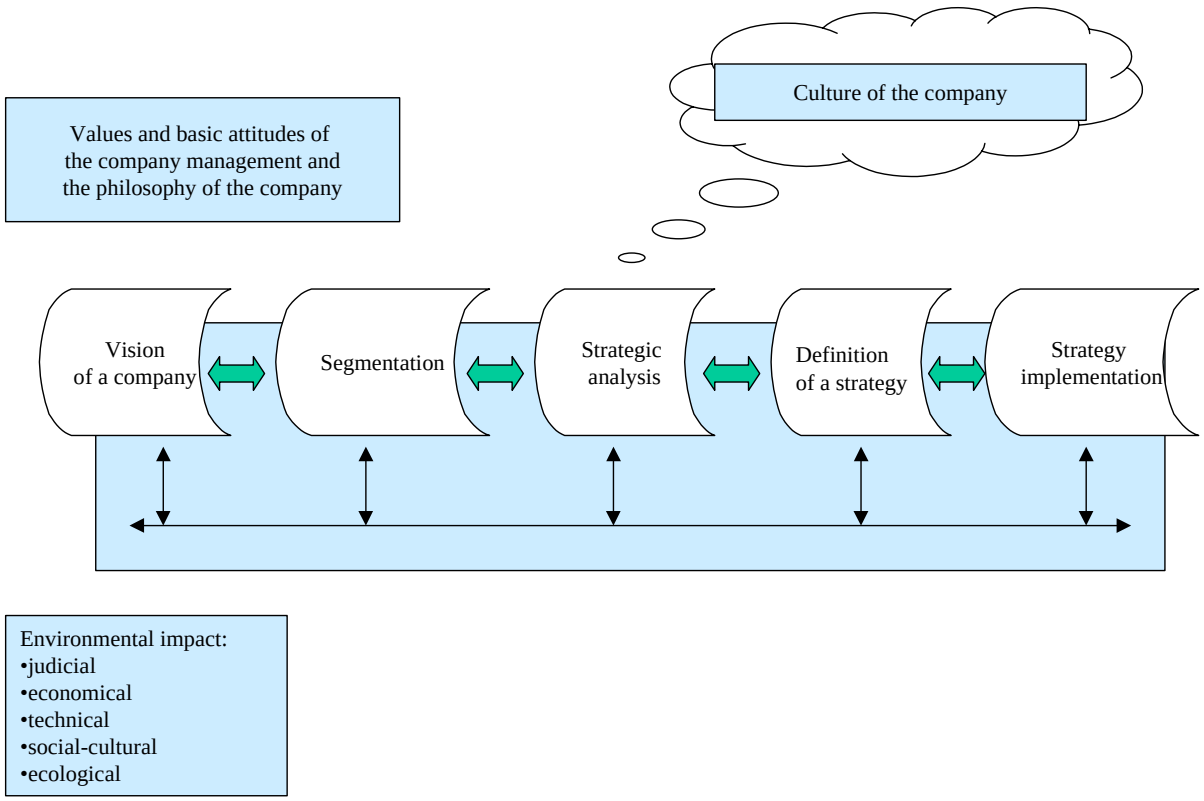

Figure 4.10 A concept of strategic management by Gilbert (Gilbert, 2001, handout)

Lopes (1996, p. 9) also presents a few management concepts and tools applied to corporate real estate management. These tools are adapted from popular management concepts like balanced score card (real estate score card), the Boston matrix, and the Dupont tree, to be used in CREM. In a modification of the balanced score card, he empasizes the importance of identifying critical success factors, vision, mission, goals and strategy, and then analysing the following:

- To achieve our vision, how should we appear to our customers?
- To achieve our vision, how will we sustain our ability to change and improve?
- To satisfy our stakeholders and customers, what business process must we excel at?
- To succeed financially, again, how should we appear to our customers?

The Dupont tree tool is adapted to real estate investment analysis. Its main advantage is to link bottom-line financial information with portfolio information. According to Lopes, the tool can be used as a competitive benchmarking instrument once the basic data is available (Lopes, 1996, pp. 9-10).

Lopes has also defined a CREM-MM meta model for organising the features used in the crem process into a coherent framework which can be used as a reference of available resources. The main dimensions of the model are based on the literature, and is presented in figure 4.11 (Lopes, 1996, p. 11). Lopes focuses on management tools, for he assumes they contain key aspects of management.

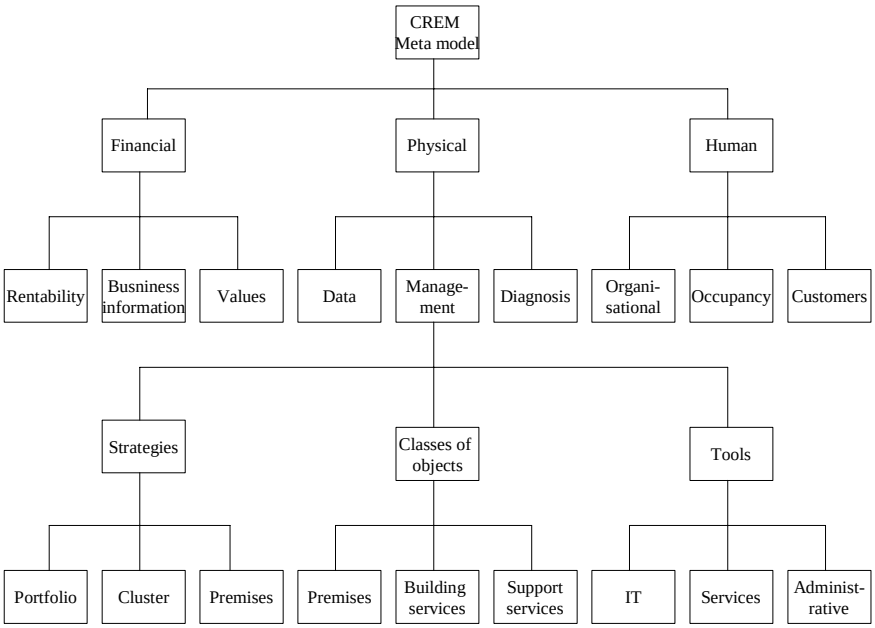

Figure 4.11. Structure of the corporate real estate management meta-model (CREM-MM) (Lopes, 1996, p. 11).

In a real estate company, the core business--the most important decisions and tasks--are strategic, tactical or operational. Lundström presents some examples of these actions, and notes that whether they are insourced or outsourced depends on various factors (Lundström, 1999, p. 15).

- To decide the business idea and the core business.
- To decide the relationship to real capital and make decisions connected to real capital: decisions related to acquisitions, selling and maintaining of the property, as well as decisions connected to renovations, etc.
- To decide questions directly connected to finance.
- To decide questions that have a direct influence on net operating profit and an indirect influence on real capital.
- To decide questions connected to cash flow or image: structure of the organization; decisions about internal service provision or outsourcing, questions connected to information flows as well as questions connected to personnel and environmental policies.
- To decide the up-keep of the company's business activities.
- To decide questions connected to normal infrastructural provision of services: catering services, telephone and data networks, cleaning and security services.

According to Jaffe (Jaffe et al., 1986, p. 4), "an investor who wants to invest in real property should consider one, all or any combination of the following considerations:

- Means of building an estate
- Pride of ownership
- Hedge against inflation
- Desired rate of return on equity invested
- Diversification of investor objectives."

He also points out that very often real estate owners perceive the rewards associated with real estate investment and ignore the risks. Still, since all investment decisions must face the trade-

off between risk and return, risk management, risk analysis and future planning are very important tasks of a real estate owner (Jaffe et al., 1986).

The views taken of a real estate vary according to the objectives of the owner organization which builds it. Building companies and constructors focus on the production process, users need the real estate to support their own core business, and for real estate investors, real estates are one investment object among other objects (Kaleva 1998, internet report, see also Brown et al., 1993, table 4.1 in this thesis). According to Kaleva, in the real estate business the investor can define an investment strategy and user organizations define a facility (business premises) strategy (Kaleva, 1998). Traditional corporations that use and own the premises they use manage acquisitions and sales, development of premises (real estates) and have a responsibility for the required qualities of business premises (Bon, 1999). In traditional corporations, strategic business goals should be effectively communicated to the departments responsible for premises and real estate in order to develop better real estate and business premise strategies (Bon, 1989 in Toure 1999, p. 8).

The strategic areas of the real estate business according to this literature review are presented figure 4.12.

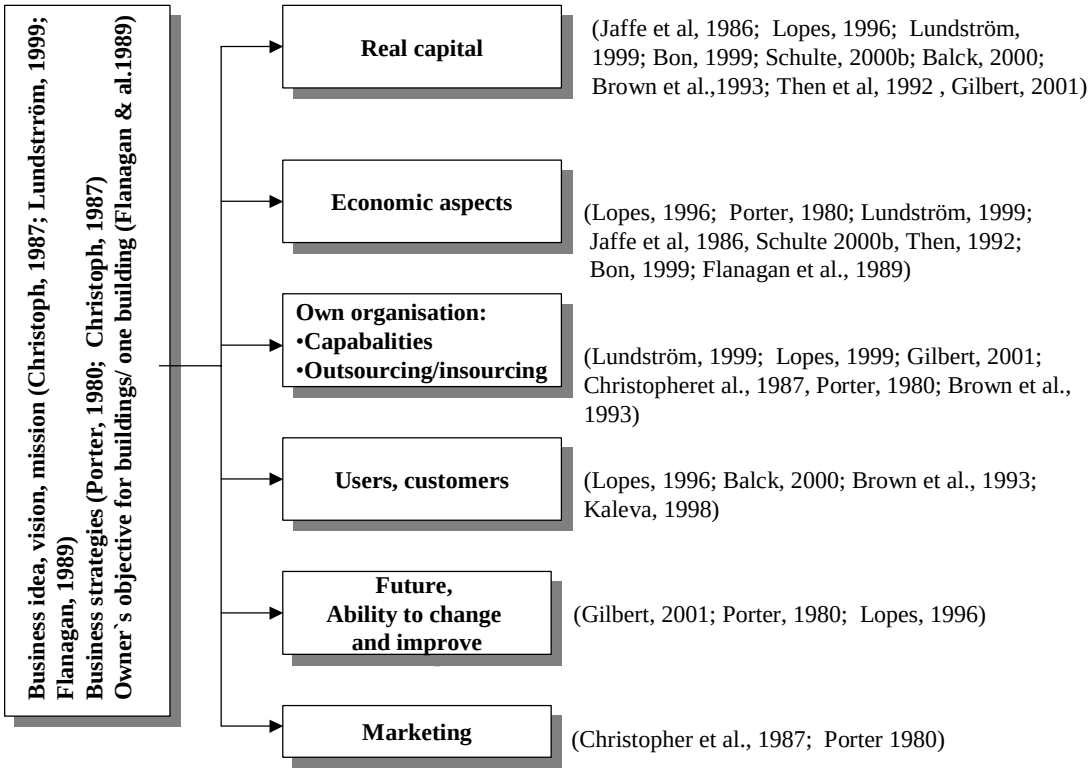

Figure 4.12 The strategic areas of the real estate business.

As our focus in this thesis is technical management, we further examine below the ways technical factors are considered in strategic objective setting and decision-making within real estate management, paying special attention to factors closely related to the TLCM domain. We are trying to identify the underlying theories related to real estate management and especially the practices related to TLCM management. We assume that the technical

characteristics of a building also affect marketing, but here marketing is only considered through human aspects related to the users of buildings.

4.2.1 Decisions related to real capital

According to Halder, the life cycle of a building starts in land acquisition and lasts till demolition of a building, and includes all the following phases: land acquisition, development of a building, utilization of a building, the time after utilization when the building is vacant, redevelopment of a building, second utilization and demolotion (Halder, 1999, p. 4). There are a few situations during this life cycle in which the technical characteristics and performance of a building should be considered.

As Lundström suggests, some of the most important decisions a real estate owner needs to make are related to real capital: acquisitions, selling and maintenance of the property, as well as decisions connected to renovations, etc. (Lundström, 1999, p. 15; also Jaffe et al., 1986; Lopes, 1996). Nutt pointed out that there are four recurrent circumstances for management decisions related to FM and strategic decision-making (Nutt, 1992, p. 3):

1. Management and maintenance of facilities, so-called steady state facility management through which a high quality working environment is secured and maintained.
2. Modification and improvement of facilities, where decisions about incremental improvement and periodic modifications to premises, plant and equipment are made.
3. Adaption of existing buildings and facilities, related to major change and review, including total refurbishment, extensions, partial demolitions and significant changes of function or categories of use.
4. Planning and design of new buildings and facilities**,** covering facility decisions in the strategic briefing, planning, design, construction and commissioning of new buildings.

Facility consultants are increasingly being used in the 3rd and 4th circumstances. According to Nutt, “a fundamental question is which problems may be resolved by management and which may not” (Nutt, 1992, p. 3).

Horner has studied the effects of maintenance and strategic planned maintenance on the cost-effectiveness of building management, showing that a non-budget driven maintenance strategy, which is based on actual needs, proved to be cost-effective (Horner, 1997, IA p. 5). (IA refers to “internet articles”, articles in journals available on the Internet.) Lehtinen et al. also emphasize the importance of strategic choices in design and maintenance planning, which should be done in the early stages of a new construction project. Lehtinen`s hygrothermal design model also considers future needs, restrictions, and environmental effects as a basis for design. He points out the importance of design from the perspective of effects of use on building and as well as from the perspective of user satisfaction (Lehtinen et al., 2001).

Trivers (1999b) and also Smith (2000) point out that if the owner company has to decide between renovating or demolishing and constructing a new building, such decision-making should be based on an exact analysis of the needs of the owner and/or the user of a building (Trivers, 1999b; Smith, 2000). However, according to Aikivuori, who studied the decision-making of real estate owners in a situation when renovation was considered, the renovation decision was most commonly based on subjective values, with the aim of adding “pleasure” (Aikivuori, 1994, p. 62).

According to Sarja (Sarja et al., 1999b; Sarja, 2000; anon., 2001b), during the investment analysis phase of a new construction project, it is important that owners consider their own goals and needs. Also, his multi-attribute decision analysis method helps designers take into account the constructors` needs connected to the characterеistics of a building. Pekkanen also

notes that the owner needs to be clear about all details connected to the construction process and have a central key position in decision making (Pekkanen, 1998). Since everything is ultimately based on the owner's needs and objectives, it is necessary to do a strategic needs analysis which clarifies the needs and objectives of both the owner and users; this basic knowledge can then be used in the decision-making process (Zavadskas et al., 1998; Trivers, 1999; Smith, 2000). This needs analysis is also related to investment analysis (Smith, 2000) and to risk analysis. Both are considered important in evaluating the cost-effectiveness of an investment (Jaffe et al., 1986; Hintikka, 1999). Estimating the life cycle costs also provides plenty of valuable information about a real property (Flanagan et al., 1989). The life cycle design may include different kinds of life cycles (Flanagan et al., 1989; anon., 2001b; Aho, 1993).

In considering the means by which the objectives can be achieved and decisions should be made, the markets, locations and properties themselves should be analyzed against those objectives. According to Isenhöfer (Isenhöfer et al. 2000, in Schulte, 2000b, 321-325), analyses of real estate can in practice be divided into two groups: basic analysis and special analysis, as seen in table 4. 3.

Table 4.3 Real estate analysis (Isenhöfer in Schulte, 2000b, p. 321-325)

Real estate analysis	
Basic analyses	Special analyses
Analyses of location	Evaluation analyses
Market analyses	Investment analyses
Technical analyses	Financing analyses
Lease analyses	"Development potential analyses"

The basic analyses - location, market, technical and lease - aim to clarify issues related to a building's characteristics and location, related to the real estate market. Special analyses are integrated with these basic analyses, addressing questions related to decision-making (Isenhöfer, 2000, in Schulte, 2000b, pp. 321-325). In addition, risk analyses are often mentioned in the literature of real estate investment analysis.

Important issues related to investment analysis include:

1) Risk, return and investment value (Jaffe et al., 1986).

2) Market research (Greer et al., 1988; Jaffe et al 1986, pp. 7-13).

3) Forecasting cash flows (Flanagan, 1989): There are two major sources of cash flow from a real estate investment: 1) the annual cash flow from rental collections; and 2) the cash flow from the disposition of the investment, which is typically sale (Jaffe et al. 1986, pp. 13-19). Zavadskas also points out the importance of evaluating the cost-benefit ratio (Zavadskas et al., 1998, IA p. 1).

4) Analyzing the technical characteristics of an investment: Related to building performance apparaisal techniques, Bottom points out that "there are user-based apparaisal systems and expert-based systems. A user-based system focuses on organizational or user satisfaction. Measurements range from the physical aspects of the building to occupiers' judgements of how such physical charactersitics affect work behaviour and attitude. The expert-based techniques are based on the judgements of professional experts" (Bottom et al., 1998, IA p. 2).

4.2.2 Economic aspects and real estate value

We next consider concepts related to real estate economics and investments: different concepts of value in the real estate business, life cycle costs and cash flows. Budgeting is related to life cycle costs and financing as well, but since our perspective in this thesis is technical, we do not concentrate on those terms and concepts.

Value is at the heart of the real estate investment decision, where decisions are essentially a choice between consumption in the present and consumption in the future. An investment is a present sacrifice for an expected future benefit (Jaffe et al. 1986, p. 1), or in other words, the "real estate investor make an immediate and certain sacrifice of current purchasing power for the prospect of expected future benefit" (Greer et al. 1988, p. 9). Benda et al. also point out the value of buildings to their owners, arguing that preserving and enhancing that value is an important element in every decision that a building owner makes regarding the design, construction, operation and management of the building. The perception of a building's quality is one factor in evaluating it, while another is the building's ability to meet and adapt to the needs of its users during its service life (Benda et al., 2000, p. 697).

The real estate business uses several concepts related to value. For example, a real estate can have an investment value (Jaffe 1986, p. 1; Brown et al., 1993, p. 479), subjective value, market value (Greer et al., 1988, p. 15; Brown, 1993 et al., p. 477), productive value and technical value (Aho, 1993, p. app. 1), use value, liquidation price value, going-concern value, book value, scrap value, mortgage value or loan value (Brown, 1993, pp. 476-484). "Value" itself can be defined in several ways. Value is the ability of a commodity to indirectly or directly satisfy needs, says Aho (Aho, 1993, app. 1), whereas Jaffe says, that "value is the present worth of rights to future benefits arising from ownership." He argues that there are two major concepts of value: market value and investment value. Market value is the present value of anticipated benefits from the market's perspective. Investment value is the maximum price that an investor is willing to pay (Jaffe et al, 1986 p. 4).

There are, moreover, a few additional concepts of value. Salvage value is the value of a real estate as salvage (Brown et al., 1993, p. 483). Residual value is re-sale value, the value which residual life may have for another owner, to the benefit of the present owner (Flanagan et al., 1989 p. 177). The technical value of a building is the remaining value between the replacement value of an entire building, or part thereof, and the decrease in value due to wearing of a building, to deterioration of characteristics important from the perspective of usage (Aho, 1993 app. 1).

Brown et al. point out the importance of the interrelationships between different concepts of value, for example market value and investment value, market value and construction cost or market value and liquidation value (Brown et al., 1993, pp. 484-487).

Ratcliff focuses on the so-called value-generating characteristics of a building, which may for analytical purposes be grouped as follows (Ratcliff, 1961, p. 58):

1. Functional efficiency, the adaptation of the structure to the activities for which it is to be used.

2. Durability, the physical qualities of the structure, which determine how long the building can continue to render useful services.

3. Attractiveness, the aesthetic qualities of the building.

Many analyses of real estate value emphasize the connection between value and the realization of objectives. As we mentioned above, the value of an investment can be broadly defined as the present worth of the future benefits of owning an investment (Jaffe et al. 1986, p. 1; Greer et al. 1988, p. 9). Generally an investment is considered profitable if it satisfies

one's objectives. Thus, for cost-effective ownership, it is important to set precise objectives, which can itself be done from a variety of perspectives. Zavadskas et al. (1998) present a model for analyzing an efficient building lifetime, with cost-benefit ratio optimization and functional considerations, to be used for developing an efficient maintenance strategy. Flanagan points out that buildings are long-term durable assets and must be considered as such (Flanagan et al., 1989, p. 15). He developed a life cycle costing appraisal method which estimates costs at the investment stage and costs during the service life of an investment in order to estimate future expenditure. He emphasizes that it is important to consider total costs rather than just initial capital costs. Horner (Horner et al., 1997, IA p. 4) further emphasizes the importance of strategic long-term maintenance planning instead of annual budget-based maintenance programs. Long-term maintenance planning aims at achieving cost savings and technical quality while maintenance actions are implemented according to actual need. Benda`s (Benda et al., 2000) model also aims at optimizing asset value, both from the perspective of the owner and user. He points out that when net operating income and variable asset value are clearly documented, a building owner or manager can make rational choices among existing alternatives. Bottom (Bottom et al. 1998) presents a model for evaluating the suitability of premises for business use. This model is based on analyzing the business characteristics and property requirements of different kinds of users. As we have seen, all of these analyses are related to the value of buildings, with the goal of setting objectives and making decisions for the long term (Zavadskas et al., 1998; Benda et al., 2000; Bottom et al., 1998). Figure 4.14 shows the effects of maintenance on the value of a property (Osara et al., 1976, p. 10, in Aho, 1993, p. 13).

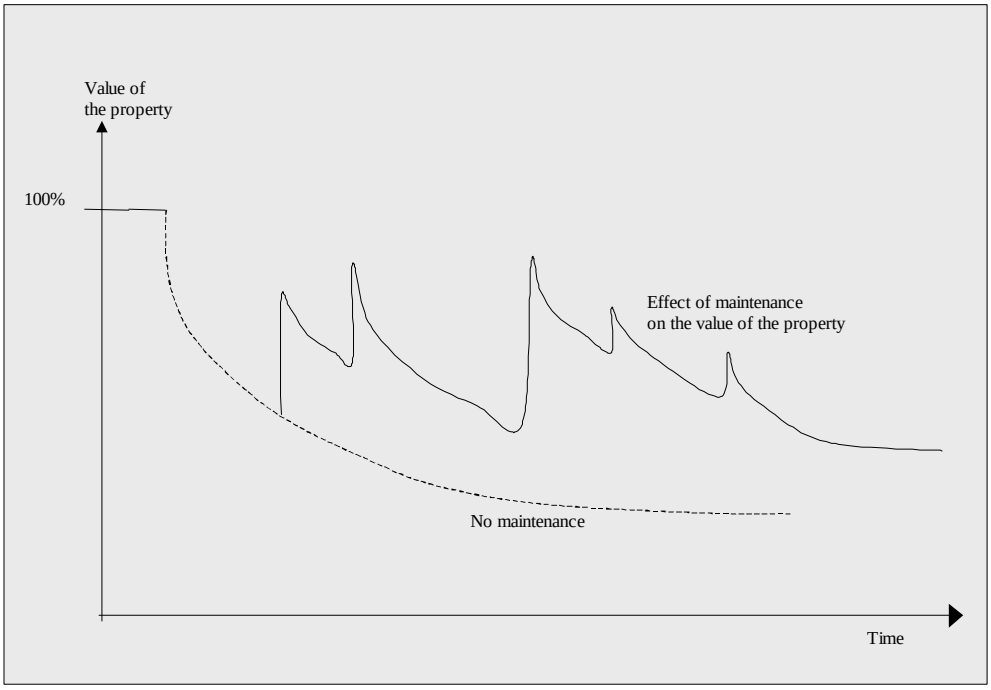

Figure 4.13. Performed maintenance and property value (modified version of Osara et al. 1976 in Aho, 1993, p. 13)

According to Benda, two components should be used in determining the variable asset value (VAV) of a building: net operating income (NOI) for the property and cap rate (CAP) (risk adjusted rate of return on investment). Variable asset value can be determined as follows: VAV=NOI/CAP. NOI= (I)-(O+R+V), where I=income from the property, O=operating costs

for the building, including energy, maintenance and housekeeping, R=repair and replacement costs for equipment, structure, finishings, including refits for tenants, V=vacant space, meaning the lost revenue from rentable space when unoccupied (Benda et al., 2000, p. 698-699).

Life cycle costs are a sum of every cost incurred for a particular item over its lifetime. Since life cycle costs are used to compare alternatives, all of the costs for each alternative must be in the same form: "If we were to look at the life cycle costs of a car we would start with the purchase price, including tax and then add for the expected life of that car the sum of the costs for gasoline, oil changes, tune-ups, repairs, insurance, registration fees, tires etc." (Wallwork, 1998, p.1).

Another definition of "life cycle costs" is as follows: "The monetary cost of a life cycle includes design, construction, maintenance, repair and replacement costs as well as costs of renewal and energy" (anon, 2001b).

According to Flanagan et al. (1989), investors are concerned about the capital value and condition of a building as well as yields. Life cycle costing looks at the balance between initial and future expenditures. The basic idea of life cycle costing is that "spending a little bit extra now may well reduce expenditures in the future" (Flanagan et al., 1989, p. ix). He points out that more intangable benefits may flow from increased initial expenditures in terms of improved aesthetic quality, less disruptions during refurbishment projects or increased income possibilities through improving the income-generating power of the building.

Total occupancy costs of a building can be divided into "costs of utilities" and "real estate costs." Real estate costs are capital costs, taxes and insurance, and maintenance costs. "Costs of utilities" includes the costs of electricity and water and other variable costs caused by usage. The costs of operations caused by maintenance and building management are included in maintenance costs (anon. 2001a). In figure 4.14 some of the concepts related to real estate costs are presented. In addition, there are costs due to the needed user services. The quality and quantity of user services depends upon the usage, users, and their needs (Anon., 2001a; McGregor, 2000.) Mattson studied real estate costs and different ways of managing real estate in Swedish industrial companies. In companies where the premises were a self-evident fact, costs were very high, and Mattson thought that these costs should be more efficiently apportioned to the user organizations. An internal maintenance charge could be levied in order to try to increase the users' awareness of costs, thus helping them see the premises as a strategic resource (Mattson 1996, in Toure, 1999).

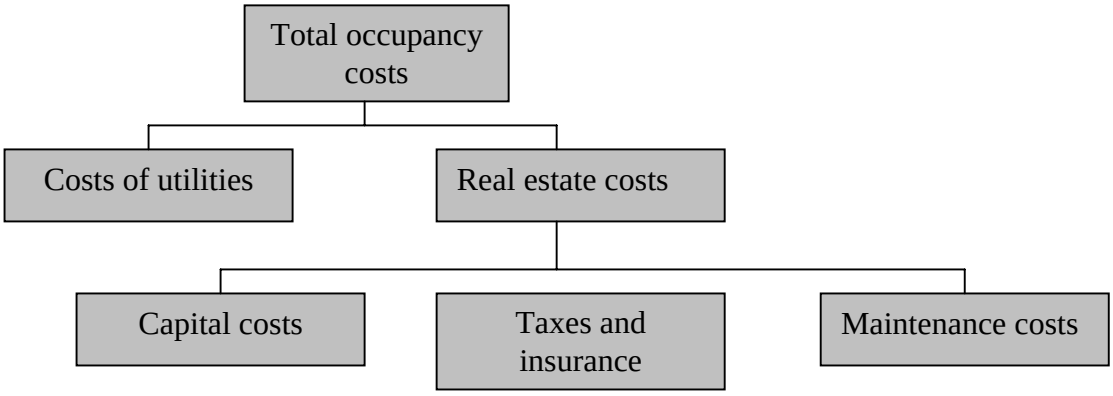

Figure 4.14. Concepts related to real estate costs (Anon., 2001a, figure 4)

Life cycle costs during the service life of a building can be quite significant. Schulte (Interview, 2000; Pierchke in Schulte, 2000b, p. 281) estimates that initial capital costs are about 30% or less of the total life cycle costs (fig. 4.15). According to Flanagan, the total

capital costs are about 42-45% of life cycle costs (fig. 4.16) (Flanagan, 1989, pp. 10-11). Aho calculates that the share of maintenance costs of total building management costs in Finland is 40%. He also divides the total building management costs in a way similar to figure 4.14, identifying capital costs, taxes, leases and insurance costs, and maintenance costs (Aho, 1993, p. 49 ; also anon., 2001a, in fig. 4.14.) Flanagan points out that the type of premises has an effect on the division of costs (Flanagan, 1989, pp. 9-11).

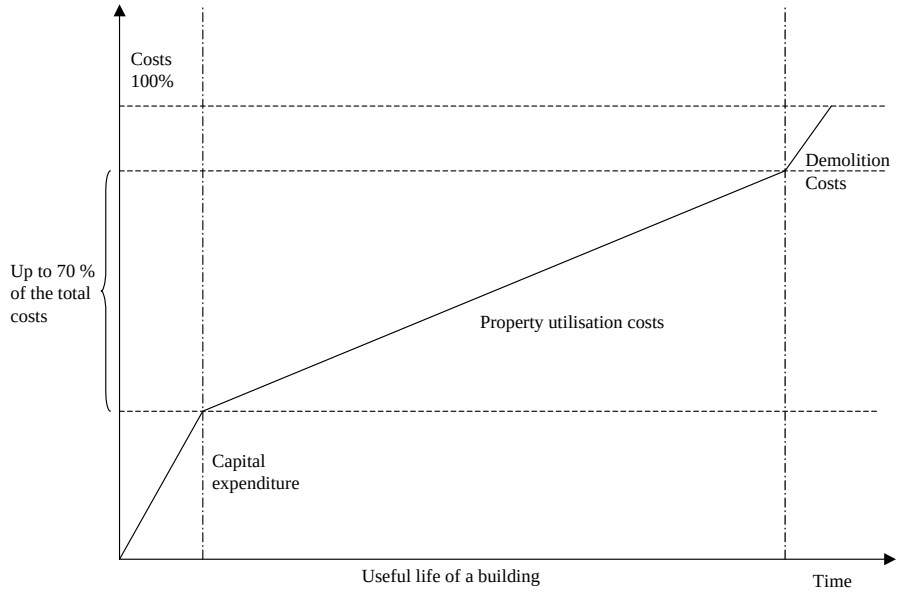

Figure 4.15. Life cycle costs of a building (Pierchke in Schulte, 2000b, p. 281 org. Richter, 1996, p. 8)

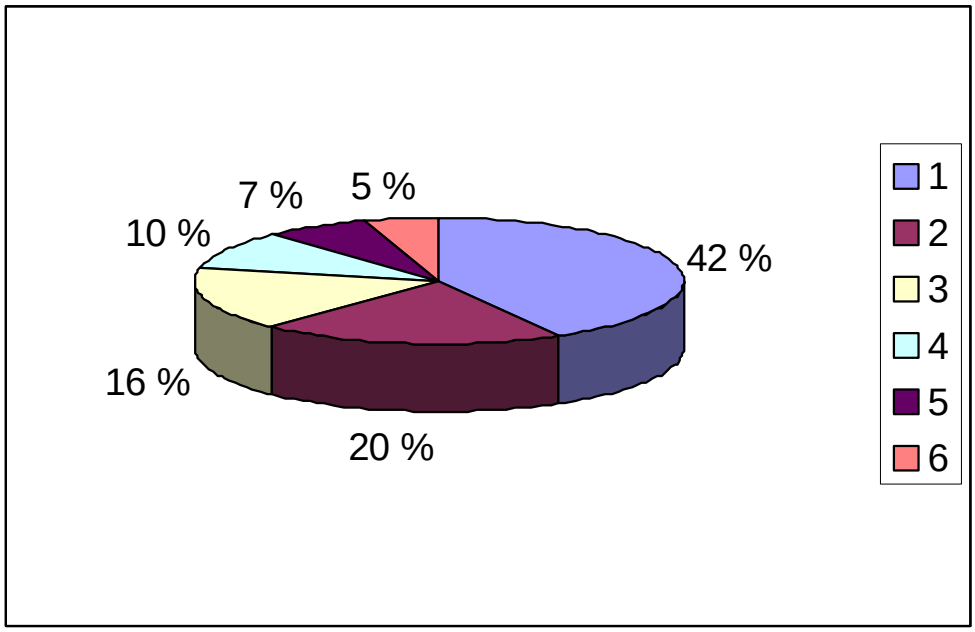

Figure 4.16. Life cycle costs of an office building. Time horizon is 40 years. Legends: 1) Total (not initial) capital costs 42%, 2) Cleaning costs 20%, 3) Rates 16% (general and water rates), 4) Energy costs 10%, 5) Annual Maintenance costs 7%, 6) Other maintenance costs 5% (Flanagan, 1989, p.10)

The rate of return is the relationship between the **cash flows** and the amount invested, typically measured in a percentage per year on the equity (Jaffe et al., 1986, p. 4). The rate of return therefore has a strong connection to the life cycle cost, which is the total cost of ownership of an item, taking into account all the costs of acquisition, operation, maintenance, modification and disposal, for the purpose of making decisions (Flanagan et al., 1989, p. 176).

Yield expectations are justified, since buildings are expensive, long-term investments (Aho, 1993, p. 46). The owner`s objectives for a building have an effect on expectations. These can be monetary, such as short-term profits or long-term returns, or something else, such as pleasure, added value for the business, etc. (Flanagan et al., 1989, p. 6; Aho, 1993, p. 49-50; Jaffe et al. , 1986, p. 4).

Jaffe points out that it is important to consider the relationship between income expectations and risks in investment situations. This relationship is depicted in figure 4.17. Jaffe notes that the relationship between risk and return is one of the most important relationships for investors in the real estate business. The strength of this relationship also tells the investor about the existing degree of market efficiency, and therefore this basic understanding is essential (Jaffe et al., 1986, p. 28-29; Greer et al., 1988, p. 21).

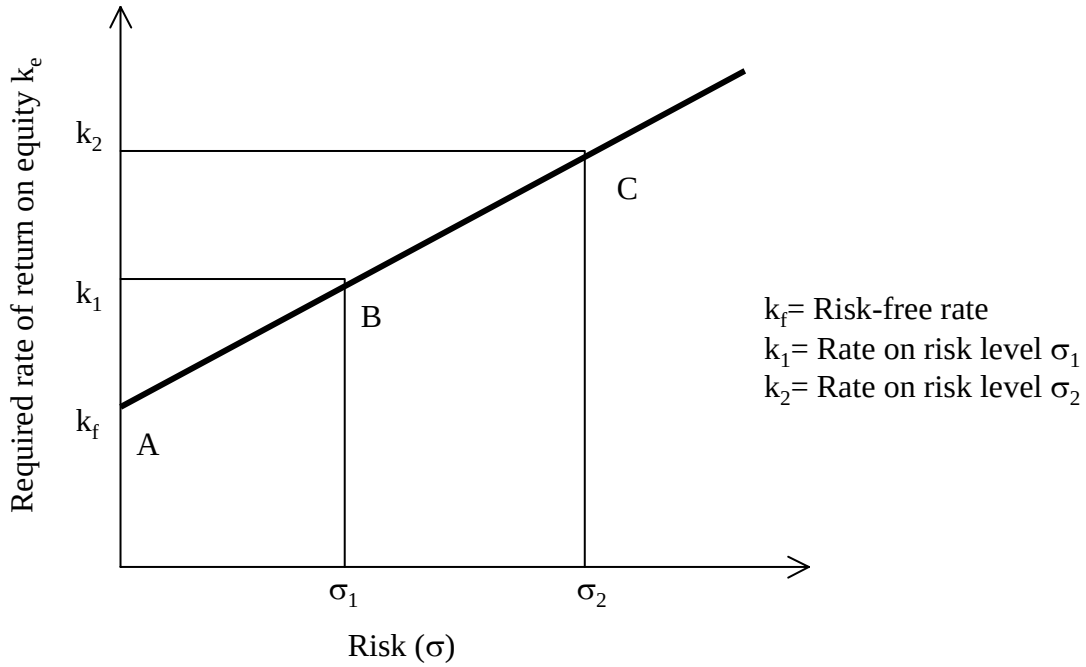

Figure 4.17: Relationship between required rate of return and acceptable risk level (Jaffe, 1986, p. 29; also in Greer et al., 1988, p. 21)

Zavadskas et al. also comment that the relationship between costs and benefit expectations is important. They emphasize that the cost-benefit ratio should be optimized, in part by doing a complex analysis which aims at cutting the costs expended on the building brief, design, construction and maintenance processes (Zavadskas et al., 1998, IA pp. 1-2).

Buildings do not last forever. They wear out and become obsolete for various reasons. In the life cycle phase where redevelopment is needed, the reason is often physical deterioration or obsolescence. According to Flanagan, the physical deterioration of a building and its components is a function of its use and time. Deterioration can be controlled to some extent by provision of good quality components and high levels of maintenance (Flanagan et al., 1989, p. 40). The maintenance action plan – defined by the actual need of different technical

parts and structures of the building – can slow down physical deterioration (Aho, 1993; Aikivuori, 1994, pp. 23-24; Flanagan et al., 1989, p. 45; Horner et al., 1997). Controlling obsolescence is not that easy, since obsolescence is influenced by uncertain future events and is irregular in nature. Deterioration results in an absolute loss of utility, but obsolescence produces a relative loss of utility. Still, obsolescence is important for commercial properties: as buildings grow older they can no longer perform as well financially. While deterioration can be overcome at a price, obsolescence may prove more costly. Both will involve some or all of the following costs: adaptation, refurbishment or rehabilitation, modernization, replacement and repair, fitting out and minor work to comply with legislation. (Flanagan et al., 1989, p. 40-43.) These actions produce costs which can be seen as new investment. Figure 4.14 presents the effects of maintenance on the value of a building. At the end of its service life the building, or at least the site, has residual and salvage values (Flanagan et al., 1989, p. 7). If the owner of the building decides to demolish the building, demolition costs must also be considered (see fig. 4.15).

Benda emphasizes that the level of technical design and construction work has an important effect on the cost-effectiveness of the real estate business during the service life of a building. Through high-quality design and construction work, it is also possible to achieve satisfactory results from the perspective of the user and usage (Benda et al., 2000, p. 697-702).

The period of analysis over which life cycle costs are considered is not necessarily the same as the expected physical life of the building or an individual building component. This period, for example, can also be defined by the expected period of use that either the user or the owner of the building requires. According to Flanagan et al. (1989), costs during the life cycle of a building are of two basic types: tangible and intangible. The former are readily quantified, though the measurement of the latter in monetary terms is more problematic. Tangible costs can be divided into two categories, initial capital costs and running costs. Initial capital costs are bedding, finishes, adhesives, and other allied construction costs. Running costs are cleaning, fuel, general rates, insurance, annual and recurring maintenance, replacement, alteration, financing, alternative temporary accommodation and disposal costs net of salvage or residual value.

In addition, costs can be direct or indirect. Indirect costs are, for example, costs due to poor indoor air quality. These costs can be significant; e.g., Clements-Croome et al. (2000, pp. 629-634), Wargocki et al. (2000, pp. 635-640) and Hannula et al. (2000, pp. 659-664) all point out that the office environment has a direct influence on the well-being of users and their productivity at work. Nguyen et al (Nguyen et al., 2000, p. 647-652) shows that treatment of respiratory diseases associated with moisture and mold dwellings was costly both for society and patients.

Flanagan et al. point out that some real estate owners have criticized life cycle techniques for being based on forecasts of future events, commenting that these forecasts are too inaccurate, involving too many variables. Nevertheless, according to him, these forecasts are better than no forecasts at all. As buildings are long-term durable assets, ignoring the future is folly. They recommend the use of life cycle techniques in the following situations (Flanagan et al., 1989, p. 14-16):

- As an evaluation technique helping to choose between competing options, whether these relate to a complete building, system or material.
- As a basis for predicting future running costs
- As a management tool to ensure that the facility is being used effectively and that maximum value for money is being obtained
- As a basis for budgeting for future expenditure
- As a means of considering total costs rather than merely initial capital costs.

The fundamental problem in real estate management is maintaining continuity and cost-effectiveness. Costs must be covered by yields. Maintaining buildings includes the actions whereby the necessary circumstances are maintained. The owner's motives and main objectives also affect yield expectations (Aho, 1993, p. 49).

4.2.3 Human aspects: the organization and users

The organization and customers – choice between insourcing and outsourcing

As Lundström (Lundström, 1999) points out, one of the most important questions in real estate organizations or owner companies is to define which tasks should be outsourced and which should be provided internally. The services needed are determined by the use and usage of the building, but also according to the owners` objectives for the buildings. To answer these questions it is necessary to do a strategic needs analysis (Smith, 2000).

Which real estate functions should be outsourced for a particular company depends upon the company's industry, size, locations and business strategy. It is generally true that property-specific real estate services such as brokerage, construction and property management can often be more efficiently performed through outsource vendors. It is also generally true that in-house executives can better perform strategic company-wide real property process management responsibilities (Manning et al., 1997). Various forces act on the facilities manager, influencing his choice between in-house or outsourcing as presented in figure 4.18. (Barrett et al., 1992b, p. 169-170). Also, Barrett points out that the relative importance of each factor varies according to the type of organization, its goals and culture, the time frame, and according to additional forces such as economic forces, organisational changes, technological changes, social and legal changes (Barrett, 1992b, p. 169).

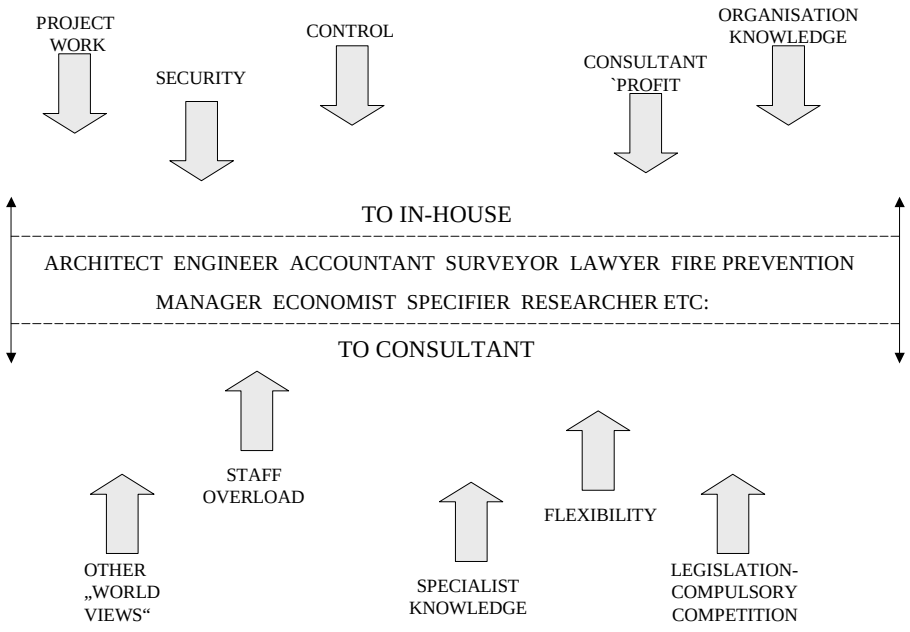

Figure 4.18. Forces acting on the facilities manager (Barrett, 1992b, p. 170)

Routto presents some of the benefits of outsourcing service providing (O´Malley, 1998; in Routto, 2000, p. 5)**:**

- Outsourcing offers a possibility to concentrate on one's own core business.

- Outsourcing offers a possibility to use the best professionals within the outsourced business area.
- Outsourcing makes the development of business activities more effective.
- Outsourcing minimizes and shares the risks related to business.
- Outsourcing frees up more resources.
- Outsourcing frees up more operating funds.
- Outsourcing makes it possible to redirect cash flows
- Outsourcing reduces action expenses, general expenses and administrative expenses
- Outsourcing makes it possible to use outside resources and competencies, makes it possible avoid managing difficult tasks

According to Manning et al. the possible benefits of (CRE) outsourcing are (Manning et al., 1997, p. 3):"

- Efficiency gains of economics of scale
- Efficiency gains and effectiveness from economics of scope
- Lower transaction costs for routine tasks
- Timely updates of market values on real estate holdings
- Other real estate reporting improvements"

Economic scale can be achieved by service providers spreading their personnel across several clients. Economic scope can be achieved if service providers posses distinctive expertise in various related real estate areas (Manning et al., 1997).

Manning also notes, however, that "outsourcing is not without disadvantages. For example when transferring activities from inside the company to service providers there are disadvantages related to transactions and their complexities. Another disadvantage is that outside service providers cannot know the subtle implicit, often unspoken cultural factors that determine how an organization does its business – translation of cultural meaning to outside service providers can be difficult. In addition, sometimes when competition is limited it is difficult to find partners with whom to contract. In the future, the need will be greater than ever for internal CRE-managers to create, monitor and control the cost effectiveness and quality of CRE transactional service support to their companies business units. Outside Corporate Real Estate service providers are expected to contribute more innovative and comprehensive strategic thinking as well as to become more able to make key contributions to the process management of a firm's corporate real estate portfolio. Yet corporate real estate management knowledge and expertise specific to the firm will be key to integrating corporate real estate strategies with overall company business strategies" (Manning et al., 1997, p. 3).

Ojala points out that the trend in Finland is to outsource as many services as possible that cannot be considered one's core business. For example, related to services of business premises there are two target customer groups: real estate users and real estate owners (Ojala, 1999).

According to Blumberg (1998, IA pp. 1-2), the issue of outsourcing and downsizing is much more complex than most authors and speakers on the subject have described. "It is not simply a matter of deciding whether to outsource or not. This is particularly true of service issues, the usual focus of outsourcing. The question of outsourcing requires the firm and its consultants to carry out a full strategic assessment and evaluation in which a number of factors must be considered, including, but not limited to:

- The importance of service to the organization's customers and users.
- The market or use community's observed perception of the vendor's service quality and responsiveness.

- The current levels of service efficiency and productivity compared to other equivalent service organizations in the market."

Also, when deciding whether or not to outsource some function, other factors also need to be considered, such as the customer's view of the function, the capabilities and physical assets required to perform this function, the technological requirements related to real estate, the world-class abilities of different stakeholders, the performance and delivery capabilities versus competitive alternatives, the time and cost required to close performance gaps and the long-term commitment of different stakeholders (Blumberg, 1998, IA pp. 4-5).

According to Pietilä et al. (2001, p. 7), the general criteria for a function that could be outsourced are that the function is routine, it is delineated, it can be measured and managed at arm`s length, it can be readily provided by established vendors and it is offered in a competetive environment.

Axelsson (1998, in Lundström, 1999b, p. 4) also discusses the corporate choice between outsourcing and intenal provision, arguing that every company should first identify its core competence, the competence that distinguishes it from other companies. Then it can further consider whether there are competent service providers in the service market for the necessary services, the economics of scale and scope, the frequency of transactions, the uncertainty and degree of specialty in the service provided, the effects of teamwork, and the possibility to go back to earlier management solutions and staff policy.

Lundström (Deavers, 1997, in Lundström, 1999b, pp. 4-5) notes several new factors affecting a company's decision to outsource services: technical solutions are changing quickly, the risks and occupiers` need for flexible buildings are increasing, real estate owners are putting more emphasis on their core business, and, in addition, the real estate business is becoming more global and there is increasing competition.

Pottinger points out that "there are two main areas to be developed within competitive tendering of property services. These two areas are complementary to one another, they are also essential, if delivery of a quality service is to be achieved:

- The procurer of the client needs to have contract management and procurement skills, which provide a formal framework and informal development of the working relationship.
- The provider of services or contractor needs skills in tendering, contract management and quality management. Personal communication skills are also highly important to achieve an understanding of the client's objectives and to develop an appreciation of the client's needs which leads to trust" (Pottinger, 1998, IA p. 8).

Barrett et al. (1992a, pp. 48-56) also emphasizes the importance of the relationship between clients and professional service providers in the construction industry, noting that this relationship is relevant in many ways to facilities managers especially when they are dealing with the built infrastructure of organizations. Grönroos distinguishes between the client's perception of the service provided and the initial expectation of what the service would be. He introduces the concepts of technical quality and functional quality, adding that: "Because many of the services that professionals provide are intangible, the way in which they are delivered assumes great importance to the client. The professional should be aware that how he provides his service is often as important as what he provides" (Grönroos 1984, in Barrett et al., 1992a, p. 50). Walker points out that "the construction industry and its professions…need to understand how their clients´ organizations operate…the members of the project team need to have the ability to understand the structure of their clients` organization and where authority for decision lies" (Walker 1989, pp. 12 and 64, in Barrett et al., 1992a, p. 52).

Barrett similarly comments that professionals generally operate in increasingly competitive areas of high uncertainty, delivering an intangible service, which is likely to be judged as much by how it is rendered as on its actual content. Key characteristics of professional services are the knowledge and skill available and the quality of the analysis of the client's needs (Barrett et al., 1992a, p. 50).

According to Lundström (Lundström, 1999b) the quality of FM services or service providers can be evaluated by using the following criteria: reliability, response time, competence, ability to improve competence (know how), accessibility, customer oriented service, communication skills, financial solidity, reputation and understanding of customer needs.

To summarize, the main factors affecting a decision to outsource are the size and structure of the organization, the role of real estate in the owner organization and the services and service providers available in the neighborhood.

Needs of users and usage

Alexander points out that the total workplace in which building occupants perform includes the social and managerial environment as well as the physical setting for work (Alexander, 1996, p. 98). Users are central to this kind of "intelligent building." The goal of intelligent building performance is to create and sustain an environment which maximizes the efficiency of the users while enabling effective management of resources at minimum lifetime costs (Robathan, 1992, p. 107). Such management also affects the cost-effectiveness of ownership.

According to Bottom et al. (Bottom et al. 1998), the operational property can be managed creatively and effectively as a valuable resource, which contributes to an organization's business objectives. There is "a perceived necessity for the development of a comprehensive property strategy, which should underpinned by the flow of good quality and meaningful information for proactive management decision-making" (Avis et al. 1989, in Bottom et al., 1998, IA p. 2). In addition, the usefulness of property performance measurement and benchmarking is being recognized. Building appraisal techniques for measuring building quality and changing tenant (user) requirements are of particular relevance, as well as techniques for evaluating investment risk associated with aesthetic, functional and social obsolescence (Bottom et al., 1998, also: Avis et al., 1989 in Bottom et al, 1998; Becker 1990 in Bottom et al., 1998; Bon, 1992; Noha, 1993). Smith (2000) and also Trivers (1999b) emphasize that it is important to identify the strategic needs of clients when considering the development process of a building. During the project initiation stage, the client's needs, objectives and requirements are clarified, and are included in the definition of the project or projects. The project may be a construction project, new building, extension project, renovation or refurbishment project, recycling or a combination of these (Smith., 2000; Trivers 1999b). "When the strategic analysis of needs has been rigorously and conscientiously pursued then it should result in a clearer view of the goals of the organization, a better definition of its real needs and the strategic decision should recommend the best means to achieve those corporate goals" (Smith, 2000).

Piirainen (Piirainen, 1996) developed a needs analysis methodology which is based on the visions, scenarios and assessments of the business needs of users. During the project, the organization's future is assessed: its ideal action profiles and images, future location, estimated number of positions, and best way of achieving added value. According to Piirainen, only after an organization is aware of its needs can it know what kind of business premises it needs in order to realize its objectives. In Piirainen`s method, the objectives of a construction project are determined by the visions and needs of a building's users.

According to Benda et al., a building's technical characteristics also affect use and user satisfaction (Benda et al., 2000, p. 697-702). Similar opinions are expressed for example by

Trivers (1999b), Bottom et al. (1998) and McGregor et al. (2000). In addition, many characteristics of buildings related to aesthetics and functionality have an effect on usability and user satisfaction (Ratcliff, 1961, p. 58.; Pierchke in Schulte, 2000b, p. 285-290).

A building's usability is related to cost-effective ownership, since usability affects user satisfaction. The needs of users are related to services, premises, usability – factors that provide added value for the business (McGregor et al., 2000; Bottom et al., 1998). User needs are also related to the technical characteristics which affect usability. According to Lehtinen, new construction projects should take into account usage, maintainability and internal and external moisture loads in the preliminary planning and objective setting phases, so that the building's physical characteristics can be designed according to the actual needs (Lehtinen et al., 2001; Also Lehtinen, 2000, pp. 507-512). Flanagan et al. (1989) also points out that usage affects maintenance needs, and therefore also has an effect on usability and life cycle costs.

Even if the technical characteristics of a building had no direct effect on the user, the indirect effects may be significant. As Horner points out, in maintenance management the maintenance strategy should be defined by actual need, and the structures and parts of a building should be divided into "critical" and "non-critical." The criticality of one part is determined by the health effects on users or by the costs due to failure in one structural part or system. Some research has been published on the effect of indoor air quality of offices on productivity. Seppänen et al. (2000a), Clements-Croome et al. (2000), Wargocki et al. (2000) and Hannula et al. (2000) all demonstrate that the office environment has a direct influence on the well-being and productivity of users. Crowded work places, thermal problems and sick building symptoms were the principal complaints about unsatisfactory premises/environments. (Clements-Croome et al., 2000, pp. 629-634; Wargocki et al. 2000, pp. 635-640; Hannula et al., 2000, pp. 659-664). Moreover, many problems based on indoor air quality are very costly. Nguyen et al. (2000, p. 647-652) show that the treatment of respiratory diseases associated with moisture and mold dwellings was costly both for society and for patients.

4.2.4 Future planning

Ratcliffe points out the importance of strategic property planning. He has created a "scenario building" method which offers a methodology for understanding the whole range of possibilities that present themselves in the fields of property investment, development, management and marketing, and the valuations that result, to organizations and agencies of all kinds. He defines the term "scenario" as follows:

- "A scenario approach involves developing future environment situations and describing the path from any given present situation to these future situations.
- Scenario building is an instrument that aids decision makers by providing a context for planning and programming, lowering the level of uncertainty and raising the level of knowledge in relation to the consequences of actions which have been taken, or are going to be taken, in the present.
- Scenarios tend to clarify the present possibilities of decisions by indicating the guidelines for decisions.
- Scenarios are a synthesis of the different paths (events and actor strategies) that lead to a possible future.
- Scenarios are descriptive narratives of plausible alternative projections of a specific part of the future.
- They resemble a set of stories built around plots that make significant elements of the world stand out.
- … about making choices today with an understanding of how they might turn out.

- … a tool for ordering one's perceptions about alternative future environments in which one's decisions will be played-out.
- … a means for investigating important decisions."

According to Ratcliffe, the scenario method has been widely used by decision-makers in business, industry and government for over 30 years. The technique aims at learning about the future before it happens (Ratcliffe, 2000, IA p. 3).

Flanagan et al. also write about the importance of scenarios, focusing especially on the importance of scenarios about life cycle costing and forecasts of building usage, the needs connected to use, etc. They write that there are "numerous books and articles concerning the benefits of using the life cycle cost approach in evaluating buildings, elemental parts of buildings, systems or the components and materials used in buildings." As we can see, life cycle costing techniques have a very important role to play in decision-making. For example, in investment appraisal techniques, it would be important to:

- Make assumptions about the periods of occupancy,
- Define how the building will be used, types of users.
- Decide upon the methods of forecasting the running cost categories, energy and building performance models, etc.,
- Make forecasts about the life expectancy of materials and components
- Make forecasts about maintenance (planned, preventative, unplanned, corrective) and modernization, refurbishment, adaptation needs
- Forecast salvage and residual values

By doing this, it would be possible to evaluate the costs and benefits, and evaluate risk and uncertainty (Flanagan et al., 1989, p. 4).

Many authors, lecturers and interviewees (Ratcliffe, 2000; Alexander lecture 2001; Bottom et al., 1998; McGregor et al., 2000; Trivers, 1999b; Zavadskas et al., 1998) have pointed out that in the real estate sector it is essential to be able to take into account the impacts of cultural, social, moral, legislative, demographic, economic, environmental, governmental and technological change, as well as changes in the business world on international, national, regional and local real estate markets. It is also important to investigate more closely and creatively such obvious property-related issues as the changing nature of work and the future of the office, advances in information technology and the potential consequences for retail and residential real estate development. Because of changes in the needs of users, tenants and the nature of work, future planning related to the technical factors of a building is also very important. The technical characteristics and usability of a building as well as its flexibility and aesthetic durability and value are related to design decisions. In investment analysis situations these factors, as well as technical risks, should be considered.

4.2.5 Strategic real estate planning

All organizational levels should participate in strategic planning, as they are responsible for different strategies. Therefore, it is important that the whole strategy process is interactive, involving all levels of the organization (Chakhavarthy et al., 1991). The strategy defines the company's goals and the means by which the company is trying to achieve these goals (Porter, 1980). In the real estate business, at least the following issues are important in strategic planning: decisions related to 1) real capital, 2) economic aspects, 3) the organization and users (customers) of a building, 4) future possibilities and threats and 5) marketing.

Figure 4.19 presents the strategic focus areas of the real estate business that are connected to the domain of technical life cycle planning and management (TLCM).

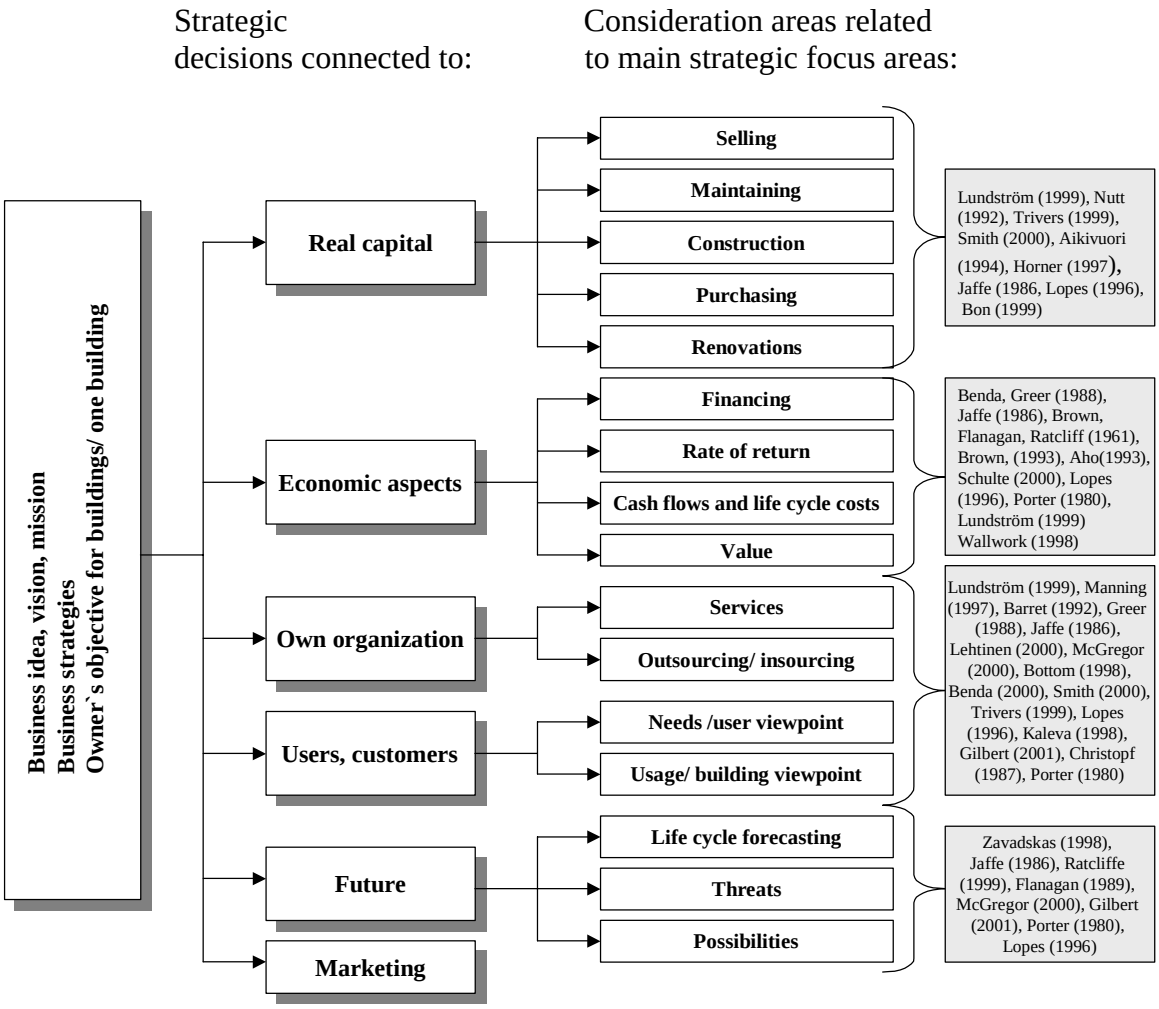

Figure 4.19 The strategic focus areas of the real estate business.

Technical life cycle management (TLCM), as we defined it in Chapter 1, does not exist as a concept in the literature. According to DIN, there is a concept of technical real estate management (Balck, 2000) as a part of facilities management. Halder writes about strategic and operative facilities management. In his definition technical facilities management is considered as a part of operative FM (Halder, 2000). Many authors also point out that there are strategic, operative and tactic tasks related to designing, managing and budgeting the technical actions effecting characteristics of buildings (Then et al., 1992; Bon et al., 1999; Benda et al., 2000, Brown et al., 1993; Nutt, 1992). Often the responsibility for managing strategic, tactical and operative tasks is decentralized in real estate owner companies (see chapter 4.1).

Technical characteristics and performance of a real estate have an effect on the *cost-effectiveness of ownership* (Benda et al., 2000; Jaffe et al., 1986; Flanagan et al., 1989) as well as the usability of a real estate from the *perspective of users* (Benda et al., 2000; Horner, 1997; Smith, 2000; Trivers, 1995b). Also, *objective setting* related to technical issues and its importance from the perspective of *cost effective* managing of real estates is discussed (Smith, 2000; Trivers, 1995b; Jaffe et al., 1986; Sarja, et al., 1999b, Sarja 2000; anon., 2001b). Especially Flanagan et al. (1989) emphasizes the importance of managing life cycle costs and decisions and actions related to them. Technical issues affect life cycle costs and the technical value of the building, so economic aspects are tightly connected with technical life cycle management (TLCM) and the managing of maintenance actions. Technical management

therefore has strategic and tactical dimensions. It also should be considered from the perspective of user and usage.

Maintenance (as part of property management or facilities management) is related to our domain of TLCM, as strategic maintenance can be seen as "the implementing of technical related issues." During usage of a real estate, issues related to maintenance have a remarkable effect on usage and user satisfaction (Blumberg, 1998) Maintenance also effects ownership, since the owner is often responsible for at least the technical facilities/property management of buildings (Bon et al., 1999, also Then et al., 1992). In addition, the maintenance strategies affect the structure of an owner company in terms of making choices between *in- or outsourcing different* actions in the real estate business. Managing of outsourcing is also related to technical design as well as characteristics and performance of a real estate (Lehtinen, 2000; Benda, 2000; Flanagan et al., 1989; Zavadskas et al., 1998; Nutt, 1992; Lundström, 1999, 1999b; Barrett, 1995). Many FM- or PM-related services are often outsourced. Real estate owners should consider what is their core business and what actions related to real estate affect this core business, and decide whether to outsource or insource services related to that (Manning et al., 1997; Barrett, 1992b; Routto, 2000; Blumberg, 1998; Axelsson in Lundström, 1999b). In this sense, technical management also has an operative dimension. This operative part of real estate management needs to be strategically planned, which affects the planning of in- or outsourcing of services.

Strategic planning itself should be done in order to examine opportunities and threats in the early stages, controlling the whole spectrum of the business area and minimizing risks related to incorrect decisions (Gilbert, 2001). In addition, the future planning of a real estate is connected to a building's technical potential and performance since the needs and values of users, work environments and the usage of buildings are changing (Ratcliffe, 2000; Flanagan et al., 1989). Moreover, cultural, social, moral, legislative, demographic, economic, environmental, governmental and technological changes, as well as changes in the business world on international, national, regional and local real estate markets, have an effect on a building's technical potential. Therefore, in evaluating *future threats and possibilities, it is also important to consider the technical threats, risks and possibilities related to ownership* (Ratcliffe, 2000; Alexander lecture 2001; Bottom et al., 1998; McGregor et al., 2000; Trivers, 1999b; Zavadskas et al., 1998). Technical management as a part of overall business planning should be taken into account in future considerations - long term technical planning is important.

In different phases of the total life cycle of a real estate, there are different kinds of actions that should be planned and implemented in order to keep the real estate in such order that it serves both the usage and the ownership (Nutt, 1992; Zavadskas et al., 1998; Horner, 1998; Flanagan et al., 1989; Halder, 2000). Halder writes about the life cycle of a real estate, starting from an empty land area, continuing through the design of a building, to usage and eventually to refurbishment or development, finally to demolition and a return to an empty land area (Halder 2000). Benda points out that decisions made about the technical design of a new building have long lasting effects on ownership and usage (Benda et al., 2000). Also, Sarja points out the importance of life cycle design in new construction projects (Sarja et al., 1999b; Sarja 2000). Technical decisions and their implementation also affect the suitability of the premises for some specific usage (Lehtinen, 2000; Trivers 1999b; Benda et al., 2000; Smith, 2000). Long term objective setting, decision making and implementing of decisions affect the cost-effectiveness of ownership and is therefore an important management aspect in the real estate business (See the domain of TLCM).

We study TLCM as a domain in which the real estate owner sets goals, makes decisions and plans and implements actions directed at an individual real estate that affect the physical characteristics of the building. Therefore, technical life cycle management (TLCM) issues are

a part of strategic, tactical and operative long-term management. We focus on the characteristics that are important from the perspective of cost-effective ownership. The time period of considerations in our domain is from the investment analysis phase until a demolition decision. According to this literature review, all the issues related to our domain of Technical Life Cycle Management (TLCM) are considered by one or more authors, though none has considered TLCM as an individual management issue, despite the fact that regardless of an owner's relationship to the owned real estate, the technical objective setting, decision making and implementation of decisions have a great effect on his or her business (Brown et al., 1993; Ring et al., 1981; also Flanagan et al., 1989). Then et al. point out that FM should be seen as a management discipline that contributes to the overall management of a business by relating accommodation and support infrastructure issues to business, financial and personnel criteria. He points out that the role of facilities manager is strategic and demands specific knowledge and skills (Then et al., 1992). Still, while the role of facilities manager is defined in the literature as a role in real estate organizations of traditional corporations, there is no solid idea how TLCM should be seen in general.

Therefore, the following section examines in more detail how stakeholders in the real estate business perceive the performance of technical life cycle management in practice.

4.3 Design and implementation of strategies in the real estate business

Ratcliffe points out that "even if strategic planning is considered very important in the real estate sector it is not often very well organized in common practice," and adds that "even if the property industry is constantly cited as being one of, if not the, largest business activity in any economy, yet its record of foresight is poor. All too often property markets are caught out by unforeseen events or the unforeseen consequences of planned events." He believes that the real estate sector should have better methods of appraisal, analysis, prediction and planning in order to improve decision-making in real estate investment, development, management, marketing and valuation (Ratcliffe, 2000, IA, p. 14).

There are several explanations for this lack of strategy and long-term planning. Many companies do not generally conceive of the real estate business as their core business. According to Brown (Brown et al., 1993, pp. 2 and 6-7), many corporations ignore real estate asset management, with the attitude that "we are not in the real estate business." Also, there is general ignorance about the corporate real estate business as well as about how intelligent management of corporate real property inventory can have a positive impact on the (core) business.

Also, Manning (Manning et al. 1997, IA, p. 1) notes that "25% or more of corporate assets are in real property and occupancy costs of corporate space represented 40%-50% of their net operating income, yet many companies still claim that they are not in the real estate business. Such statements are true from a very narrow perspective and from a larger perspective such thinking is naive and dangerous – this because the success of all large business today, admitted or not, depends upon how well they manage their human resources, capital, information systems and investment in fixed assets."

Loch points out that "nowadays anything that is non-core for the companies has been marginalized, or outsourced, or both – somehow non-core has come to mean non-strategic, non-relevant and non-important." He wonders "how many facilities professionals for example can even quote the corporate mission statement or can outline their organization's three-or-five-year goals. Or are intimate with this year's business plan." Loch argues that in order to understand the importance and benefits of the strategic planning of FM, facilities

professionals first need to get strategic themselves. They should first become aware of their own goals see the possibilities and changing needs of their customers (Loch, 2000, IA, pp. 1-2). Smith also emphasizes the importance of strategic needs analysis related to the strategic planning and decision-making of clients, real estate owners and/or users, and notes that identifying these strategic needs is a significant stage in the development process (Smith, 2000, p. 1.; see this thesis, 4.2.3). And Manning points out the importance of strategic thinking both in real estate owner organizations and in service provider organizations (Manning et al., 1997, p. 9; see this thesis, 4.2.3).

As organizations increase their investment in capital equipment, the effectiveness of the maintenance function has become a major management issue. “Typically, the maintenance function is perceived to be confined to the tactical role of maintaining, servicing and fixing facilities already in place. With such a perception, maintenance is often regarded as an expense account, a popular target for cost reduction programmes” (Tsang, 1998, IA, p. 1). According to Tsang, the maintenance of assets is a strategic question. When writing about strategic maintenance, he says that “considering maintenance a purely tactical matter is myopic. It also has a strategic dimension covering issues such as design of facilities and their maintenance programmes, upgrading the knowledge and skills of the workforce, and deployment of tools and manpower to perform maintenance work. These decisions have lasting effects on the future operation and maintenance (O&M) of physical assets” (Tsang, 1998, IA, p. 1). With this broadened view, according to him, strategic issues relating to the acquisition, improvement, replacement and disposal of physical assets will fall into the domain of maintenance. Obviously, the scope of this enlarged view also includes proactive tasks, such as routine servicing and periodic inspection, preventive replacement, and condition-monitoring. There are four steps in the strategic maintenance performance process, according to Tsang (Tsang, 1998, IA, pp. 3-5):

1. Strategy formulating,
2. Operationalising the strategy,
3. Developing action plans to achieve the strategic objectives and
4. Periodic review of performance and strategy.

It is a common practice to have disconnected processes for strategic planning and for operational budgeting (Kaplan and Norton, 1996, in Tsang 1998). This way, however, resources allocated through the annual budgeting process may not be adequate to deliver the short-term expectations of the strategic objectives (Tsang, 1998, IA, pp. 3-5).

Ratcliffe (2000) and also Flanagan et al. (1989) write about the importance of scenarios. Related to strategic real estate planning he points out the importance of scenarios about life cycle costing and forecasts of using of building, periods of occupancy, needs connected to use, forecasts about maintenance, etc. The risk analysis of critical structures, indoor air quality and needs, interaction of material combinations and other building physical factors have an effect on life cycle costs, user satisfaction and salvage and residual values of the building and should be taken account in scenarios. According to Flanagan et al. (1989), a constant criticism of life cycle costing is that it uses assumptions and forecasts which are no more than best guesses. However, even though forecasting does not guarantee you will make the correct decisions, Flanagan believes that it is better if you are almost correct, rather than precisely wrong.

Life cycle cost estimations are related to budgeting and financial planning. The common problem is “one-year budgeting,” as Horner explains: ”Current building maintenance strategies, whether based on planned or unplanned maintenance, are most likely to be budget driven. This means that maintenance is not carried out according to actual need, but is dictated by financial priorities decided at the time or during the previous 12 months. Although

theoretically the budget should be built up as a result of estimated needs" (Horner et al., 1997, IA, p. 4).

In his article "Asset and maintenance management – becoming a boardroom issue," Spires (1996) points out that assets are, more often than not, expensive: they are operated by expensive and highly-skilled people, replacement parts are often costly and assets represent a much larger cost through lost production, output, customer credibility, etc. when they are out of action. Therefore, managing the asset life-cycle, from acquisition through maintained life, to disposal, is key. Spires continues (Spires, 1996, IA, p.1): "Often considered a poor relation to other areas of business, asset and maintenance management has not, until recently, enjoyed the investment and understanding allotted to other areas within a business such as production or finance. Subsequently, managers have worked on limited budgets and with practices that were established as a matter of tradition. It was almost a question of 'Do what you have to do at minimum cost' rather than 'If we invest more the return will be greatly increased.' Furthermore, it is more than a survival tool, it is a competitive weapon. The cost and efficiency savings that can result from a strategic review can be considerable." He argues that there should be two levels of asset and maintenance management: first the strategic level, where high-level corporate objectives and business plans are inputs to the asset management process; and then the operational level, where the actual methodology on the ground is managed - how much maintenance, by whom, at what cost, etc. Of course, both these areas are influenced by other corporate functions - finance, human resources, production, etc. At the strategic level, broad corporate or company objectives feed business plans, which in turn feed actual operational plans and objectives.

It is often true that the information gathered by these systems at the operational level is in fact strategic--improved asset availability, life-cycle costs, resource management, inventory control, trend analysis, planning, etc. It is also true that the adoption of new and improved practices such as reliability centred maintenance (RCM) or total productive maintenance (TPM) can show such remarkable benefits that they too are regarded as strategic (Spires, 1996).

According to Bon (Bon, 1989 in Toure, 1999, p. 8), there would be many good reasons to pay more attention to maintaining real property. He points out that real property is commonly not maintained at an adequate level. Too often, real estate departments are perceived as cost-producing units more than "productive service" units. In addition, too often if there are needs related to premises, new construction is planned and implemented instead of developing an existing building. Investment decisions are considered the only decisions requiring intelligence. The lack of defined goals and objectives and the lack of adequate communication between corporate management and real estate management units is a real problem.

The real estate owner should also be aware of the possibilities of strategically planning the management of a building's technical life cycle. According to Benda (Benda et al. 2000, p. 697), the asset value of a building, the measure of its worth in financial terms, is related to how the building is designed, constructed, operated and maintained. Technical life cycle management has an effect on both users and owners of real estates. For users, it is possible to offer a healthy, safe, flexible work environment that strongly supports the primary objectives of the organization, while for owners it has in the long term a clear effect on net profit. Benda continues: "An owner typically creates a 'brittle building' by selecting features with the lowest first cost for construction or renovation. These selections are often based on the advice of the building professionals the owner has hired. By ignoring impacts caused by the poor quality of the environment, lack of flexibility for future use and occupancy, and the life cycle costs of equipment and materials, the owner chooses the path of limiting or reducing the asset value of the building in which they invest. A brittle building is created. By understanding the

resilient building equation, the owner can make more rational choices, resulting in a building characterized by its ability to adapt to changing tenant needs, few complaints, low maintenance and energy costs and high tenant retention. All these factors contribute to a building that can be appraised at its highest value at the time of sale, which reflects its true asset value." As Flanagan says, "Buildings are durable assets, they wear out, they become obsolete for a variety reasons, but the buildings and the sites have residual and salvage values" (Flanagan et al. 1989, p. 7). This value should be taken into account when choosing designers and designing methods, as well as maintenance programs.

In a study of the refurbishment cycle of real estates, Wong points out that "conventional valuation techniques tend to ignore refurbishment or re-development. In the absence of a close comparison, a property is often valued by its Years Purchase in perpetuity, even though everyone knows that the building could not possibly last forever" (Wong, 2000, IA, p. 1). He says that "investors are now questioning the use of this conventional approach to buildings, which have an average life of 15 or 20 years at most, before major refurbishment is needed" (Wong, 2000, IA, p. 1). He also points out that the traditional valuation approach fails to take into account the economic context of the investment, and thus allows risk and depreciation in their initial yield analysis. By contrast, he focuses on an alternative theoretical perspective, considering depreciation as a repeated cycle whose duration can be determined by an optimization of property value (Wong, 2000, IA, p. 3).

There is a need to facilitate technical life cycle decision-making. Caccavelli et al. have studied decision-making related to the upgrading of buildings, focusing on the question of whether to renovate or not. They are developing a computer-based program addressing the multi-disciplinary and multi-professional problems associated with the retrofitting of office buildings. Their aim is to develop a tool for experts to assist with two tasks: 1) evaluating the general state of office buildings with respect to deterioration, functional obsolecence, energy consumption and indoor environment quality; 2) defining retrofitting actions and their costs to improve an office building's condition and energy performance. The method starts at the beginning of a refurbishment process and ends with a decision about the refurbishment strategy (Caccavelli et al., 2000a, b).

Design and implementation of strategies in practice

Charakhavarthy et al., and also Christopher et al. pointed out that all organizational levels should participate in strategic planning, as they are responsible for different strategies. Therefore, it is important that the whole strategy process is interactive, involving all levels of the organization (Chakhavarthy et al., 1991; Christopher et. al. 1987). In real estate owner organizations, quite often, it is not a common practice to define the strategic business goals clearly enough (Loch, 2000; Smith, 2000). In addition, there are problems in communicating across levels, and the necessary information systems and practices, as well as technical information, are not readily available in all decision-making situations (Bon, 1989; Loch, 2000; Smith, 2000; Ratcliffe 2000). Some scientists also point out the lack of goal setting and/or information (Loch, 2000) – real estate organizations are not aware of their own strategic goals (Loch, 2000; Smith, 2000). In addition there is a lack of understanding of the changing needs of customers (Loch, 2000).

In addition, despite the strategic role of technical management, there is a conceived lack of strategic thinking about the asset value related to design, maintenance management, purchasing activities (Tsang et al., 1998; Spires, 1996; Smith, 2000; Brown et al., 1993) as well as cost effective and strategic CRE and/or Asset Management (Manning et al., 1997; Brown et al., 1993). Maintenance does not often have a strategic role in the real estate business, although it very much should have a strategic dimension covering issues such as design of facilities and their maintenance programmes, upgrading the knowledge and skills of

the workforce, and deployment of tools and manpower to perform maintenance work. These decisions have long lasting effects on the future operation and maintenance of physical assets (Tsang, 1998). Also, when companies do not generally conceive of the real estate business as their core business (in traditional corporations), the intelligent management of corporate real property would have a positive impact on the (core) business (Brown et al., 1993). Wong points out that traditional technical valuation is not a relevant or accurate way of considering the technical value of a real estate (Wong, 2000). Moreover, maintenance management is too often budget, rather than need, driven (Horner et al., 1997). According to Tsang et al. (1998) and Bon (1998) there is a lack of strategic maintenance programming. Annual budgeting is not cost effective; there is a disconnection between strategic asset management and budgeting (Tsang et al., 1998; Horner et al., 1997). Flanagan et al. (1989) also emphasize the importance of cost considerations, not only the initial costs but also total life cycle costing. According to him is also a lack of long-term life cycle costing (LCC) considerations.

Future planning and decision making is not performed adequately in many real estate owner companies (Ratcliffe, 2000; Manning et al., 1997). There are no tools or methods for improving future decision-making (Ratcliffe, 2000). In general there is a lack of long term planning (Manning et al., 1997). Business plans should be better connected to maintenance strategies (Smith, 2000; Tsang et al., 1998).

Having now examined the available literature in the field, we can now proceed to answering the first research question according to this information.

4.4 Answer to the first research question

The main objective of this literature review was to study the theoretical backgrounds of the research problem and answer the first research question: What is the status of Technical Life Cycle Management (TLCM) processes in the real estate business? We are studying Technical Life Cycle Management as a domain of actions related to setting goals, making decisions and planning and implementing actions directed at a real estate from the investment analysis phase to a demolition decision, affecting the physical characteristics of a building which are important from the perspective of cost effective ownership (See chapter 1). The aim was to find out what are the underlying theories, key concepts, methods and tools in the real estate sector and if there are appropriate theories for technical life cycle management. We also studied practices of TLCM and how the stakeholders perceived the performance of TLCM.

According to this literature review, the real estate business is very interdisciplinary, including managerial, functional and phase-specific management aspects. Different kinds of institutions are involved in the business in different life cycle phases of a real estate and property types vary according to use. In the real estate business there are various interdisciplinary aspects that must be taken into account in strategic, tactical and operative managing of real estates, like economics, law, regional planning, engineering and architecture (Schulte, 2000b; Halder, 1999; Also anon., 2001a). Different scientists have developed theories for different management sectors of real estate business. For example, Schulte focuses on real estate economics (Schulte 2000b), Gilbert emphasizes the importance of the strategic management of a real estate company (Gilbert, 2001) and Lopes presents a few management concepts and tools that are adapted and developed for the real estate business, such as the Boston matrix, Dupont tree and balanced scorecard. He also defines a “meta model” for organizing the features used in the CREM process. Pierchke, Halder, Then et al. and Nutt et al., have studied Facilities Management activities (Schulte 2000a, Schulte 2000b; Halder, 1999; Then et al., 1992; Nutt et al., 1992), Lundström (1999), Blumberg (1998) and, Barrett et al. have studied and developed practices in making decisions related to outsourcing services. Zavadskas et al. (1998) and Horner et al. (1997) developed theories for strategic maintenance of buildings and

Jaffe et al. (1986) emphasized the importance of the role of PM. Sarja (1999b, 2000) and Lehtinen (1999, 2000) have developed theories for multiattribute decision methods and objective setting related to the technical characteristics of buildings in new construction projects. In terms of new construction projects, there have been efforts to develop efficient objective setting, decision making and implementation of decisions in practice, such as those described in domain of TLCM, partly from the perspective of cost effective ownership and satisfactory usage. However, as Benda points out, even if "the asset value of a building, the measure of its worth in financial terms, is related to how the building is designed, constructed, operated and maintained, an owner typically creates a 'brittle building' by selecting features with the lowest first cost for construction or renovation" (Benda et al., 2000). In life cycle management and maintenance management, the practices developed for new construction projects have not been applied, and consequently there are plenty of gaps in life cycle management practices (Smith, 2000; Brown et al., 1993; Tsang, 1998; Ratcliffe, 2000; Horner et al., 1997).

The real estate business concerns the ownership and usage of buildings. This literature review demonstrates that technical issues, technical objective setting, decisions related to real capital, investment, usage, selling and demolition, and maintenance are part of the core business of real estate companies and are also very important issues for those who own real estate for different purposes (Jaffe et al., 1986; Lopes, 1996; Lundström, 1999; Bon, 1999; Schulte, 2000b; Balck, 2000; Brown et al., 1993; Then et al., 1992). Investors, who put money into real estates based on careful analysis with the expectation of realizing income or profit over an extended period; speculators, who sell and buy properties with the expectations of realizing quick profits due to changes in price and developers, who improve and prepare land for use ususally by construction of a building, as well as traditional corporations, real estate lenders and real estate equity funds, all have different expectations related to the real estates according to their core business (Ring et al., 1981; Flanagan et al., 1989; Brown et al., 1993). Technical questions are also relevant in terms of the economics of real estate management: in strategic planning, maintenance and other life cycle costs and expected income are measured, enabling one to evaluate the cost-effectiveness of real estate ownership (Aho, 1993; Flanagan et al., 1989; Zavadskas et al., 1998). Since the life cycle of a real estate starts in land acquisition and investment analysis of a new construction and ends in demolition of the building, life cycle costing should take into account both initial costs and total life cycle costs (Halder, 1999; Flanagan et al., 1989). Furthermore, in future planning, it is important to consider technical characteristics and the technical value of buildings (Jaffe et al., 1986; Greer et al., 1988; Benda et al., 2000; Aho 1993, Ratclif, 1961.) In addition, the technical characteristics of a building are important for usage and should be taken into account from the perspective of user satisfaction. In addition, usage also sometimes affects the technical performance and durability of the building itself (Bottom et al., 1998; Benda et al., 2000; McGregor et al., 2000; Lehtinen et al., 2000, 2001). Since owners and users have different kinds of expectations related to buildings and the total life cycle of a building includes different kinds of phases, the strategy should be continually updated regarding technical strategies. Therefore strategic technical life cycle management (TLCM) is important.

The importance of all strategic, tactical and operative management aspects are pointed out by many authors in the literature related to the real estate business (Then et al., 1992, Brown et al., 1993; Loch, 2000; Smith, 2000; Tsang, 1998; Ratcliffe, 2000, Horner et al., 1997). The responsibility for those different management levels is usually decentralized in real estate owner organizations and the performance of management is often not considered satisfactory (Brown et al., 1993; Loch, 2000; Smith, 2000; Tsang, 1998; Ratcliffe, 2000; Bon 1989; Benda et al., 2000; Manning et al., 1997). As noticed, many scientists have developed different parts of the multidisciplinary real estate business and many have also pointed out the need to

further develop and improve practices of real estate business. *In short, at present there are gaps in the available theories and practices supporting overall business management, particularly with regards to connecting technical issues to overall management* (Ratcliffe, 2000; Horner et al., 1997; Manning et al., 1997; Tsang, 1998; Loch, 2000). However, there are theories and practices in the real estate business which could be used and adapted to develop the technical management of real estates (Flanagan et al., 1989; Then et al., 1992; Lehtinen et al., 2001; Sarja et al., 1999b; Sarja, 2000; anon., 2001b; Smith, 2000; Zavadskas et al., 1998; Horner et al., 1997; Jaffe et al., 1996; Hintikka, 1999; Ratclif, 1961; Lundström, 1999). Importantly, connecting technical issues more effectively to overall business management could provide added value for the real estate business as a whole (Flanagan et al., 1989; Ratcliffe 2000).

Technical life cycle management (TLCM) issues are related to all strategic management fields in the real estate sector. *Nevertheless, to answer the first research question, there is no solid foundation of appropriate theories, key concepts and methods or tools for TLCM.* Ratcliffe points out that strategic planning is considered very important in the real estate sector and yet is seldom organized well in common practice. He believes that the real estate sector should have better methods of appraisal, analysis, prediction and planning in order to improve decision-making in real estate investment, development, management, marketing and valuation (Ratcliffe, 2000).

Therefore, there *is* a need for improving the management of TLCM-related issues in real estate owner companies (see figure 4.20: Smith, 2000; Brown et al., 1993; Tsang, 1998; Spires, 1996; Bon, 1989; Flanagan et al., 1989). To further develop the answer to the first research question, we have demonstrated that issues related to TLCM are considered important from the perspective of cost-effective management of real estates and from the perspective of the satisfactory use and usage of buildings (Loch, 2000; Smith, 2000). *Even though the TLCM -related issues are considered important* (Lundström, 1999; Nutt et al., 1992; Trivers, 1999b; Smith, 2000; Then et al., 1992, Sarja, 2000, Horner, et al., 1997, Zavadskas et al., 1998), *however, their management is not perceived as satisfactory by the stakeholders* (Smith, 2000; Brown et al., 1993; Tsang, 1998; Spires, 1996; Bon, 1989; Flanagan et al., 1989). Because the real estate owners differ from each other, not only in expectations related to owned premises, but also in sizes and structures of their organizations, there are no general clearly defined roles and described ways of acting in managing technical life cycles of real estates (Flanagan et al., 1989; Brown et al., 1993). There is a lack of strategic planning in the real estate business (Smith, 2000; Brown, 2000; Loch, 2000). Furthermore, technical issues are often not connected to the overall strategic business planning of real estates (Tsang, 1998; Ratcliffe, 2000). Moreover, there is a lack of strategic planning and managing of issues related to real capital and its maintenance (Tsang, 1998; Spires, 1996; Horner et al., 1997). There are plenty of reasons for these lacks, including the perceived importance of real estate management issues in owners` organizations (Brown et al., 1993; Manning et al., 1997; Loch, 2000), or budgeting practices that do not support long term planning (Horner et al., 1997; Tsang, 2000; Flanagan et al., 1989; Ratcliffe, 2000). Maintenance is often not considered a strategic value generating business area that needs to be objective driven but more as a cost that is managed by annual budgeting not leading to real long term planning (Spires, 1996). In addition quite often the party responsible for objective setting is not the same person as the decision maker, the person responsible for budgeting and cash flows, or the person responsible for operative managing of properties. Information exchange between the different managing levels should be improved (Bon, 1989; Loch, 2000; Smith, 2000). In short, practices related to the TLCM domain should be improved.

Figure 4.20 presents the gaps in strategic business planning and/or managing of real estate business.

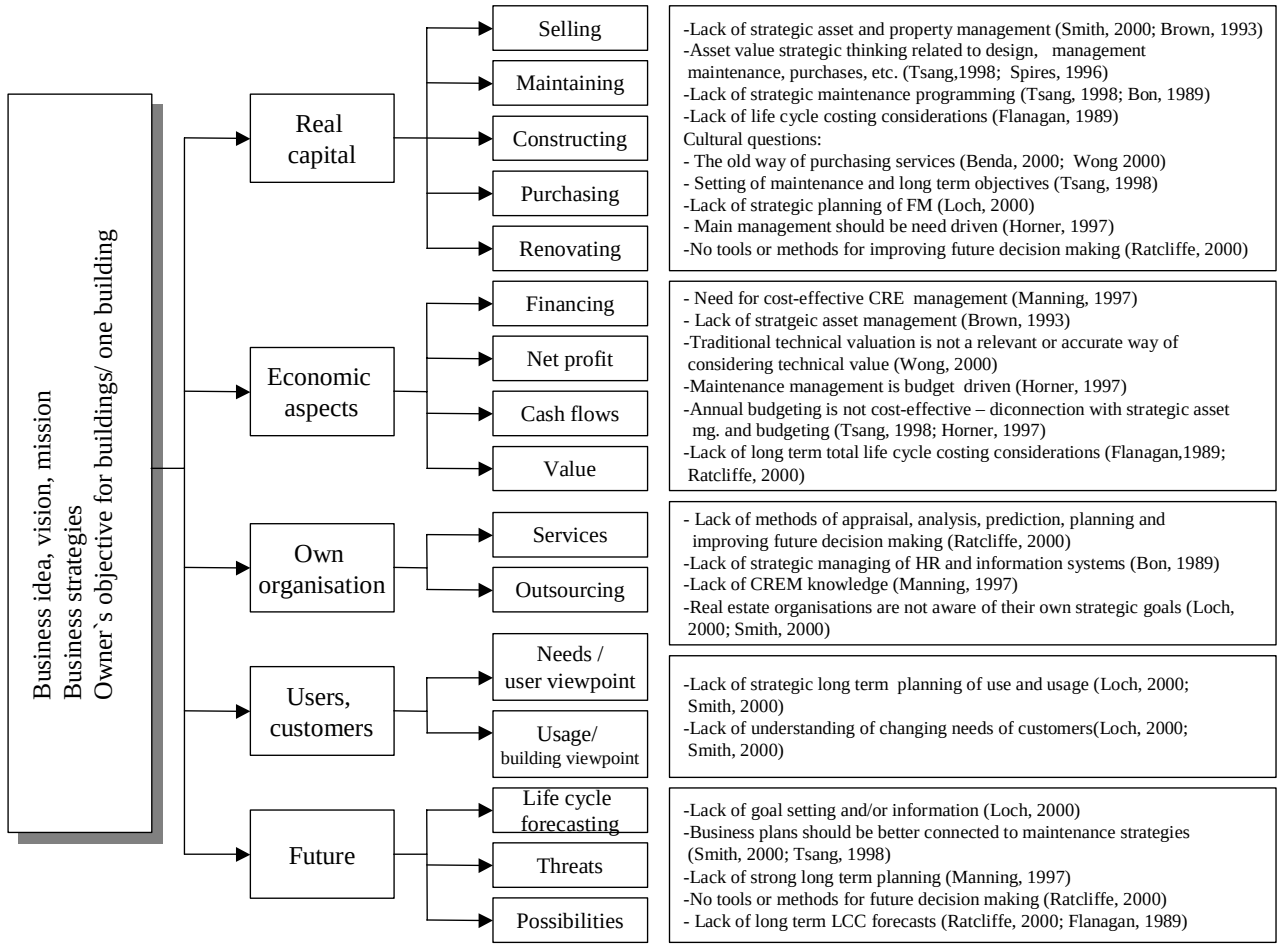

Figure 4.20 The strategic business areas of a real estate owner organization and shortcomings in their strategic planning.

Technical issues are related to all management aspects in the real estate business. They are also related to the core business of traditional corporations in terms of user satisfaction, usability of the buildings and cost effective ownership. Therefore, they should be considered from different perspectives of the businesses. On one hand, Technical Life Cycle Management should be seen as a totality itself, as an engineering discipline that contributes to overall business management and as a chain from technical objective setting to implementing the action plan. On the other hand, TLCM should also be seen as part of the overall business management of real estate owner companies. Even though all the issues related to our domain of Technical Life Cycle Management (TLCM) were considered by one or more authors, TLCM was not described as a solid management discipline. It was not defined as a business management concept or considered as a totality. The management of technical issues in the real estate business was partly the responsibility of strategic, tactical or operative managers in real estate owner organizations and at the same time there was a lack in information exchange between those organization levels. Strategic TLCM was not defined in general. Since there was a lack of a solid definition of technical life cycle management we ended up defining TLCM as a new concept.

The concept of TLCM refers to the management field in which the technical objective setting, technical decision making and technical implementation of decisions are connected to managing of the overall strategic, tactical and operative real estate business (Then et al., 1992;

Smith, 2000; Brown et al., 1993; Tsang, 1998; Spires, 1996; Bon, 1989; Ratcliffe, 2000). Figure 4.21 shows the elements of the real estate business and location of TLCM in it. The elements are collected from the literature review in which they were discussed by different authors. In figure 4.21 TLCM is related to the *core business* of real estate owners: it is part of the business strategies, one part of strategic overall real estate strategic planning (Jaffe et al., 1986; Lopes, 1996; Lundström, 1999; Bon, 1999; Schulte 2000b; Then et al., 1992; Smith 2000; Nutt, 1992). As Then et al. (1992) point out, investment analyses, real estate decisions, strategic premises planning (and IT strategies) are one part of the *strategic real estate business*. Ratcliffe (2000) points out the importance of *future planning* related to investments, development, management and marketing of real premises and value setting and managing is discussed widely by multiple authors, also related to technical value of the building (Benda et al., 2000; Aho, 1993). It is also related to *users of real estates and the needs of users* (customers of the real estate owner company, in figure 4.21) since the technical characteristics of a property affect usage and the usability of buildings (Bottom, et al., 1998; Trivers, 1999b; Benda et al., 2000; McGregor et al., 2000; Loch, 2000; Smith, 2000). Furthermore, it is related to decisions in a real estate company about insourcing and outsourcing facilities management or property management services (*personnel*, FM/PM and out- or insourcing of services in figure 4.21) (Lundström, 1999, 1999b; Barrett et al., 1992b; Routto, 2000; Manning et al., 1997). *Life cycle costing considerations*, taking into account initial costs in investment, are quite significant, and should be reflected against the setting of technical objectives, making decisions and implementing actions during the life cycle of a building (Flanagan et al., 1989; Aho, 1993; anon., 2001a; Schulte, 2000b).

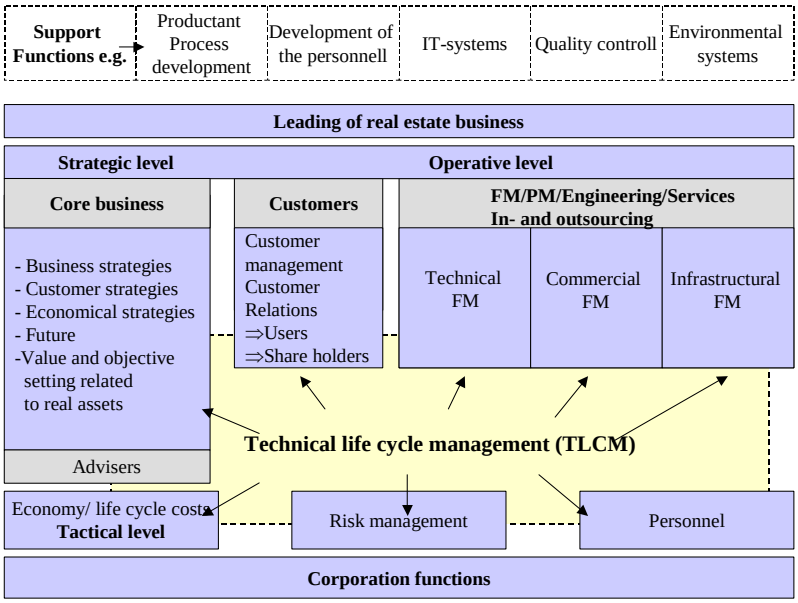

Figure 4.21 Location of TLCM in the real estate business. The elements of the figure are collected from the literature as presented above.

According to this concept of TLCM, technical objective setting, decision making and implementing of decisions are considered in terms of the overall strategic management in the real estate business. Since technical performance and technical characteristics of buildings affect 1) life cycle costing and budgeting considerations in the real estate business, 2) the cost-effectiveness of ownership, 3) future planning, taking into account risks and the potential of buildings to fulfill their owner's objectives for it, 4) user satisfaction and usage, 5)

maintenance and its possibilities, taking into account the structure of the owner organization and possibilities for outsourcing, we attempted to take all management issues and aspects into account. Our aim is to efficiently and cost-effectively connect management of the total technical life cycle of a real estate, from the investment analysis phase to a demolition decision, to overall business management.

Given this aim, we needed to develop TLCM processes and define how TLCM could be managed more efficiently. If a model, tool or method was available for facilitating technical life cycle management and connecting technical objective setting and decision-making more tightly to the overall business planning of real estates, it would need the following initial factors to succeed:

1) The method should facilitate the strategic planning of technical life cycle strategies as a part of overall business strategies and implementing of the technical strategies in practice (Tsang, 1989; Spires, 1996; Bon, 1989; Brown et al., 1993; Smith, 2000).

2) The method should include the technical perspective of life cycle costing and facilitate costing considerations (Flanagan et al., 1989; Ratcliffe, 2000; Tsang, 1989; Horner et al., 1997).

3) The method should facilitate purchasing activities related to technical services (Tsang, 1998; Spires, 1996; Benda et al., 2000; Wong, 2000).

4) It should take into account the changing needs of the building's users as well as the owner's business needs (Loch, 2000; Smith 2000).

5) The method should help to predict, plan and implement future decision-making (Ratcliffe, 2000; Manning, 1997; Tsang 1998).

6) The method should facilitate goal setting and decision making related to the technical objectives of a real estate and also facilitate information systems in real estate organizations, so that all levels of the organization can be easily informed about the strategic goals (Smith, 2000; Loch, 2000, Tsang, 1998; Bon, 1989).

7) The method should make it possible to connect business plans more efficiently to maintenance strategies and their development (Horner et al., 1997; Tsang, 1998; Loch, 2000).

5 Interview studies – a practical view of the subject

Chapter 5 presents two interview studies of technical life cycle management, carried out in Finland in 1999-2001. Based on the literature review, these interviews gathered practical information on the purchase and provision of technical life cycle services, as well as more general opinions on technical issues in the real estate sector in Finland. In the first interview study, Finnish real estate owners and users as well as other leaders in the real estate sector were interviewed, while the second interview study focused on technical experts.

5.1 Interview study 1

The first interview study included a total of 28 real estate managers (18) or other leaders (10) in the real estate sector. Its aims were three-fold: to examine the status of technical life cycle management in the real estate business; to further develop our research questions; and to clarify how Finnish real-estate companies or the real estate departments of traditional corporations manage the following strategic business areas (see table 4.20 in Chapter 4) :

1) Strategic business planning:

- How are these companies organized, what critical know-how do they need in their own organizations?

2) The status of technical life cycle management, including decision-making related to real capital;

3) How they value and set objectives for TLCM, including issues related to real capital, users and economics:

- How do they define their needs for buying technical life cycle and technical life cycle management services for their real estates?
- How and from whom do they buy technical life cycle services and how should they be bought? How do they manage the technical life cycles of their real estates?

4) Future planning:

- How do they see the future of the real estate industry?

5.1.1 Research method

This was a hermeneutic, semi-structured, qualitative interview, where the questions were prepared ahead of time. The same questions were asked in every real estate manager interview and discussed in interviews with other leaders in the real estate sector. The answers were written down. The write-ups were sent to the interviewees (real estate manager interviews) for checking, and only after that were they classified and the results interpreted. Because the focus of this study was on technical life cycle management, the questions mainly focused on technical life cycle management issues.

The first interview included the following questions *(Table 4.20)*:

I How do they set values for their own (real estate) business *(Vision)*?

- General values?
- Vision of the business?
- What is the most important factor in their real estate business?

II How is their real estate business organized *(Own organization)*?

- Strengths, weaknesses of the organization?

- The most important areas of competence which are being developed?

III How are technical life cycle services provided *(Real capital and economic aspects)*?

- Are they internally provided or outsourced? Who makes the calls for tender, evaluates them and chooses the service provider?
- What kinds of services and service packages do they purchase/would like to purchase?
- How is the quality of services measured or defined?
- What kinds of contracts are made between service providers and real estate owners?
- What is the status of technical life cycle management in the real estate business?

IV Real estate and/or customer strategy - does it exist? *(Real capital and users)*?

V. How is the real estate business going to change in the future *(Future)*?

Each interview lasted 1-3 hours.

Table A1.1 in appendix 1 presents the interviewed persons and the dates of the interviews.

5.1.2 Results

I General values, needs, vision, mission, procedures of the real estate business:

The most important aim of traditional real estate companies was to earn as much profit as possible, or at least to optimize profit, which was usually achieved by decreasing expenses. Usually, according to the real estate managers, they tried to find an optimal rate of return. In traditional corporations the aim of the business more clearly targeted users. In these companies the core business was said to be something other than real estate. In traditional real estate companies there were two customers: the owner/shareholder and the user.

The quality of expert services was said to be the most important criteria when choosing service providers, although at the same time it was considered impossible to measure quality. Some of the interviewees said that they would pay for quality and know-how, were they available. At the same time they admitted that they do not have the tools to evaluate expert services.

Almost everyone said that the real estate business in Finland is “slightly confusing” today. Many organizations are trying to find an optimal organizational structure and to define their visions, values and core competences.

Customer satisfaction or user satisfaction were considered to be the most important business values, yet factors connected to the needs of customers were not clarified. Customer satisfaction was regularly measured in some companies, while others assumed that customer complaints could be considered feedback. Even if customer satisfaction was the most important business factor in real estate companies, the cost-effectiveness one’s business should be in proportion to the requirements of customers. Owner-occupied real estate owners (traditional corporations) concentrated more on user satisfaction than real estate companies.

II Real estate organizations

Generally, the person who buys technical life cycle services is either a Real Estate Manager or a Property Manager. They are typically Civil Engineers or sometimes have a lower technical or commercial education. Sometimes they are HVAC engineers or builders, while in some companies real estate managers have an academic degree.

Real estate management organizations are often thin, with just one real estate director and then real estate managers each responsible for a few real estates. They are not sure if their organization is functioning well enough, and are mainly concerned about how to develop their purchasing competence.

The most important strategic business areas in the real estate business are managed internally, though FM/PM services were usually outsourced. Lower-level (FM) services should be seen as an automated function; these services are easy to buy and easy to evaluate. Technical life cycle management services were considered so complex that these services were usually bought from some specialist consultant. Most of the managers wanted to purchase the difficult tasks themselves, in order to ensure that the condition and value of the real estate would be maintained.

The need for technical life cycle services appeared either when some acute problem occurred or was based on long-term planning. Acute problems, especially when connected to mold and moisture problems, were often considered the most difficult to solve. In these cases it was quite common to fall into a situation where it was very unclear who was responsible for resolving it: the user, owner or the insurance company.

There was a great deal of variation between real estate owner organizations. The organizational structures and the workers' level of education varied. Some managers said it should be possible to organize in a new way, but it is not. Sometimes the educational level of workers was considered too low.

III Buying technical life cycle services: service packages, setting objectives, choosing service providers

The status of TLCM in the real estate business

Some of the managers said that it is safer to use a bigger service provider who can provide all the necessary services. Still, most of the managers wanted personally to purchase the services targeting complex problems. Ideally, managers wanted buy all their technical knowledge from the same service provider, though in fact there did not seem to be a clear protocol for buying technical services. Usually they were individually bought from different service providers who were considered either competent or cheap.

Many of the managers wanted to create partnership relations with a few service providers in different areas of technical facilities management and technical life cycle services. For the moment, the technical life cycle is considered the responsibility of the internal organization.

Technical life cycle services are related to the property itself. The general opinion was that it should be possible to buy different kinds of technical life cycle service packages. The services most often needed should be included in basic service packages, and the service providers should have custom-made final service combinations, according to the customer's needs.

Purchasing of technical services was considered difficult. There were no tools or means for purchasing such services. Generally it was considered that technical tasks should be managed by the organization itself, though they often lacked the knowledge or know-how for doing so.

How the quality of technical life cycle services is measured or defined.

Quality is very difficult to measure. Firstly, it is difficult to define and secondly, it is difficult to determine the required quality level case by case, as this level should be adjusted to comply with the vision for the real estate.

There are no criteria for evaluating the competence or the quality of the services of technical life cycle service providers. Services are typically intangible and knowledge-intensive, and the real estate manager is rarely a specialist in sometimes theoretically difficult technical

questions. It is possible to require that individual tasks be performed according to some quality system or standard, but even in this case it is impossible to evaluate competence in handling technical questions. Usually the "quality" of services is measured afterwards: if business with a service provider goes well, the provider is able to take assignments immediately and the prices of services are reasonable, it is easier to use the same provider again. Service providers should be able to offer services at the proper level and which correspond to the owner's objectives.

According to the interviews, in practice some of the important service provider qualities or factors leading to contracts include price, quality (which was difficult to evaluate), co-operation experiences and reputation, software used, procedures (quality system, communication), competence, innovativeness (related to R&D activities), products and service descriptions (facilitates purchasing).

Contracts between service providers and real estate owners

FM/PM services are mainly outsourced with long-term contracts to infra-structural facility management service providers or technical FM/PM service providers. In Finland, services are normally not integrated, including commercial, infrastructural and technical FM/PM services, but providers have more or less specialized in one of them. Technical life cycle services are usually purchased separately from different service providers and managed internally.

Real estate managers do not have the tools for evaluating technical life cycle service providers. For example, competence, quality and "the ability to manage complex tasks" were considered very important selection criteria, but evaluating these kinds of properties was considered impossible. Also, for example, "what competence means and who was competent enough for critical tasks" was not defined, nor were there clear definitions of what kinds of competence should be expected and what is the critical know-how of a technical life cycle service provider.

In addition, one of the service providers pointed out that many technical service providers want to offer overly "comprehensive" services. Information on and documentation of technical assessments are too difficult to read and understand, and it is hard to identify the most important issues related to one's own real estate business.

IV Real estate and/or customer strategy - does it exist?

It was not very common to have any clearly defined and/or implemented strategies for real estates or customers. Some of the companies had visions but no clear strategies on how to achieve them. Some had decided to specialize in certain kinds of real estates, certain kinds of customers or businesses but none of the persons interviewed had strategies for the technical life cycle. Technical strategies were mainly one-year budget strategies for maintenance, and were not really long-term. Long-term planning was sometimes used as a base in annual budgeting, but it was usually not connected to overall strategic planning. There was no competence in organizations for defining technical life cycle strategies. There was a cognitive need for strategies, but no means to define them.

Technical life cycle strategies as a part of real estate strategies did not exist for two main reasons:

Firstly, the situation in the real estate business was considered confusing. Organizations are changing and trying to find their optimal organizational structures. They are presently defining their core business, and areas of competence and knowledge which would be important to their business. They are defining their visions and goals. According to the interviews, some companies have the "wrong kinds" of real estates and sometimes the "wrong kind" of personnel. Of supreme importance is coming to terms with the "confusing" situation

in their core business, for when this is done they can create strategies for property development. Traditional corporations are organizing their real estate departments and defining the role of these departments in corporate management.

Real estate companies (insurance companies and property holding companies) and real estate departments of traditional corporations had different opinions on the priority of technical life cycle management. In addition, the type of real estate caused differences in the requirements of these two types of owners. Their opinions about customers differed as well.

For the real estate companies (insurance or property holding companies), the most important task was to improve the ROI. The whole business is based on annual profit and thus the visions and strategies are mainly focused on yearly plans. Technical life cycle strategy was considered important to define, but difficult to do. The managers of the real estate departments of traditional corporations were oriented to solving problems connected to the availability, flexibility or image questions of premises, and they were clearly interested in fulfilling user expectations and needs related to premises. Their main mission was to offer premises for the "business makers" of their company and thus customer/user needs were important to them, as well as needs connected to IAQ and healthy, safe and economical buildings. In some cases, day-to-day needs were more important than the sustainable life cycle process--which was considered important although there were no resources, competence or time available to create a system for doing it. Of all the managers interviewed, only a few actually tried to create technical life cycle concepts, which they considered important for customer satisfaction in the long run.

Outsourcing services but coordinating them within the organization was considered to be the right solution. But how and to whom the different parts of FM and PM services should be outsourced was the unanswered question.

The real estate sector is very interdisciplinary and thus it is difficult to find skilled personnel. Critical know-how for personnel making decisions related to technical questions and purchasing outsourced services is not defined. Better concepts in managing the technical life cycle are needed.

The second reason for the lack of a practical technical life cycle strategy was that service provider companies were themselves changing. Companies were making strategic alliances and buying each other. Their core competence and core business were not quite clear to most customers. According to the interviews, there were no qualified comprehensive service providers or qualified service provider company networks. It was hard to define the quality of technical life cycle services, it was hard to find good quality, and it was very difficult to measure the competence of service providers.

V How will the real estate business change in the future?

Most of the real estate managers interviewed did not have any clear ideas about the future. General opinions related to the future were as follows:

Real estate strategies and total life cycle strategies in particular will be important decision-making tools in the future. Characteristics of the real estate, such as flexibility, healthiness, and economical use, will become more important. Almost all tasks except overall management will be outsourced, probably not just to one or two service providers but to a few. In the future, FM/PM services will be divided in two, with so-called "user services" and "owner services." Owner services will be directed at buildings.
Qualified personnel is going to be hard to come by. Real estate management is the core competence of real estate companies and better purchasing and management skills are needed. Partner relationships are going to be increasingly common.

More attention is going to be paid to expenses. Therefore, in the future, more and more attention will be paid to total life cycle costs. The business is not going to function if returns do not increase. The whole real estate sector should be seen and understood as a totality, taking into account all the factors affecting cost-effectiveness.

5.1.3 Conclusions

I) General values *(Vision)***:**

- The most important aim of the traditional *real estate companies* was to earn as high an income as possible. This was usually achieved by decreasing expenses.
- Customer satisfaction or user satisfaction were considered the most important business value in traditional companies (traditional corporations).

According to the interviews, in most companies creating a technical life cycle strategy was considered a very important part of the long-term planning and maintenance of buildings. However, none of them had a clear procedure or strategy for the sustainable development of real estates.

II) Real estate organizations (own organizations)

There was lots of variation between real estate owner organizations. The organizational structures and the level of the education of workers varied. Some of the managers pointed out that it should be possible to organize in a new way, but it is not. Sometimes the education level was considered too low.

III) Status of technical life cycle services and their purchase *(Real capital and economic aspects)*

There are no tools for evaluating technical life cycle service providers. For example, competence, quality and ”the ability to manage complex tasks” were considered very important selection criteria, but evaluating these kinds of properties was considered impossible. There was not enough know-how within owner organizations to manage difficult technical questions: needed services are hard to evaluate. Also, service providers should be able to offer services that are at the proper level and correspond to the owners’ objectives.

IV) Technical life cycle (TLC) strategies *(Real capital aspect)*

Generally, companies lacked technical life cycle strategies or strategic planning of technical life cycles of real estates, because:

- There was no co culture for strategic TLC planning.
- They lacked adequate skills for the strategic planning of TLC

Technical strategies were outlined when the general business strategies and organizational changes and other systems were defined.

V) Future

- In the future, real estate strategies and total life cycle strategies in particular will be important decision-making tools.
- Characteristics such as flexibility, healthiness, and economical use will become important.
- FM/PM services will be divided into two parts: “user services” and “owner services.” Owner services will be directed at buildings.
- Almost all tasks except overall management will be outsourced, probably not just to one or two service providers but a few.
- Partner relationships are going to be increasingly common.

- Qualified personnel is going to be hard to come by. Real estate management is the core competence of real estate companies and better purchasing and management skills are needed.
- More attention is going to be paid to expenses.
- The business will not function if returns do not increase.
- In the future more and more attention will be paid to total life cycle costs.
- The whole real estate sector should be seen and understood as a totality.

5.2 Interview study 2

The aim of the second interview was to focus more closely on the provision and importance of technical services in the real estate sector. For this study, 13 managers and technical and building physical experts in service provider companies in the capital area of Finland were interviewed. These interviews took place in 1999-2002, with the bulk of them being done in 2000. The interviews were semi-structured, with preprepared questions. The interviewees represented different organizational levels of technical service provider companies. The interviews were done face to face, tape recorded and also notes were taken. The focus of the study was to further define the practical part of research question 1: What is the status of technical life cycle management (TLCM) in real estate owner organizations? What are the practices of TLCM? How is the performance of TLCM perceived by the stakeholders?

The following questions were asked *(Aspects according to table 4.20)*:

Questions related to technical services and the importance of TLCM in the real estate business *(Real capital, also relating to user, organization and economic aspects)*:

1. What is the importance of technical life cycle management in the real estate business?
2. How are technical issues taken into account in the real estate business?
   - Are they adequately taken into account?
   - If not, what should be done?
3. How do real estate owners purchase technical life cycle services for real estates?
   - Do the customers (real estate owners) get what they need?
   - Is there something in the purchasing methods that needs to be developed, and if so, what?

One question related to future decision-making related to TLCM:

4. How is the role of technical life cycle management in the real estate business going to be developed in the future? Why do you think development will be like this?

In addition, a few questions were discussed related to specified case projects, with the aim of focusing on real projects, which were considered easier to discuss and analyze.

Related to some specific case projects, the questions were as follows:

- In this case, what was the customer's (real estate owner's) aim, how was the call for tender made?
- Was the reason for the expressed need discussed?
- Did the customer finally buy what was needed (from the technical perspective /own opinion), and if not, what were the differences between the service package bought and the service package actually needed from the technical perspective?
- Did the customer company have a technical life cycle strategy and was it discussed?
- If they did not have a strategy, do you think they should have had?
- What is your opinion of the importance of technical life cycle strategies?

- What do you think is the customer's opinion of the importance of a technical life cycle strategy?

The interviewees and dates of interviews are presented in table A1.2 in appendix 1. In this report B1, B2...etc. refer to interviewed persons.

5.2.1 Results of interview study 2

The interviewees considered the technical value of a building to be important, and thought it necessary to assess it as part of an investment analysis. Still, based on real life cases, using this information in a cost-effective way was not very common. The interviewees pointed out that they lack adequate means and ways to use this information in practice. They also pointed out that there was also a lack of knowledge or interest related to technical questions in real estate owner organizations. Some interviewers said that "the relationship between technical risks and expected benefits from ownership could be examined more efficiently" (B9, B2) Some of the interviewees wondered if real estate owners actually understood the effects of different technical life cycle decisions on real estates (B5, B11). They also pointed out that it is difficult to estimate life cycle costs, but if cost-effectiveness is a goal, it is necessary (and possible) to define the necessary life cycle actions and evaluate their costs. Technical needs are dependent on the owner's objectives for the building, but these objectives are not adequately defined or communicated with technical service providers or perhaps even within the owner organization itself.

Purchasing of technical services is often not carried out according to actual need but too often according to "what must be done in the current crisis situation" (B5, B9). If it were possible to anticipate problems, real estate owners would not be forced to correct them, and technical life cycle management would be more cost-effective. Technical service providers believed that "goal-oriented technical life cycle management would cut costs and increase the cost-effectiveness of real estate ownership" (B2, B9).

According to the interviews, the situation is frustrating for technical service providers, as they argue that "better results, more cost-effective life cycles and cost reductions could be achieved by using comprehensive long-term technical life cycle planning and management" (B2, B9, B11). Generally, the interviewees believed that the current way of managing technical issues and purchasing technical life cycle services does not serve either real estate owners or service providers, and commented that developing the whole sector will be impossible as long as there are insufficient prerequisites for examining the big picture (B2, B5, B8, B9, B11).

Technical service providers agreed that they were not satisfied with the current ways of purchasing technical services as well as the general meaning of technical life cycle management. Change is needed. Some interviewees explained that the importance of technical life cycle management should be recognized and its role in the real estate business should be defined and developed (B2, B5, B9). In addition, they argued, technical issues should be taken more accurately into account in strategic real estate business, for service providers could focus more on the cost-effectiveness of maintenance programs if they were more aware of the business objectives of the real estate owners (B1). They could use their know-how more effectively. Improvements in co-operation, purchasing activities and goal-setting would help both real estate owners and service providers (B11).

The case-oriented part of the interviews included several kinds of cases, such as: 1) cases where objectives were set and prioritized in such a way that it was possible to clearly take into account in the early stages of structural and building physical design all the important factors related to the necessary technical quality of the building during its lifetime (B8, B11); 2) cases

where a real estate owner invested in a real estate, but after purchase turned to technical professionals with some technical problems. Technical risk assessment revealed some large and costly technical problems in the building, and also significant technical risks related to the building's usability and the durability of its technical parts. In the end, the previous owner was forced to sell the real estate at a much lower price than he planned (B3, B7); 3) one case where unfocused purchasing of different technical services (condition assessments, other measurements and corrective actions) significantly increased the building's life cycle costs. In this case, the real estate was not considered as a totality, but rather each of its multiple problems were solved one at a time. The building's users suffered from a variety of sick-building diseases related to moisture physical problems. Thus, the way technical services were purchased not only affected the building itself, but also its users, and consequently there were also social costs associated with the users' illnesses. Done in co-operation with the National Public Health Institute, this project, "Development of tools for evaluating repairs and their effects in practical situations" (Haverinen et al. 2000), was part of a TEKES-financed research project related to the Healthy Building program (B5, B3, B8).

Interviewees felt that the provision and purchasing of technical life cycle services was illogical and did not lead to cost-effective solutions. There was a lot of potential to develop technical life cycle management. The opinions and comments are based on real life cases or general views of the provision and purchase of technical services in the real estate sector. The cases varied from investment analysis, the preliminary design phases in new construction projects, investment analyses and needs analysis in renovation projects, to condition assessments of buildings with moisture and mold problems. These are the comments of technical professionals, and therefore the technical perspective is emphasized.

The role of TLCM in the future

The interviewees stressed that the technical value of a building is important. They also believed that the importance of total life cycle management, including technical life cycle management with life cycle costing considerations, will increase in the future.

TLCM today – real capital

Purchasing technical services

At present, the most problematic issue in technical life cycle management is that the current way of purchasing technical life cycle services does not lead to cost-effective business. In order to improve the purchasing of technical services, the following issues need to be addressed:

- There is limited knowledge of the effects of different decisions, and it is not adequately discussed (B5).
- The relationship between service providers and real estate owners hinders the flow of information related to primary objectives (B1, B3).
- Managing the physical totality of a building is difficult for anyone, and purchasing and decision-making without clear objectives is impossible. In the current situation, according to the interviewees, the objectives of real estate companies are rarely clear or at least are not adequately discussed in practice (B10).
- Purchasing is too often linked to crisis situations, which has an effect on 1) the cost-effectiveness of property and facilities management; 2) the building's technical quality and performance; and 3) the ability of service providers to provide high quality services
- Purchasing is cost-oriented, based on annual budgeting, and is too often failure-based rather than being based on actual need and long-term planning (B5, B9).
- Although clients like pre-defined service packages, in many cases knowledge-intensive services should be provided on case-by-case needs that can only be defined after

objectives have been set and the real estate has been assessed in terms of these objectives.
- The use of multiple service providers without co-operation or communication between them hinders the flow of information and sometimes multiplies the needs of some actions (B5, B3, B8).

Technical value of the building

The interviewees agreed that technical long-term value was not generally taken into account in the long term, partly because of purchasing practices and partly because of the way budgeting is done. Therefore, the "benefits it would be possible to achieve through technical actions are too often incidental." (B11)

Organizations

Communication

There is inadequate communication of technical information in real estate owner organizations connected to their objectives, e.g. in investment decisions.

> "Decision-making is decentralized in many real estate companies." (B10) =>Personnel are not adequately informed about objectives. Or, the persons with whom technical professionals usually co-operate are not adequately informed about the strategic business objectives. Information systems and information flows related to technical information are inadequate.
> Personnel do not have a comprehensive understanding of technological and economic issues. (B3, B7, B5, B9)

Know-how

Many real estate owner organizations lack adequate understanding and knowledge related to the technical potential of buildings and technical decision-making. They do not have the means, tools, knowledge or procedures for increasing the cost-effectiveness of property/facilities management related to technical issues. In addition there is a lack of motivation to concentrate on technical issues in many companies (B3, B7) and lack of knowledge of the real possibilities of technical life cycle management, possible cost savings etc. (B9, B2). Some of the interviewees wondered if technical issues were perceived as at all important in some companies.

Similarly, many service provider organizations lack know-how, knowledge, understanding and information related to the business or objectives of real estate owner organizations. Service providers do not adequately understand the real estate business (B2, B3, B1) and they should be better at simplifying technical issues, able to provide understandable solutions to complex questions which could be discussed (B11).

Economic and managerial aspects

Budgeting principles

The budgeting criteria related to technical solutions do not lead to cost-effective business: Too often there is no real long-term technical planning, and purchasing of technical services is based on crisis situations (B2, B9). If there is long-term technical planning, it is budget driven and based on annual budgets rather than based on getting long-term benefits (B5, B3, B8).

The setting of business goals and objectives

The setting of business goals and objectives in connection with technical objectives is not adequate in the real estate business, or at least the subject was not adequately communicated between real estate owners and technical service providers. There is a lack of objective-setting

or long-term planning, an inability to prioritize technical characteristics and difficulties linking technical requirements and future planning (B5, B3, B8, B7).

According to those interviewed, standard practices in the provision and purchasing of technical services do not lead to cost-effective technical decisions. One area which could be developed is the critieria for choosing services, as too often decisions are based on price: “Price-based purchasing is easier than competence-based purchasing if evaluating competence is not possible.” These professionals pointed out that price competition was the only way to choose service providers, partly because: 1) real estate owner organizations were unable to set and prioritize objectives related to the technical durability and quality characteristics of a real estate; 2) owners did not fully understand the consequences of technical decisions; and 3) long-term future planning was inadequate.

Annual budgeting instead of long-term planning is a common practice, but leads to a situation where real estate managers only consider technical decisions from a monetary perspective and not from the perspective of life cycle value and costing.

These old ways are deeply-rooted, and there seems to be a fear of having to learn new things or act in new ways. This fear may be based on uncertainty about the own abilities of practioners.

5.3 Summary of the results of the interview studies

As we have seen, these studies showed that the role of technical life cycle management was considered important in practice. TLCM is one of the key business activities in real estate owner organizations, and indeed owners are responsible for it. The owner has a dual interest in TLCM: 1) by planned and goal-oriented TLCM, the technical value of a building can be maintained and managing cash flows is easier; and 2) income correlates with user satisfaction, and user satisfaction correlates with the building’s technical performance. Still, technical issues are not adequately taken into account, and strategic business planning and the implementation of strategies related to the technical life cycle of buildings needs to be developed.

These two studies demonstrated that there is a need to develop the practices of providing and purchasing technical life cycle services. A list of issues which need developing is presented in table 5.1.

Table 5.1: Unsatisfactory issues related to the technical life cycle management of real estates according to interview studies 1 and 2.

Interview study 1	Interview study 2
There is a lack of: - Purchasing skills (for technical life cycle - services) - Time for creating technical strategies - Methods: Creating a technical life cycle strategy was considered a very important part of the long term planning and maintenance of buildings. However, none of them had a clear procedure or strategy for the sustainable development of real estates. Qualified personnel – in the future, they are going to be hard to come by. Real estate management is the core competence of real estate companies and better purchasing and management skills are needed. Tools for evaluating service providers **Purchasing and cost-effective business** - More attention should be paid to expenses. - The business is not going to function if returns do not increase in the future. - Cost management will be improved? - Service providers should be able to offer the appropriate services which correspond to the owner's objectives. **General** - Properties such as flexibility, healthiness, and economical use will become important. => The importance of technical strategies will be increased? - Effects on life cycle costs will have a great importance in the future. The whole business should be seen as a totality, taking into account all the importance aspects => technical issues can no longer be seen as an individual issue? - Income and user satisfaction, the most important general values, canot be adequately achieved? - In the future the total life cycle strategy will be an important decision making tool => it does not exist yet.	**There is a lack of:** - Setting of business goals and objectives and/or connecting technical objectives to them - Communicating of business goals. This lack makes it impossible to create adequate technical strategies - Understanding and knowledge related to the technical potential of buildings - Knowledge needed for technical decision-making - Long-term future planning - Objective setting or long-term planning - Setting priorities for technical characteristics - Means, tools, knowledge or procedures for increasing the cost-effectiveness of property/facilities management. - Motivation related to technical issues - Adequate understanding and knowledge related to the real estate business in service provider companies **Purchasing and cost effective business** The way of purchasing technical life cycle services does not lead to cost-effective business within technical life cycle management: - Price competition instead of purchasing according to objectives and actual needs - Annual budgeting instead of long-term planning: The budgeting criteria related to technical solutions do not lead to cost-effective business. - Technical long-term value is not taken into account in strategies - Purchasing in crisis situations does not allow long-term cost-effective management Current purchasing practices affect the durability, technical quality and performance of buildings. Too often, benefits are only incidental: Cost-oriented purchasing is not based on actual need Current purchasing practices cause a lack of comprehensive understanding of technological/economic matters; owners do not adequately understand the influences of technical decisions Life cycle costing estimates cannot be made due to a lack of objective setting, and the ways purchasing and budgeting are done. Future planning is therefore difficult and achieving cost savings through long-term planning is impossible **General** Service provider organizations lack adequate know-how, knowledge and information related to the business or objectives of real estate owner organizations. - Information exchange in making investment decisions in real estate owner organizations is not adequate related to technical information. - The relationships between owners and service providers should be improved in order to improve the information flow related to primary objectives: - Better communication are skills needed - Better ways of setting goals are needed - Service providers need to be able to simplify technical information to make it understandable to non-specialists.

These interview studies demonstrated that although technical questions were considered important, nevertheless technical life cycle management of real estates is not carried out in an acceptable and satisfactory way. Since there are no tools or methods for improving technical life cycle managing processes, research question 2b seems particularly relevant:

RQ2b Assuming that there is a lack of a solid foundation of appropriate theories, key concepts and tools for TLCM, by which means can such a method be successfully developed and deployed?

As a summary of the interview studies (see table 5.1) we made a list that includes the main factors which need developing in the real estate business related to technical life cycle management. The list represents "initial success factors" (according to practical studies) of a method for TLCM if such was developed. The list is as follows:

1) The method should make communication easier between different levels of real estate organizations and between real estate organizations and service provider organizations. Practices in purchasing technical services should be improved, e.g. relationships between different stakeholders.

2) Real estate owner organizations should be able to define their business objectives and communicate them clearly to service providers so that the appropriate technical services and service packages can be provided in different situations.

3) Technical solutions should be proportioned to the business needs of real estate owners.

4) Technical possibilities and the costs of different possible technical actions should be presented clearly and understandably. Also, the importance of technical properties will increase.

5) The cost effects of different technical life cycle strategies should be more accurately connected to long-term planning. Long-term planning should be done according to the owner's objectives.

6) Causal relationships between different technical solutions should be more visible. (See table 5.1: Current purchasing practices cause a lack of comprehensive understanding of technological/economic matters; owners do not adequately understand the influences of technical decisions. Service providers need to be able to simplify technical information to make it understandable to non-specialists Service providers should be able to offer the appropriate services which correspond to the owner's objectives.)

7) Life cycle costing considerations should be possible. (See table 5.1: Effects of life cycle costs will have a great importance in the future. Technical issues can no longer be seen as an individual issue.)

PART THREE

6 Scientific approach and research design in the main part of the research

In the first part of this research, the research problem with research questions was presented. In the second part the concept of TLCM (in Chapter 4) was defined and the first research question answered. Also, using literature and empirical studies, "initial" success factors were collected for a method that could facilitate TLCM processes in the real estate business. We call this the TLCM Method.

In this third part we establish the need to construct some kind of TLCM Method to facilitate technical life cycle management. In this chapter the scientific method for the main study is grounded and justified based on an information/knowledge available related to the research topics, existing practices within science and the possibilities to carry out the research. In addition this chapter presents the design process.

6.1 Scientific approach in the thesis

The pre-understanding phase was technically a separate explorative study at the beginning of the research project, and is described at length in part two of this thesis. The aim of this phase was to study the perceived status of technical life cycle management in real estate owner organizations, to refine the research questions and to identify an appropriate research strategy. This phase of the study had a hermeneutic nature, and was both theoretical and practical.

The preliminary studies made it possible to focus the research and refine the additional research questions. The results of the preliminary studies (literature review and interview studies 1 and 2) showed that a hermeneutic case study approach (Eisenhardt, 1989) to the research topic was not possible; there was no solid foundation of appropriate theories, key concepts, methods and tools for technical life cycle management. Since there was no method connecting technical life cycle management to overall business planning in real estate owner organizations, an innovative and theoretically grounded solution for a relevant problem was needed. There was a concern about "how things ought to be in order to attain goals" – not "how things are." We did not pursue a better understanding of "a complex phenomena" since there was a need for a concrete solution. The needed method was not going to substitute for any existing theory since there was no existing method for technical life cycle management. The method should be more normative than descriptive and more empirical than theoretical.

Additional research questions arose: by which means could such a method be successfully developed and deployed? What are the characteristics of such a method? What is it required to do? What would be the appropriate scientific approaches in studying such a subject?

In chapter two the potential scientific approaches were discussed. According to chapter two, the action-oriented research approach is close to the constructive approach (figure 2.2). In both strategies an empirically-demonstrated connection to real life is needed. Deep understanding of organizational processes is needed to be able to accomplish the intended changes in organizations. Still, the aim of action-oriented approach is not to create a new construct, e.g. way of operating or method, but to develop theories, change the operations of an organization. In the constructive approach, the development of a new construct is the core objective. In this research, the study was field-oriented but there was no single issue or item that needed to be improved or developed, for there was a lack of methodologies. This research also has the goal of constructing knowledge, as deep understanding of organizational processes is needed. The aim was to change the operations of an organization, but even this wasn't adequate: a new generic method was needed, for it is not enough to change just a few

single actions. In this study the organizations in which the change was needed were organizations of different stakeholders of technical life cycle process. Both parties, real estate owner organizations and technical life cycle service provider organizations, were new users of the needed method.

The constructive case study approach seemed to be appropriate, as this is based on a relatively small number of empirical samples and aims at understanding the business processes in the real estate business and then finding possibilities to construct an innovative, useful and theoretically grounded solution for a relevant problem.

6.2 Research questions

To review, once we had determined that a TLCM Method could and should be developed, we had to identify its essential features, leading to research question three:

RQ3 What are the characteristics and capabilities of such a method? What does it require?

Our focus was on features which would facilitate use: what kind of method would be needed, what should it be like, how could it be made most logical? Then, if it proved possible to develop such a method, it would need to be tested in real life case studies. The fourth research question thus focused on how the method works in practice:

RQ4 Does the method work?

- Is it useful?
- Does it facilitate analysis of the technical potential of a building and the development of technical life cycle strategies?
- If it works, what features could possibly make it easier to use and more useful?

6.3 Research design: research process and methods

Chapter 2 includes a detailed discussion of the constructive approach, so here we will only review the main features with the help of Figure 6.1, which provides a general description of the entire project, with its different phases and data sources. It also presents the output of the different phases of research.

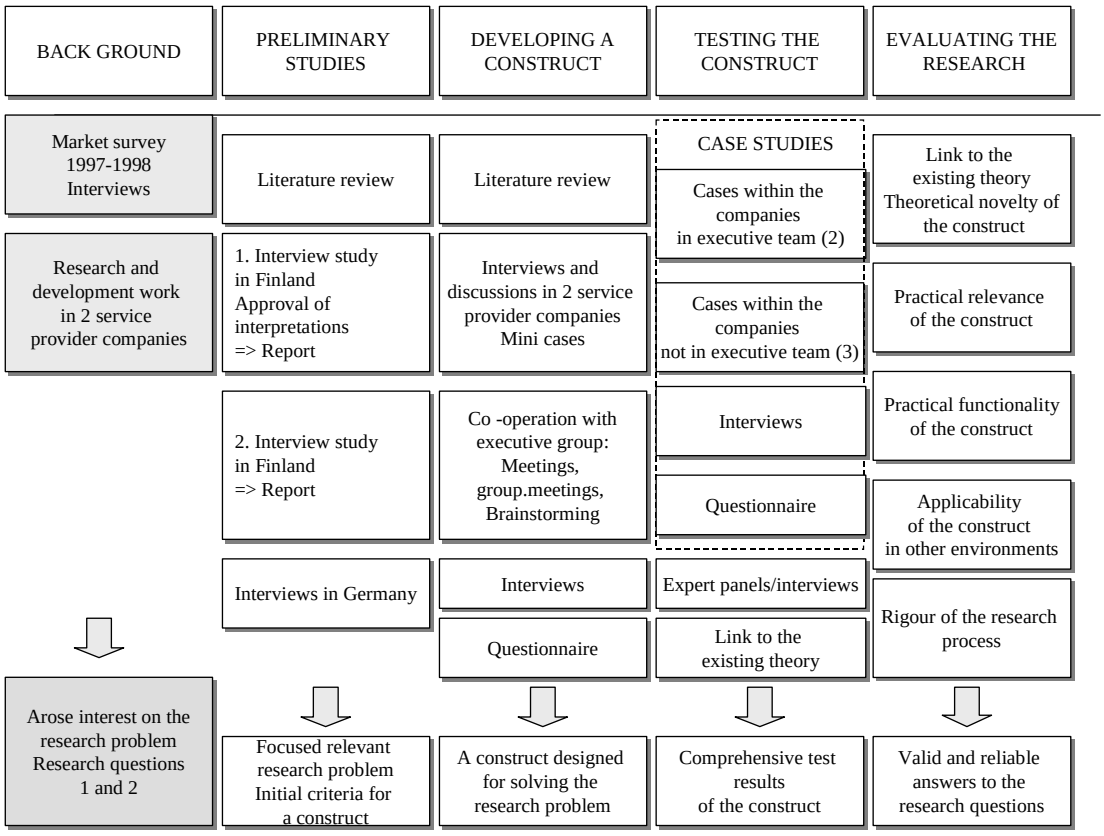

Figure 6.1 General description of the entire research project: The research process and its outputs in different phases of this research.

6.3.1 Data sources in case studies

Since this part of our research is a constructive case study where the construct needs to be evaluated using cases, we next present a short review of potential data sources. According to Yin, evidence for case studies can come from six different sources: 1) Documents; 2) archival records; 3) interviews; 4) direct observations; 5) participant-observation and 6) physical artifacts (Yin, 1989, p. 84). In addition, Yin says that documentary information is usually relevant to every case study topic, including:

- Letters, memoranda and other communiqués
- Agendas, announcements, written reports
- Administrative documents – proposals, progress reports and other internal documents
- Formal studies or evaluations of the same site under study
- News and articles in mass media (Yin, 1989, p. 85).

Archival records are also relevant in many case studies, including:
- Service records
- Organizational records
- Maps and charts
- Lists of names
- Personal records (Yin, 1989, p. 87).

Interviews are one of the most important data sources in case studies. Interviews may take different forms, such as open-ended (where the investigator asks for facts or the opinions of

the interviewee), focused (a short, often open-ended interview where the investigator follows a certain set of questions derived from the case study protocol) or a formal survey (where the investigator has structured questions). Using a tape recorder is more accurate than any other method of recording data (Yin, 1989, p. 88-91). Lanning added questionnaires to group interviews. He says that although questionnaires are traditionally associated with the quantitative method, they can also support qualitative methods and case studies since this method has some indisputable advantages: they can clearly produce answers to such questions as how much, how many or how often (Lanning 2001, p. 58).

By making a field visit to the case study site, an investigator gets the opportunity for direct observations. These observations can range from formal to casual data collection activities, and such observational evidence may be useful in providing additional information about the topic. The investigator may have either a passive role or, in participant-observations, a more active role (Yin, 1989, p. 91-92).

Lanning has presented the strengths and weaknesses of different sources of evidence, as seen in Table 6.1.

Table 6.1. Strengths and weaknesses of different sources of evidence (Lanning, 2001, p. 57).

SOURCE OF EVIDENCE	STRENGTHS	WEAKNESSES
Documentation	- Stable – can be reviewed repeatedly - Unobstructive – not created as a result of a case study - Exact – contains exact names, references and details of an event - Broad coverage – long span of time many events and many settings	- Retrievability – can be low - Biased selectivity, if collection is incomplete - Reporting bias – reflects (unknown) bias of author - Access – may be deliberately blocked
Interviews and questionnaires	- Targeted – focused directly on case study topic - Insightful – provides perceived causal inferences	- Bias due to poorly constructed questions - Response bias - Inaccuracies due to poor recall - Reflexivity – interviewee gives what interviewer wants to hear
Observation	- Reality – covers events in real time - Contextual – covers context of events - Insightful into interpersonal behavior and motives (in participant observation)	- Time-consuming - Selectivity – unless broad coverage - Reflexivity – event may proceed differently because it is being observed - Cost – hours needed by human observers - Bias due to investigator's manipulation of events (in participant observation)

6.3.2 Data sources in this study

A general analytic testing strategy should be used in order to find out what should be analyzed, why and how (Yin, 1989, p. 105-106). The aim of developing the testing strategy is to be able to treat the evidence fairly, to produce compelling analytic conclusions and to rule out alternative interpretations (Yin, 1989, p. 106). This section presents and grounds the case testing strategy used in this study.

Table 6.2. Data sources used in the different phases of the study.

SOURCE OF EVIDENCE	IN WHICH PHASE	ACHIEVING WHAT
Case studies	Testing phase	Evaluating the model
Documentation: Old customer cases at 2 service provider companies Research documents of research work related to this research done in 2 service provider companies (Co-operative projects with universities and research centers.) Literature Reports of case project meetings Newspaper articles	Preliminary study Constructing phase Testing phase Analyzing phase	- Finding out the relevance of the research topic - Finding out pre-construction practices in the real estate business - Constructing the model and finding out its essential features - Evaluating technical life cycle processes done according to the constructed model - Evaluating the usefulness and usability of the model.
Interviews	Preliminary study Constructing phase Testing phase Evaluating phase	- Relevance of the research topic - Feedback on the model during the construction phase - Evaluating the usefulness, usability and novelty of the construction.
Questionnaires	Constructing phase Testing phase	- Feedback on the model during the construction phase - Evaluating the usefulness, usability and novelty of the construction.
Brainstorming and discussions	Constructing phase	- Innovating and gathering opinions
Observations	Testing phase	- Evaluating the constructed model

6.4 Design of different phases of the study

The research design of the preliminary studies is described in chapter 3. The following sections present a detailed description of the different phases of the main study and how the method was designed.

6.4.1 The developing phase of the construct

During this process of development, we used the following research and data collecting methods:

Documents:

- Old customer cases.
- Research documents, related to research work done in 1997-2001 in co-operation with two service provider companies and a few research center and university departments in Finland.
- Literature review 1 and an additional literature review 2 which focuses on different life cycle phases of real estate and common practices in the real estate and construction businesses.
- Articles.
- Interviews and questionnaires
- Brainstorming sessions and formal and informal discussions
- Testing parts of the model and related ideas in mini-cases in two service provider companies (this part is used but not documented in the thesis).

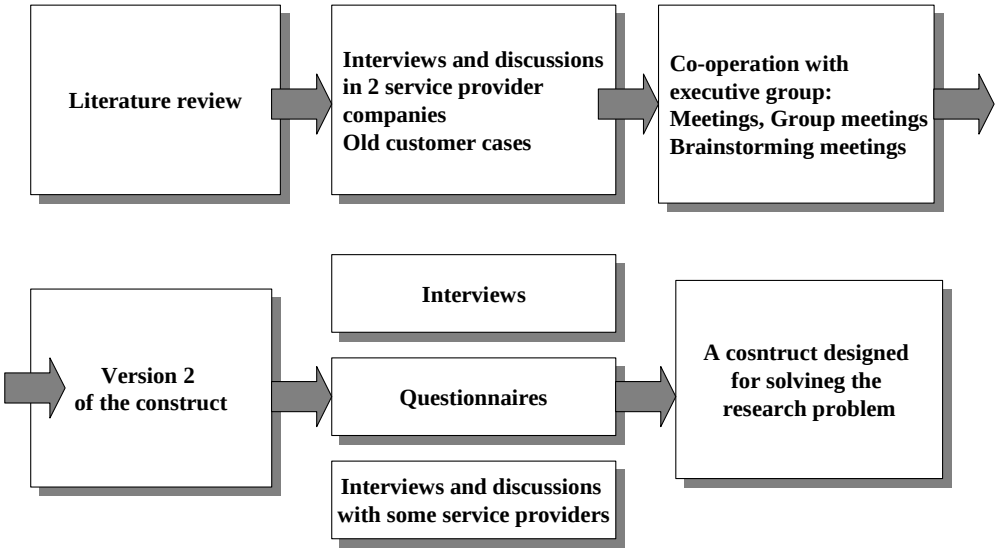

Figure 6.2 The developing phase of a construct.

The aim was to answer research question 3 and construct an innovative and practical tool for real estate owner organizations. In order to further define the essential features for a practical and innovative construct, we next did an additional literature review focusing on practices concerning the different life cycle phases of a real estate.

1 Literature review 2 - an additional literature review

An important starting point for the second literature review was that we needed to construct an entirely new tool for managing life cycles, since one did not exist. Therefore, it was necessary to perform a wide review, in order to identify the essential features of such a method. The following issues related to different life cycle phases were studied:

- Investment analyses and other real estate analyses
- Risks in the real estate business
- Different life cycle definitions of a real estate
- Construction of a new building
- Utility of a building
- Value of a building - life cycle quality

2 Discussions, brainstorming sessions and interviews at service provider companies

Some interviews and/or discussions were carried out during the constructing phase in order to find out if the ideas related to the method under construction were relevant and potentially useful. These were more informal and were not reported. Some of the interviews were tape-recorded, and notes were taken during all of them.

3 Executive group meetings

There was an active project executive group representing different stakeholders of technical life cycle management. Three of the members represented real estate owner organizations and three of the members different kinds of technical service provider organizations. This group

supervised the research project. At every meeting the ideas related to the research were presented, and we discussed the relevance of different ideas for developing the method. Their proposals for developing the construct or parts thereof were written down, and afterwards this feedback was incorporated into the method itself. In addition, brainstorming sessions were arranged in order to get as many comments and ideas related to real life needs as possible.

The aim of the meetings and brainstorming was to ensure the usability and usefulness, as well as the practicality, of the method under construction. Also, ideas based in theory were discussed and reflected against practical perspectives. The discussions were open in order to make it possible to air different perspectives and get a comprehensive picture of the different needs, practices and possibilities of different stakeholders.

4 Presentation of the construction before testing in cases - Interviews and questionnaire

The construction was presented to executive group members before testing in real life cases. The aim of this presentation was to find out if the construction/ method was ready for real-life testing. The interviews were semi-structured and questionnaires were used as well. This presentation was considered important since testing in real life cases was expected to be time-consuming and also quite costly. These comments were collected and the final construct developed accordingly. The interview questions and questionnaires was drawn up after the method already existed.

6.4.2 Testing the construct

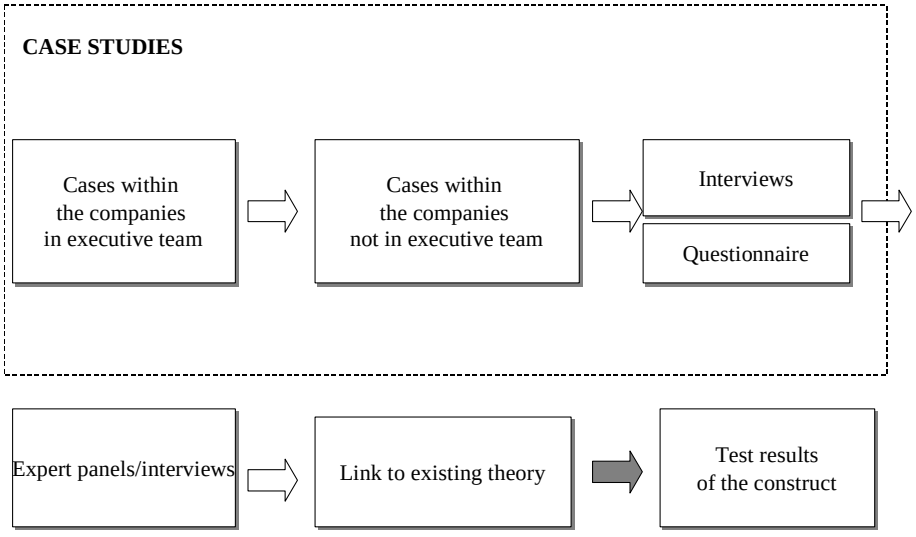

Figure 6.3. Schematic figure of the testing program

The construction was next tested in real life cases in order to find answers to the 4th research question:

Does the method work?
- Is it useful?

- Does it facilitate analysis of the technical potential of a building and the development of technical life cycle strategies?
- If it works, what features could possibly make it easier to use and more useful?

Testing was done in five case projects. There were some criteria for choosing cases and participants:

In choosing cases, the main criteria was to maximize learning, so the cases were chosen so that they represent all the possible situations in which the method/tool was intended to be used. This way, we could learn as much as possible about how the construction actually facilitates technical life cycle management, and how useful and easy it is to use in the different situations for which it was developed. For this reason, all the cases differed from one another.

We also needed to ensure that the different parties of a TLCM project were commited to using the construct according to their own needs, and would stay with the project from the beginning to the end, as this was the only way it would be possible to study the construct's usability and usefulness, as well as to gather information on how it could be improved. In addition, participants needed to be commited to the cost and schedule frames established for the cases. Finally, participants needed to agree to give interviews and answer questionnaires, as this was the only way to gather the necessary data on whether the construct worked.

We needed to ensure that different levels of the organizations were represented, so we selected members from different levels.

We also needed to ensure that different types of owner and service provider organizations were represented, so we selected participants representing different kinds of owner and service provider groups. Table 6.3 presents the different groups of owners who participated in the cases, while table 6.4 presents different types of service providers.

Table 6.3. Different kinds of owner organization groups and levels of the organization represented

Type of Entity Functions	Traditional Real Estate organization	Investors	Traditional Corporation
Strategy	1	1 (2 cases)	2
Management and control	1	1 (2 cases)	2
Operations	2		2

Table 6.4. Technical service provider groups and levels of the organization represented in different cases.

Type of organization Functions	Construction Industry	Consultant: Structural engineering and building physics	Consultant: HVAC	Consultant: Architect	Infra-structural FM / User services
Strategy	1 (2 cases)	2	1	1	
Management and control			1	1	
Operations	1 (2 cases)	5	2	1	1

Some projects were carried out in organizations represented on the executive group, while others were done in organizations which did not have members in this group, for example in customer organizations of executive group members. This was done because of the need for

triangulation, and it also made it possible to estimate the adequacy of training and instructions.

Most participants from the service provider and real estate owner companies were not familiar with the construct before the beginning of the project, though some were members of the executive group were.

At the beginning of each project, the method was presented and trained the participants to use it. In these meetings, the following issues were discussed:

1) The objectives of the using of the method
2) The method's modules and structure
3) The method's content

One real estate owner was involved in two cases, so we could examine the effects of learning on the method's usability.

All the users were interviewed face to face, and the interviews were carried out in his/her place of work. Interviews lasted about 1-1.5 hours. The interviews were tape-recorded and transcribed. The results were categorized, interpreted and analyzed. The interviews were focused and open-ended, with pre-defined questions. The questions were partly be related to the project itself and partly to the construct and its usability, usefulness, novelty and expected generality.

Analyzing was done within the projects, between the projects, within the participant organizations, between the service provider organizations and between the real estate owner organizations.

The interview questions are presented in appendix 7.

All the users were asked to fill out a questionnaire. Some of the questions were related to the amount of use, usability and usefulness of the different phases of the construct, while others addressed more generally the use, usability and novelty of the model. The questionnaires are presented in appendix 5 and 6.

Short descriptions were written of all five cases, to some extent including observations, but not for all projects and not for all meetings. Information related to the cases and participants is presented in appendix 4.

Expert panels

In addition to the case studies, the method was presented to fifteen experts, i.e. technical service providers, real estate managers or other experts in the real estate sector, who were asked to comment on the method and fill out a questionnaire. In these interviews, they also reflected on the method's idea and material, and compared it to their own experiences of real estate management practices. These expert interviews and questionnaires focused on the same issues as those of the case study. Information related to these interviews is presented in appendix 4. Expert interview questions are presented in appendix 8.

6.4.3 Validating and evaluating the research

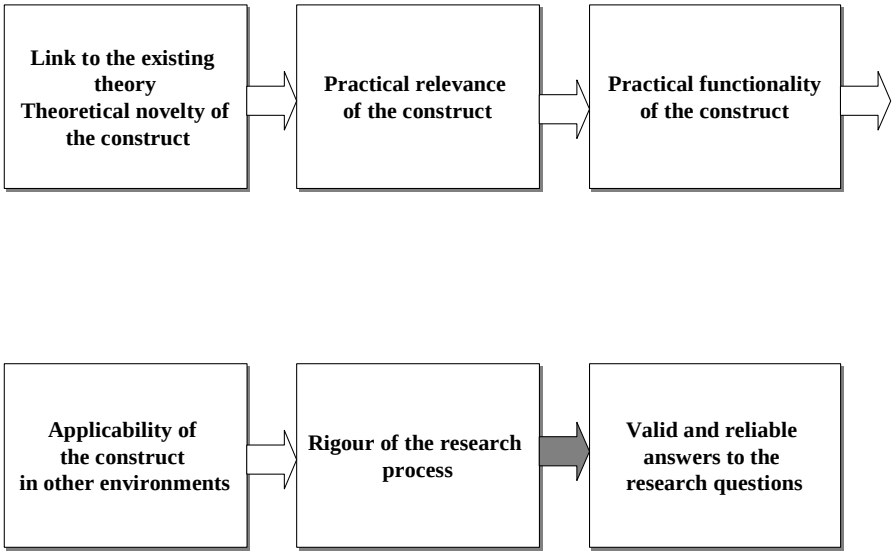

Figure. 6.4 The validation and evaluation of the research. Specific results are presented in chapter 10.

Methods of data collection and analysis as well as evaluation are presented in table 6.5.

Table 6.5. Methods of data collection, aims of collecting different data, and how the data is analyzed and reported.

METHODS	AIMS OF DATA COLLECTION	HOW THE DATA IS ANALYSED AND REPORTED
Description of the research process	**Research validity**	Described in this thesis
Presenting the essential features and connecting them to existing theory	**Research validity**	Presented in this thesis
Choosing cases: There were four criteria for choosing the cases and participants. - The main criteria was being able to test the construct in those situations for which it is constructed - Representatives are chosen: - From the different parties of TLC project - Different levels of organizations - Different types of owner organizations. - Different types of service providers	**Construct validity**: - Principles of choosing cases and participants *Being sure that the right things are measured* **Triangulation**: - Methodological triangulation **Reliability**: - Does the collected data contain inconsistencies? *Being sure that the analysis is done correctly*	Case descriptions were done
Triangulation *Data source triangulation:* Different kinds of data sources: - Observations - Documentation - Interviews - Questionnaires *Methodological triangulation:* Different perspectives: - Analyzing between the cases and within the cases - Between the different kinds of stakeholders - Within different organizations - Interviewing representatives of different roles in projects	**Construct validity and reliability**	Gathering data, classifying, analyzing and verifying it: - Between different participants - Between different levels of organizations - Between different cases - Between different sources of data (interviews, questionnaires, discussions, etc.) Using: - Interviews and questionnaires - Documentation - Observation - Expert panels
Observations: - The roles of different participants - Consensus during the project between different participants - Possible conflicts - Decision-making power and data transfer during the projects - Know-how and engaging of the participants - Cost effects - Effects of timetables - Relationships between researcher and other participants	**Assessing the validity of the research.** - How we reacted and processed the invariances - Effects of internal and external factors on research - Evaluating relationships between myself and case participants **Assessing the reliability of the research.** - Measuring the same invariances in all cases - Using the same questionnaires and asking the same interview questions of every participant **External validity and assessing how generic the model is** - Cross-case analysis	Reporting the cases: - Case descriptions - Summary of observations
Interviews after the case studies: Evaluating the model:	**Evaluation of the construct**: - Functionality and usability	Classifying, interpreting and analyzing the interviews

- Interviews in real estate owner organizations - Interviews in service provider organizations - Formulation of the questions so that it will be possible to answer the research questions.	- Usefulness - Possible taking into use - Novelty - Benefits of using the method, possibilities and lacks in construction, strengths and weaknesses **Reliability** - Asking the same interview questions in every interview - How uniform are the answers? **External validity and assessing how generic the model is** - Cross-case analysis	=>Case descriptions
Questionnaire after the cases: - Formulation of the questions so that it will be possible to answer the research questions.	**Evaluation of the construct** - Amount of use of the different parts during the case. - Usability, usefulness, benefits and lacks, strengths and weaknesses - Assessing its novelty **Reliability:** - Using the same questionnaires with every participant - How uniform are the answers?	Classifying and analyzing the questionnaire data =>Case descriptions Results documented and presented in Ch 8
Expert panels	**Evaluation of the construct:** - Functionality and usability - Usefulness - Novelty - Benefits, possibilities and lacks in construct, strengths and weaknesses - The scope of the applicability of the solution	Results documented and presented in Ch 8
Connections to the theories	**Validity:** - Is the construct an innovative, theoretically-grounded solution for a relevant problem? **Novelty**	- Connections between the construction and existing theories are presented. Results documented and presented in Ch 8

6.4.4 Summary of the research design

This section collects all the empirical data and research methods used in different phases of the research. This data is presented in table 6.6.

Table 6.6. Summary of empirical data and research methods used in different phases of the research.

Action/ phase of the study	Number of Interviewees / cases	Research techniques	Data collecting method	Report	Checking of interpretations
Background and preliminary studies					
Interviews Market survey 1997	19	Interview, face to face	Notes	Collective report written	-
Interviews 1. Interview study (Persons interviewed => 28)	14	Interview, face to face	Notes	Collective report written	Gathering comments by e-mail
	14	Interview, face to face	Notes	Collective report written	-
Interviews 2. Interview study	13	Interview, face to face	Notes/ Tape recording	Collective report written	-
Discussions in Germany	4	Interview, face to face	Notes	-	-
Developing phase of the construct					
Interviews and discussions service provider companies	Many	Interviews, face to face Documentations	Notes/ Tape recording	-	-
Brainstorming	5	Brainstorming	Notes	-	-
Executive group meetings	Many, with members of the project's executive team	Discussions Documentations	Notes	-	Checking in next meeting
Discussions and interviews / Executive group	6	Interview and presentation of the model version 2	Notes	Collective report written	Gathering comments by e-mail
Questionnaire / Executive group	6	Questionnaire	Returning the questionnaire	Collective report written	Written by interviewed
Testing the construct					
Cases	5	Observations Documentations	Notes	Short collective reports written	Checked by one participant
Interviews/ interviewed participants	21 /16	Interview, face to face Questionnaires	Notes/ Tape recording	Conclusions, reported in chapter 7	Written answers to questionnaire
Expert panels	14/(15)	Interview, face to face Questionnaires	Notes Tape recording	Conclusions, reported in chapter 7	Written answers to questionnaire

A total of 104 interviews were done: 64 were part of the preliminary interview studies (19 are used only as background information in the thesis); 16 interviews connected to the case studies where the construction was tested; and 14 (15) expert interviews. All the interviews were face-to-face and most were tape-recorded. All participants in both cases and expert interviews also filled out a questionnaire. In addition, in the construction phase of the method, additional data was collected through discussions with real estate owners and service providers who participated in the executive group meetings of the research project. The TLCM Method was also presented to the members of this group before testing it in the cases. All the group members were interviewed after the presentations and they filled out a questionnaire related to the TLCM Method. In short, documentation was available for all cases.

7. Developing the TLCM Method

This chapter presents the process of developing the TLCM Method, which has been constructed to be practical and useful. In order to determine which factors are critical for success, the relevant literature was examined: the first literature review, presented in chapter 4, is supplemented here by a second literature review focusing on the theories and issues that could be used or adapted when developing the TLCM Method. In determining the factors critical for success, data collected in interview studies 1 and 2 was also used, as presented in chapter 5. This chapter thus summarizes the final factors critical to developing a successful, potentially useful and practical construct and presents the TLCM Method.

7.1 Background

The Technical Life Cycle Management (TLCM) Method was developed in order to find a way to connect strategic technical life cycle planning more tightly with overall real estate management practices and facilitate the setting of objectives, analysis of possibilities and decision-making related to real estate investments in a more cost-effective way.

According to the initial research, which included preliminary studies, interview studies and a literature review, we lack a solid base of appropriate theories, key concepts, methods and tools for technical life cycle management (TLCM):

- The technical life cycle management of real estate is not carried out in an acceptable and satisfactory way; and,
- Unsatisfactory issues are related to the cost-effectiveness of managing the technical life cycle, the methods of managing and purchasing services.

This chapter considers whether it is possible to develop a sound base and a method based on this base for TLCM. Based on theoretical (chapter 4.4) and practical (chapter 5.3) studies, we identified what we call “initial success factors” that should be taken into account in developing a method for technical life cycle management. These can be summarized as follows:

1) The method should make **communication easier** between different levels of real estate organizations and between real estate organizations and service provider organizations. Practices in purchasing technical services should be improved, e.g. relationships between different stakeholders.

2) Real estate owner organizations should be able to define their business objectives and communicate them clearly to service providers. This would facilitate the focusing of appropriate technical services and service packages in different situations. The method **should facilitate goal-setting and decision-making** related to the technical objectives of real estates and also facilitate information systems in real estate organizations, so that the strategic goals could more easily be shared with all levels of the organization.

3) The method should **facilitate the strategic planning of technical life cycle strategies** as a part of overall business strategies and implementing of the technical strategies in practice. The cost effects due to different technical life cycle strategies should be more accurately connected to long term planning. Long term planning should be done according to the owner’s objectives.

4) The method should make it possible to **connect business plans more efficiently to maintenance strategies** and their development. Technical solutions should be proportioned to the business needs of real estate owners.

5) The method should **facilitate purchasing activities** related to technical services.

6) It should take into account the changing **needs of users** of buildings as well as the business **needs of an owner**.

7) The **causal relations** related to different **technical action solutions** should be more visible.

8) Technical **possibilities and costs** due to different possible technical actions should be presented clearly and understandably.

9) **Lifecycle costing considerations** should be possible: The method should include the technical perspective of lifecycle costing and facilitate such costing considerations.

10) The method should help in analyzing, predicting, planning and implementing **future decision-making.**

An attempt to answer research question 3 was made by the means presented in chapter 6.4.1, where that process is described. After further refining the ideas about what would constitute a successful TLCM Method through an additional literature review, we began constructing the TLCM Method in cooperation with three technical service provider companies and three real estate owner companies (the executive group of the research project, see chapter 6.4.1). This construction phase included meetings, brainstorming sessions, discussions and interviews. Some of the ideas were tested in customer cases as the method was being constructed.

In the beginning of the research project we worked on the separate parts of the method, focusing on our ideas of how a practical and useful method should work. We then developed a "second version" of the method, based on further reading in the literature and discussions in executive group meetings. These ideas were then presented individually to each of the executive group members. The members were interviewed and were also asked to complete a questionnaire. Notes were taken during the interviews, and then sent to the members for checking. It was important to develop the TLCM Method first in this preliminary way, since real life tests would take a long time and would also require large monetary and human resources. Therefore, testing with a half-finished method was considered impossible: it was necessary that the method operated in theory before it was put to the test. After this preliminary "testing", we developed the final version.

7.2 Literature review 2

The first literature review, as well as preliminary interview studies 1 and 2, showed that there is a need for a practical tool which would help strategic technical life cycle planning and the acquiring of technical life cycle services. The purpose of this second literature analysis is partly to deepen our understanding of the real estate business and technical life cycle management. It is also designed to help answer the second research question: is it possible to construct such a tool? What kind of tool is needed? What factors would make the tool practical?

Figure 7.1. briefly presents the subjects studied in this literature review and their relationship to the issues studied in the first literature review and in the preliminary studies.

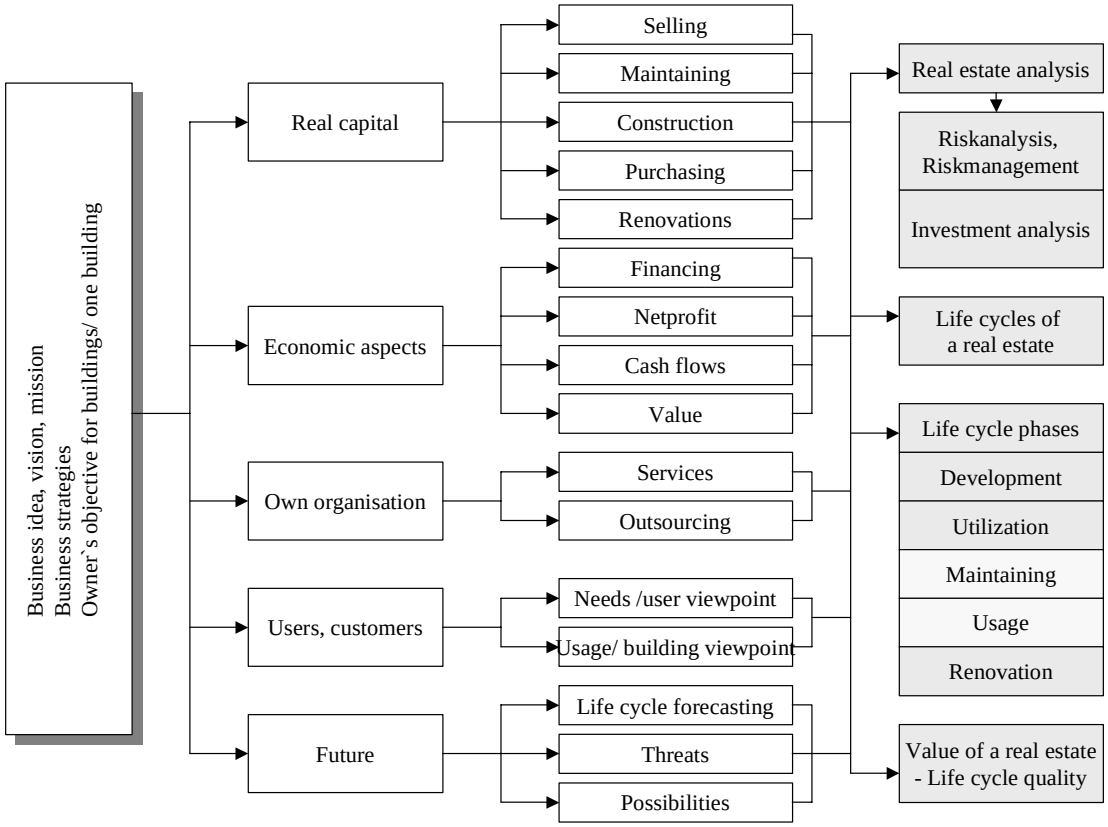

Figure 7.1 Focus areas of the additional literature review 2 are presented in gray boxes.

7.2.1 Real estate analysis

As mentioned earlier, there are several different kinds of real estate analyses an investor or real estate owner may perform in situations where they need to make decisions related to real assets (Isenhöfer in Schulte, 2000, pp. 321-325). In the following sections, we will take a closer look at risk and investment analyses especially from the perspective of technical life cycle management.

Risk analysis in real estate investments

Generally, risk is considered a negative factor. It is defined as a future possibility of loss or a probability that the investment will fail to increase in value (Maisel et al., 1976, p. 506; Arnold 1987, in Hintikka 1999, p. 13; Sirmans et al., 1985, p. 336; Aalto et al., 1981, p. 7 in Hintikka, 1999; Palojärvi 1986, p. 13). Risk can also include uncertainty related to an unfavorable event, (Willet in Palojärvi, 1986, p. 14) or an undesirable negative event (Denburg, in Palojärvi, p. 14) or the possibility of a loss (Rowe, 1976, p. 25 in Hintikka, 1999). Risk is a possibility for loss due to a poor investment or some other special reason. (Boyce 1975, in Hintikka 1999.)

There is no solid consensus in the literature about the concept of risk. Palojärvi points out that differences in definitions of risk are related to the question of whether we always have to understand risk as a negative possibility of loss, or whether it can also be seen as the possibility of profit (Palojärvi, 1986, p. 14). The concept of risk as the possibility of profit is based on the idea that there is a ratio between risk and objectives, expectations and possibilities, so that it becomes possible to take into account “an exceeding of all expectations” (Palojärvi 1986, p. 14). According to Jaffe et al (Jaffe et al. 1986, p. 4), risk is

the variation in the expected future benefits. Realization of risks means that one or more risks are realized, and we can also consider the probability that one or more risks will be realized (Palojärvi, 1986, p. 15).

The consequences of risks are the conditions after one or more risks have been realized (Rowe, 1976, p. 25; in Palojärvi 1986, p. 15). Assessment of direct and indirect consequences of risks is sometimes difficult, however. Therefore, risk analysis should include factors influencing the relationships between risks (Palojärvi, 1986, p. 15).

Identifying risks and determining the relationships between causes and consequences of risk, as well as possibly eliminating risk is important. Crockford defines risk management as a process which includes the following phases: defining the problem, estimating the possible solutions, choosing and then implementing the best possible solution. He argues that identification of risks should start from the question "what can happen?" He recommends using the components of risk as a tool for listing the existing risks: threats, resources, modifying factors and consequences, and also points out that using checklists helps to systematize this work (Crockford, 1986, p. 16-19).

In Palojärvi's view, risk management includes the following phases: 1) identifying risks, 2) estimating their likelihood and consequences 3) preventing risks and 4) preparing for the consequences of realized risks. In an ideal situation, the probabilities of given risks would be known. Because decisions are usually made in accordance with the available information, it is therefore essential to identify risks, even if it is not possible to accurately define their probability. According to Palojärvi, most risks can be managed without a considerable rise in the costs of risk management. From the perspective of risk management, the most important thing is to define so-called elementary risk (Palojärvi, 1986, p. 17-19).

In the real estate literature, risks are divided into several groups, according to the nature of a risk, whether it can be insured against, the mechanisms of its existence, how frequently it occurs, how easy it is to manage, its consequences, who has responsibility for the risk and what causes the risk (Hintikka, 1999, p. 27). Hintikka proposes that risks in the real estate business can be presented in a table where they are divided into the following groups: economic risks, political and administrative risks, social risks, risks related to nature and the environment and risks related to construction work. In addition, all these risks can be considered at the national, city and object level (Hintikka, 1999, p. 36; Sources: Sirmans et al., 1985; Ringin et al., 1981; Brueggeman et al., 1989; Giliberto, 1989; Virtanen, 1985 also in Greer et al., 1988, p. 323-337).

Greer points out that through capable property management it would be possible to control some of these risks: "Professional property managers are uniquely positioned to enhance the accuracy of cash flow projections. Their access to market data and their knowledge and experience regarding the economics of property operations are valuable forecasting ingredients. Capable property managers can greatly reduce the probability of variance between projections and actual outcomes. Competent management also plays a vital role in making outcomes conform to assumptions" (Greer et al., 1988, p. 332-333).

Jaffe et al. also emphasize the importance of competent property management. One of the most important factors in investment analysis situations is to define a building's maintenance costs, since they affect the building's net profit through its entire lifecycle. Therefore, controlling and managing these costs is very important (Jaffe et al., 1986, p. 184, 199). They identify the following risk factors related to the physical and technical characteristics of a building: locational risk, technical and economic obsolescence and risks related to property losses. In addition, Bottom et al. considers the technical performance of a building and its relation to cost effectiveness and/or riskiness of ownership, noting that investment risk

associated with aesthetic, functional and social obsolescence has a particular relevance (Bottom et al., 1998; also: Zavadskas et al, 1998; Trivers 1999b; Benda et al, 2000).

The technical risks of an existing building are related to design, construction, usage, maintenance and the relationships between all of these (see table 7.1). There are plenty of recommendations for design and construction work based on avoiding technical risks during the service life of a building. For example, Lehtinen has developed a new design procedure based on a three-level classification of buildings, rooms and structures, which takes into account a building's usage when choosing the relevant building physical design level. Lehtinen also links the possibilities and demand for maintenance to a building's design and use (Lehtinen, 2000, p. 517-512; 2001). Even for existing building stock, this approach is relevant in determining the potential to use or develop a building.

Table 7.1 presents some technical risks, as well as their effects or possible effects on a building. In tabe 7.1 IAQ means: indoor air quality. Many other scholars have also focused on these issues, and the table only provides a general view of the technical risks of a building during its life cycle.

Table 7.1 Selected technical risks

Phase	Risk or demand factor	Effect or decision	Source
Objective setting	Lack of clear objectives	Brittle building	Benda, 2000
Design phase	Construction site: quality and cleanness of soil	Moisture and or health problems (moisture physical design is needed)	Al-Hammad et al., 1997, Lehtinen et al., 2000, 2001,
	Risks related to architectural design: maintainability	Suitability of building materials, design and architecture for environmental circumstances	Al-Hammad et al., 1997, Lehtinen et al., 2000, 2001
	Climate, and microclimate	Necessary level of hygrothermal design	Lehtinen et al., 2000, 2001; Al-Hammad et al., 1997
	Adequate level of thermo physical design	Relation between use, usage and design decisions	Lehtinen, 2000, Lehtinen et al., 2001, Sarja et al., 1999b, Sarja, 2000
	Biological and environmental effects	Life cycle durability	Al-Hammad et al.,1997
	Level and standard of structural design	Life cycle potential	Sarja, 2000; anon. 2001; Al-Hammad et al., 1997
	Materials and their compatibility	IAQ	Al-Hammad et al., 1997; anon. 2000
	Premises, devises and envelope of a building and their suitability Window area, etc.	Usability, and healthy, safe and economical use.	Mendell et al. 1990; Sundell et al. 1994; Groes et al. 1996 in Seppänen et al., 2000b, Trivers, 1999b
	Ease of cleaning the HVAC apparatus	IAQ	Angell et al. 1997, Pasanen 1998 in Seppänen et al., 2000b
	Physical factors of indoor air	IAQ	Anon 2000
	Lack of QA/QC tests during the design	Possible design defects	Al-Hammad et al., 1997, Trivers, 1999a
Construction phase	Unclear specifications	Defects in performance of construction work	Al-Hammad et al., 1997
	Lack of worker competence	Building physical risks, IAQ problems	Levin et al., 2000
	Lack of QA/QC tests during construction	Possible defects in construction work	Levin et al., 2000
	Storage of building materials during construction	Moisture damage of building materials	Lehtinen, 2000, p. 510
	Procurement and contract methods	Responsibilities => "quality" of building	Seppänen et al., 2000b, Pekkanen, 1998

	Timetable	Problems due to timetables related to drying of structures	Saarela 1992 & Fleming et al. 1999 in Seppänen et al., 2000b
	Level of design of sanitary and other rooms that need water barriers		Lehtinen et al., 2000, 2001, Seppänen et al., 2000, Määttä, 1997 in Seppänen et al, 2000b
Hand over			Levin, 2000
Utilization and maintenance	Compatibility of materials used	Durability of materials, structures, IAQ, Building physical problems	Anon. 2000
	(Surface) materials and their usability in current usage	IAQ, work efficiency	E.g. Beier et al. 1994 and Fisk et al. 1993 , in Seppänen et al., 2000b
	Quality of maintenance staff, maintenance program		Heath et al. 1997
	The use and maintenance of HVAC systems, IA quality	Effects on IAQ and building physics	Heath et al. 1997; also Pasanen, 1995 in Seppänen et al., 2000b
	Health, safety, cleanness etc. of materials	IAQ	Trivers, 1999b, Rooley, 1997; Sobotka et al., 1998; also: Horner et al., 1997; Benda et al., 2000
	Structural and building physical risks due to usage	Level of design?	Flanagan et al., 1989; Lehtinen, 2000, Lehtinen & al., 2001
	HVAC efficiency, usage and maintenance, possible impurity sources in IA, physical IA factors	IAQ	E.g. Angell et al. 1997, Mendell &. Al. 1999 & Fisk et al. 1999, in Seppänen & al, 2000b, Rooley, 1997, anon. 2000
	Maintenance strategy	Must correspond to technical design and usage	Horner et al., 1997; Wood, 1999

In short, technical risks can be classified, and owners should be aware of them and evaluate their effects on the building, users and usage during the life cycle of a building.

Investment analyses

"Real estate investors make an immediate and certain sacrifice of current purchasing power for the prospect of future economic benefit." Investment proposals are evaluated by comparing the magnitude of the sacrifice with the quantity and timing of expected benefits, and by considering the level of certainty with which expectations are held. Adjusting for time and uncertainty permits comparison between various alternative proposals (Greer et al., 1988, p. 9; also Jaffe et al., 1986, p. 24).

Jaffe et al. have presented a real estate investment process, which basically includes five steps that lead to an investment decision. These steps can be summarized as follows (Jaffe et al., 1986, p. 6-7):

1) Identify the goals, objectives and constraints of the various participants in the investment process which an investment must satisfy in order to be acceptable.
2) Analyze the overall investment environment
3) Forecast the expected future benefits and costs (cash flows) arising from the ownership of the investment
4) Apply appropriate decision-making criteria to compare the benefits with the costs of an investment

5) Accept or reject the investment under the assumptions of the investment process

In addition, the first step includes the choice of investment objective. There are differences between investors regarding interests, risk preferences and tastes, though the objective of most investors is generally wealth maximization (Jaffe et al., 1986, p. 29). Possible investor objectives are presented in table 7.2.

Table 7.2 Possible investor objectives (Jaffe et al. 1986, p. 30)

Possible investor objectives
Maximization of gross income
Maximization of net income
Maximization of taxable income
Maximization of before-tax cash flow
Maximization of after-tax cash flow
Maximization of income after taxes
Maximization of leverage gains
Maximization of depreciation write-offs
Maximization of interest deductions
Maximization of appreciation
Minimization of operating expenses
Minimization of negative before-tax cash flow
Minimization of negative after-tax cash flow
Minimization of income taxation
Minimization of management expenses
Minimization of financing expenses
Minimization of required equity down payment
Achievement of an “acceptable” rate of return
Achievement of sufficient returns to pyramid
Achievement of “satisfactory” results
Maximization of profits
Maximization of rate of return
Maximization of social benefits
Maximization of wealth

There are several types of investors (Ring et al., 1981, p. 509; see also Flanagan et al., 1989, p. 6.):

1) Investor
2) Speculator
3) Developer

All three take risks, although speculator risks are generally considered to be the greatest (Ring et al., 1981, p. 509). The attitude to investments and risks is determined by the role of the real estate in the owner organization (Flanagan et al., 1989, p. 6), and the success of any real estate investment depends on the timing, magnitude and riskiness of its expected cash flows (Jaffe et al., 1986, p. 1).

The cost-effectiveness of an investment is the most important factor in real estate investments (Greer, 1988 et al., p. 20), though when making investment decisions it is also essential to consider a building’s technical characteristics and suitability for the planned use (Flanagan et al., 1989; Greer et al., 1988; Lehtinen et al., 2001; Trivers, 1999b). Important issues related to investment analysis include:

1. Risk, return and investment value.

Investment value is the maximum price an investor is willing to pay (Jaffe et al., 1986, p. 4). Investors should have an overall financial plan based on their current financial resources and reasonable expectations of future financial position and income. In decision-making, they

need to consider the relationship between benefits and costs, ask how much they should pay in a given investment situation, consider the expected rate of return of investment, and whether the expected rate of return is commensurate with the risks (Jaffe et al. 1986, p. 19).

In order to be satisfactory, real estate investments should be based on clearly set objectives:

- Objectives for ownership. For example, does the owner aim at short term profits, long term returns or is it important to satisfy public needs, etc. (Flanagan et al., 1989, p. 6, Jaffe et al., 1986, p. 4)?
- The timescale of the building for the owner. How long does the owner expect to own the building (Flanagan et al., 1989, p. 6)?
- Who will use the building and how will it be used? How long will it take before the purpose for which the building is built will cease? What are the periods of occupancy (Flanagan et al., 1989, p. 3-6)?
- Do the building's structural and physical solutions allow for this planned use? Is the building able to fulfill the needs of user and usage (Lehtinen et al, 2001)?
- The expected value and condition of the building: capital value of the asset and income (Flanagan et al., 1989, p. 9; Trivers, 1999b).

In real estate investment situations, an investor prepares an investment plan correlated with other segments of the investor's financial plan, incorporating its strategies, goals and objectives (Jaffe et al., 1986, p.3). Quite often, investors are only interested in the expected and potential rate of return related to an investment. Still, it is important to have a basic understanding of the relationship between risks and the expected rate of return. In the real estate business, as we saw above, there are several types of risk. Conceptually, each type can be represented as a premium which must be added to the risk free rate to compare it with an investor's required rate of return (Jaffe et al., 1986, p. 28-29; Greer et al., 1988, p. 330). Figure 4.18 in chapter 4.5 presents the relationship between risk and return.

2. **Market research**

In market research the following should be considered: Land utilization, the value of real estate services, the financing environment, tax environment, legal environment and market environment (Greer et al., 1988; Jaffe et al., 1986, p. 7-13). In addition, it is important to measure demand for real estate services: physical and locational characteristics, and their availability (Greer et al., 1988, p. 95; Botton et al., 1998).

3. Forecasting cash flows

There are two major sources of cash flow from a real estate investment: 1) the annual cash flow from rental collections; and 2) the cash flow from the disposition of the investment, which is typically sale. The cash flow is the amount left after all the costs of operating and selling the investment have been paid. These costs include operating expenses, payments on mortage debt, and income tax. In decision-making, one needs to consider the relationship between benefits and costs, and also how much should be paid in a given investment situation. Also, if a certain price is paid, what is the expected rate of return on the investment and does the expected rate of return compensate for the risks (Jaffe et al. 1986, p. 13-19). Zavadskas also points out the importance of evaluating the cost-benefit ratio (Zavadskas et al., 1998).

According to Jaffe et al. (Jaffe et al., 1986, p. 199), if an investor expects to purchase a real estate intending to keep it (not sell it in the near future), effective property management becomes critical. Flanagan also stresses the importance of knowing how the existing building has been managed and maintained in the past and how it has been used (Flanagan et al., 1989,

p. 3). One of the most important factors affecting an investor's decision is the building's maintenance costs, as these have an effect on net profit (Aho, 1993, p. 47). According to Flanagan et al. (1989, p. 1), the starting point is that lifecycle costing has an essential role to play in decision-making, because it would be improved if it was based on the total costs of every investment rather than being based on the initial capital costs. According to Aho, a building's technical value is a wider concept than its productive value. Moreover, the investor's motives and income expectations are also important (Aho, 1993, p. 47-49). Jaffe compares the value of an investment to the expectations of an investor: "The value of an investment can be broadly defined as the present worth of the future benefits from owning an investment. Thus value represents the present worth of the income that an investment is expected to generate" (Jaffe et al. 1986, p. 1). As Flanagan points out, investment appraisal techniques need to estimate costs and benefits, risks and uncertainty. In order to be able to evaluate,

- how much should be paid in the investment situation;
- the expected rate of return on the investment; and
- whether the expected rate of return compensates for the riskiness of an investment, the relationship between riskiness and benefits,

investors must be aware of a building's technical condition, technical characteristics as well as design parameters, planned use and usage, previous use and usage, environmental circumstaneces, how the building has been maintained, and how it should be maintained, etc (Flanagan et al., 1989; Jaffe et. al , 1986, Aho, 1993; Lehtinen, 2000; Lehtinen et al., 2001; Sarja, 2000, Benda et al., 2000, p. 697-702; Horner et al., 1997).

4. Technical characteristics of an investment:

As pointed out in chapter 4, there are different kinds of building performance appraisal techniques: user-based appraisal systems and expert-based systems. The former systems focus on organizational or user satisfaction; the latter, expert-based techniques, are based on the judgements of professional experts (Bottom et al., 1998).

If the goal is cost-effectiveness in use and ownership, numerous factors regarding a building's characteristics need to be considered based on the owner's objectives for the building. In investment situations, the following characteristics of building performance could be analyzed:

- Analysis of investment risk assosiated with aesthetic, functional and social obsolescence (Bottom et al., 1998).
- Analysis of key physical characteristics:
    - Functional efficiency and physical durability are major physical characteristics affecting a property´s ability to remain competitive. Functional efficiency is a measure of how well a property is designed to do the job it is intended to perform (Greer, et al., 1988, p. 114; Ratcliff, 1961, p.58-60).
    - Functional efficiency is related to specific property uses and can be evaluated only in that context (Greer et al., 1988, p. 114).
    - Technical efficiency and durability is related to the necessary technical and hygrothermal design, taking into account the internal and external moistrure load (Lehtinen, 2000, Lehtinen et al., 2001).
    - Physical durability is a measure of a structure´s remaining physical life and is a function of the soundness of design plus the extent to which routine maintenance has forestalled structural deterioration (Greer et al., 1988, p. 114; Ratcliff, 1961, p. 58-

61; Bottom et al., 1998, see also: Trivers, 1999b; Lehtinen, 2000; Lehtinen et al., 2001 and Sarja, 2000).

- The aesthetic quality of a building (Ratcliff, 1961, 58-62).
- The expected life cycle of a building's support and infill parts. How old is the building, and how old are its main components? Forecasts of its life expectancy, remaining life cycles and obsolescence of materials and components (Gransberg 1997; Flanagan et al., 1989; also anon 2001b).
- IAQ (indoor air quality), including health, safety, and user satisfaction as well as other aspects, such as materials and other matters related to indoor air (Sobotka et al., 1998; Horner et al., 1997; Benda et al., 2000).
- Flexibility of the building (Benda et al., 2000, Gransberg 1997).
- The relationship between floor and window area and functionality and user needs (Flanagan et al., 1989; Bottom et al., 1998; Trivers, 1999b; Ratcliff, 1961) .
- Forecasts of the running costs, e.g., energy, electricity, gas and oil costs. How is the building cleaned, and how often must it be cleaned? What performance figures are available (Flanagan et al., 1989)?
- Maintenance: planned maintenance strategy, needed maintenance strategy, performed maintenance strategy (Zavadskas et al., 1998; Horner 1997).
- Energy efficiency (Sobotka et al., 1998; also Sarja, 2000).
- Ecological level (Sobotka et al., 1998, Sarja 2000; Trivers, 1999b).
- Economic objects and expectations for rate of return, costs, residual value (Flanagan et al. 1989; Benda et al., 2000).

When making an investment, the investor needs to know the future expenditure required for the building, both short and long term. Nevertheless, developers are frequently criticized for not being interested in considering lifecycle costs because running costs are the responsibility of tenants. Tenants, for their part, are interested in service charges and running costs. Developers should thus provide the best value for the money for their tenants (Flanagan et al., 1989, p. 9).

Appraisal techniques for assessing building performance are becoming an essential part of the property and facilities management process. Management attention may be focused on badly performing buildings identified using data which relates to physical building quality and/or tenant percieved performance. The measurement, storage, benchmarking and/or modelling of such detailed information, which has traditionally been excluded from formal investment decision-making approaches, will ultimately create value for both the owners and users of buildings (Bottom et al., 1998).

According to Balck (2001, handout), several participants take part in investment analysis. The tasks of these different participants are presented in table 7.3.

Table 7.3 Lifecycle management in a real estate project (Balck/handout/2001).

Chain of actions	**Project development or acquisition**
Real estate economic plan and/or management	Investment calculations Investor model Feasibility study Marketing goal
Builder project management (formal)	Project draft and und project application Resource plan
Object controlling	Due diligence Environmental analysis
Usage /Tenant	Market analysis
Service (Facility Management)	Service field analysis
Object Documentation	Decision documentation

ASTM E1765-98 provides a standard model for applying an analytical hierarchy process to multiattribute decision analysis of investments related to buildings and building systems. The model helps investors identify a multiattribute decision analysis application, describe the elements that make up a multiattribute decision analysis problem and recognize the three types of problems which the system can address:

1. Screening alternatives
2. Ranking alternatives
3. Choosing the final and best alternative

The model includes a comprehensive list of selected attributes--monetary and non-monetary--for evaluating building decisions according to the investor's vision. These attributes for building related decisions are presented in the following table (Table 7.4, does not include references to other ASTM standards).

Table 7.4 The attributes for building related decisions (ASTM E1765-98).

Attribute	
Level One	**Level Two**
1) Work functions	Support for office work Meetings and group effectiveness Typical office information technology Special facilities and technologies
2) Environmental/ergonomic supports	Sound and visual environment Thermal environment and indoor air
3) Flexibility and space planning	Change and churn of occupants Layout and building factors
4) Security and continuity of work	Protection of occupant assets Facility protection Work outside normal hours or conditions
5) Image, amenities and access	Image to public and occupants Amenities to attract and retain staff Location, access and way finding
6) Property management and regulation	Structure, envelope and grounds Manageability Management of operations and maintenance Cleanliness Fire and life safety
7) Building economics	First cost considerations Operations and maintenance cost considerations Economic measures

7.2.1.1 Summary of real estate analyses from the perspective of the technical life cycle

Figure 7.2 presents a summary of analyses and other important issues from the perspective of technical life cycle cost-effectiveness, related to investment analysis of real estates.

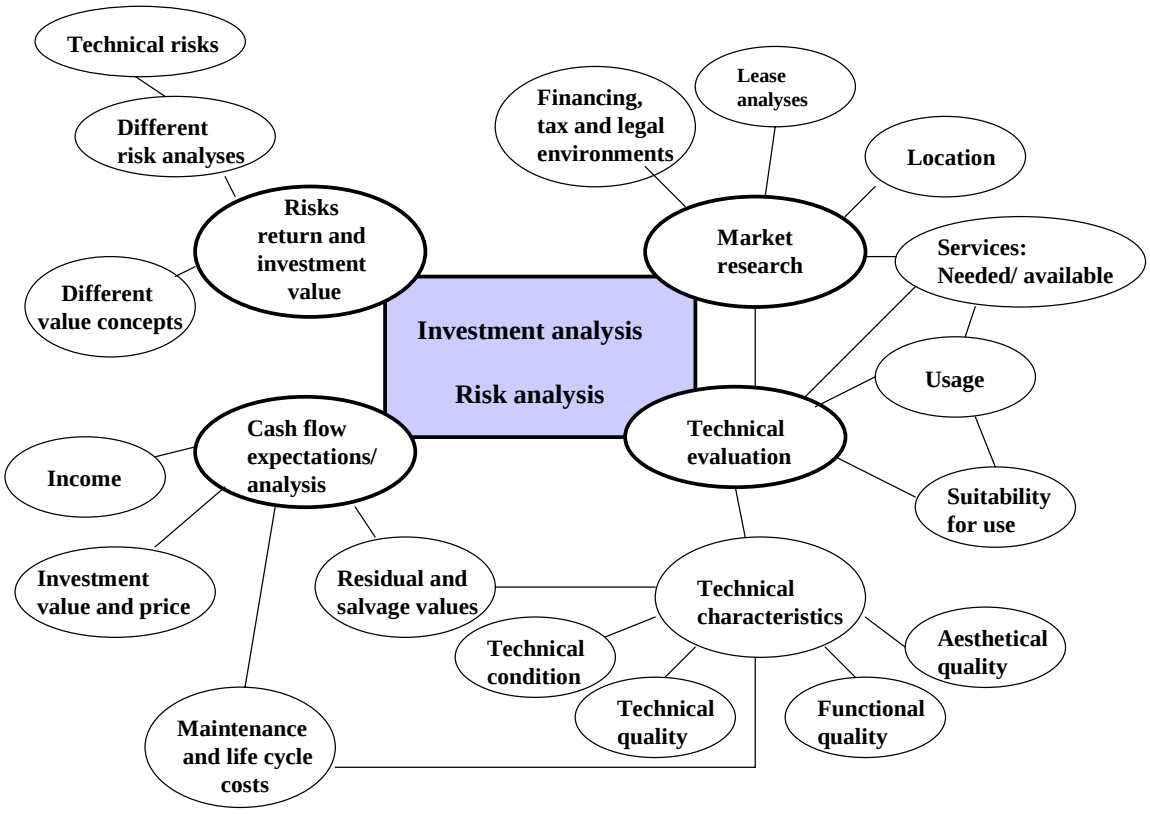

Figure 7.2 Analyzing real estates from the perspective of the technical life cycle.

7.2.2 Life cycle of a real estate

In this section, we will examine the different kinds of life cycles related to real estates, buildings and the real estate business.

The life cycle of a property can be divided into a few main phases. The life cycle of the land can be considered eternal. In terms of buildings, we can differentiate between their technical and useful economic lives (Halder, 1999, p. 4).

The life cycle of a building consists of the following phases, which are also shown in figure 7.3:

1) Land acquisition
2) Development of the building
3) Utilization of the building
4) The time after utilization, building is vacant
5) Redevelopment phase
6) Second utilization
7) Demolition

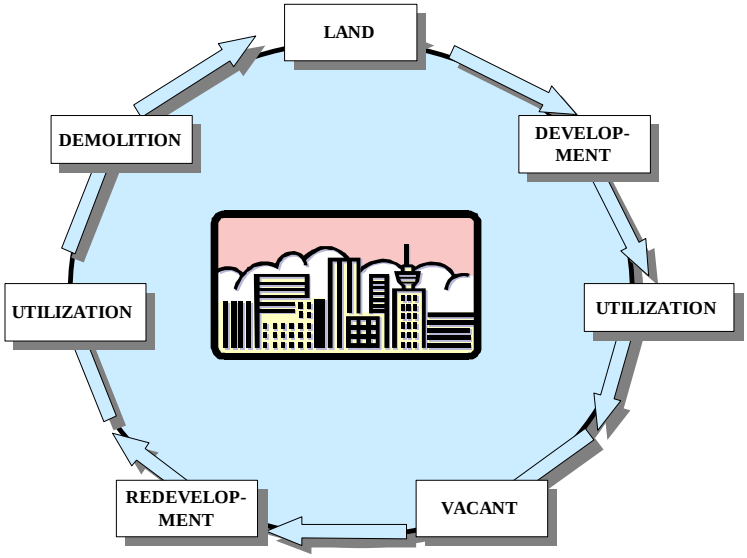

Figure 7.3 Life cycle of a real estate (adapted from Halder 1999, p. 4; see also Schulte 2000b, p. 143)

Sarja (in anon., 2001b, p. 19) defines the life cycle of a building more broadly than Halder, saying that "The life cycle of the building includes all the phases of the building or its parts from acquisition and producing of raw materials till disposal of waste of demolished building." Rakli (anon. 2001a, p.10) proposes a similar definition: "The life cycle of a real estate includes the phases of the real estate from land acquisition and possible construction of the building via utilization till the demolition of the building. "According to Zavadskas "the lifetime of the building begins with determining its purpose when a client and designers define the demands for a building and specify the limitations." (Zavadskas et al.1998, internet article p. 3).

Aho also proposes that the life cycle of a real estate consists of all the phases from the initial decision to invest in a new building to demolition. Obviously, the life cycle of a building lasts tens of years. A real estate requires a large initial investment along with a long-lasting duration of action. Moreover, it binds the owner to additional investments, e.g. energy and community technical decisions, for a considerable period. Real estates are also fixed in one location, and hence should be considered separately as long-acting investment objects with an arrogation of yield. Therefore, the most crucial factor in minimizing investment risk is to have the most accurate knowledge available about the life cycle of a real estate, as well as knowledge about the factors affecting its life cycle (Aho, 1993, p. 11 and 46).

The life cycle of a real estate also includes the life cycles of production and services in the real estate (Aho, 1993, p. 46). In addition, the usage and chosen maintenance strategy affects structures, materials and their forecastable life cycles and life cycle costs (Flanagan, 1989, p. 3). Usage makes demands on a building's structural and physical characteristics (Lehtinen et al., 2001). The life cycle of a real estate can thus also be divided into the expected periods of use, usage or ownership (Flanagan et al., 1989 p. 4), or expected period of economic life cycle (Aho, 1993, p. 48 and app. 1) or into the life cycle of structures, systems, device and premises (anon., 2001b, , p. 54-55; Flanagan et al. 1989). Various expressions are used to define the life of a product. According to Flanagan et al. (1989, p. 36) the most common are:

- “Acceptable life
- Average life. The time of 50% failure.
- Minimum life. Often the true life of the product is much greater.
- Design life. For example, the design life of bridges can be 120 years. The design life of a building (its structures) can be 100-200 years. The life cycle of a building’s infill may be shorter, such as 5-10 years.
- Expected service life. Expected life is a balance between minimum life and design life.”

The user’s needs and quality expectations vary by usage, but also by changes in work life, organizations and society. These changes in expectations have an effect on technical demands, solutions, design and also on maintenance performance (McGregor, 2000; Bottom et al., 1998; Flanagan et al., 1989, Lehtinen et al., 2001). As McGregor points out, work is no longer just a place, but more an activity that can be done anywhere. It is clear that a business’s requirements for workspace will change in terms of quality, quantity, location, diversity and functionality (McGregor, 2000, IA p. 2).

Technical phenomena have a remarkable effect on the life cycle of a real estate (Tuppurainen et al., 1988, p. 19, in Aho, 1993, p. 46). Besides a building’s technical properties, many political and social factors have an effect on the income and yield of a given real estate (Hintikka 1999). In investment situations, a wider perspective is used, so that the technical value of a building is seen as part of a wider concept of value, its productive value. It is possible to do a usability study, using estimates of yields and costs, to determine whether a building is capable of achieving an investor’s aims. Indeed, it is possible that it would not be cost-effective to own a building, and that the property might be at the end of its economic life, even if its technical performance was acceptable (Aho, 1993, p. 47).

According to Wong, conventional valuation techniques tend to ignore refurbishment or re-development of real estate, although everybody knows that real estates do not last forever. He presents an alternative approach to assessing property value as well as its sensitivity to refurbishment cost and frequencies, showing that by assessing capital value under different scenarios of the refurbishment cycle, the appraiser may advise real estate owners not only about the values of their properties, but also about the expected frequency of refurbishment cycles, taking into account the desired duration of leases (Wong, 2000).

As Loch points out, change is really the only constant. True flexibility of premises means being able to move in and out of buildings as business needs change (Loch, 2000). Therefore, one factor in analyzing technical properties of buildings and the cost-effectiveness of ownership may be the relationship between technical characteristics and changing tenant needs(the life cycles of the needs of tenants) – the purpose of ownership and the building’s ability to fulfill the objectives of cost-effective ownership. Technical solutions have an effect on these characteristics. (Lehtinen et al., 2001; Trivers, 1999b; Bottom et al., 1998.) In addition, according to the principles of open building (Tiuri et al., 1998), a building can be divided into constant support parts and variable infill parts. Infill makes it possible to flexibly adapt the premises. The lifecycle expectations for infill parts are shorter than those set for support parts. Service life planning is part of the planning and design process in which the life cycles of different parts and structures of the building are optimized and defined according to the objectives of the owners and users, and according to general instructions (anon., 2001b, p. 19).

According to Bottom, both physical deterioration and building obsolescence have an effect on life cycle and usability. Obsolescence may be aesthetic, functional, social, legal, economic and environmental (Bottom et al., 1998). In building lifetime analysis, it is possible to carry out economic, technical, managerial, comfort and other kinds of optimization throughout the

building's lifetime (Zavadskas et al., 1998). "When work is no longer just a place," the business requirements for workplaces will change in terms of quantity, quality, location, diversity and functionality (McGregor, 2000). Therefore, there may be various different life cycle phases within a real estate life cycle.

The life cycles of real estates can be considered from different perspectives: in its longest definition, the technical life cycle lasts from the decision to construct until demolition. Yet only few, if any, of a building's technical parts lasts that long without maintenance. Moreover, economic life cycles, economic use and cost-effective ownership, along with life cycles of ownership, use and usage, usually do not last as long as the total life cycle of a building. Sometimes, in a changing world, a locational life cycle may be critical. Therefore, in life cycle planning and optimizing, different life cycles, life cycle costs and risks need to be taken into account.

7.2.3 The life cycle phases of a real estate

This section takes a more detailed look at the main phases of a real estate's life cycle, focusing especially on the technical life cycle.

7.2.3.1 Development of the building

Development of a building starts in the investment decision phase. Before an investment decision, an investment analysis should be done. In this analysis, a building's technical characteristics must be considered in terms of the owner's objectives for this investment. (Sarja, 2000; anon., 2001b.)

To determine the most efficient version of a building's lifetime process, it is advisable to consider the following principles (Zavadskas et al. 1998, IA p. 1-2):

1) Complex analysis, which aims at "cutting the costs expended on the brief, design, construction and maintenance processes." It also aims at achieving higher standards of quality.
2) Functional considerations, based on the functions that will be performed in a building.
3) Cost-benefit ratio optimization
4) The application of results of various interrelated sciences
5) Simulation of a building's lifetime process, done together with all the parties interested in the building's effective lifetime and trying to achieve that goal.

The main phases of construction design are defined as follows (anon., 2001, p. 26):

1) Definition of goals, needs and functional requirements of the owner and user.
2) Definition of economic and functional requirements of the building
3) Definition of the economic (financial economy and ecology) and technical properties of the building.
4) Economic and technical specification of the building and structures

Table 7.5 shows the main phases of the construction project and the parties involved in the phases (anon., 2001b, p. 25).

Table 7.5 The main phases of the construction project and the parties involved in the phases (anon., 2001b, p. 25).

The phase of the construction project	The parties of the phases
Clarification of needs and investing analysis phase	- Owner, builder–consultant, architect
Project planning	- Owner, builder–consultant, architect - Technical advisers: construction designer and HVAC designers
Design planning	- Builder–consultant, architect, construction designer, HVAC-designer
Implementation planning, design (building physical design, architectural design, construction design, HVAC-design etc.)	- Builder–consultant, architect, construction designer, HVAC-designer - Production designer of the construction company, building material designers
Design when the building is under construction	- Builder–consultant, architect, construction designer, HVAC-designer - Production designer of the construction company, building material designers
Design of the implementation phase, the phase when the building is taken into use	- Builder–consultant, architect, construction designer, HVAC-designer - Production designer of the construction company, building material designers - Owner and user
Use of the building, maintaining phase	- Owner, maintaining consultant and organization

According to RIL (anon., 2001b, p. 29), the tasks of the construction designer in different phases of the building life cycle are:

1. Investment planning
2. Requirement definition of the life cycle design
3. Financial and economic life cycle evaluation and optimization of building by means of technical alternatives of structures, materials, architectural or HVAC-technical solutions etc.
4. Energy life cycle decisions, optimization from the perspective of ecology and economy.
5. Service life design of structural- and plant-modules from the perspective of ecology and economy as well as usability and technical performance.
6. Detailed service life design of structures
7. Implementation decisions between different technical possibilities
8. Inclusion of life cycle requirements (service life, technical performance, lifecycle costs, ecology, energy economy, healthiness etc.) on contract documents and subcontracting agreements.
9. Preparation of the building's maintenance book.

Phase 1 is the owner's decision-making phase, but it nevertheless includes the following tasks for the technical life cycle designer or manager:

- Life cycle calculations of requirements taking into account economy and ecology.
- Multiattribute decision analyses and optimizations.
- Participation in needs analyses and needs specification.

In the decision-making phase, it is very important to define the investor's/owner's strategic needs and goals, as optimization and design decisions should be made according to these goals (Smith, 2000; Zavadskas et al. 1998; Trivers, 1999b).

According to Sarja (Sarja, 2000, p. 1-3), integrated life cycle design consists of a design process model and of several design methods. A summary of the design phases and methods of his multiattribute decision analysis is presented in table 7.6.

Table 7.6 Design phases and methods of multiattribute decision analysis (Sarja, 2000, p.3)

Design phase	**Life cycle design method**
1. Investment planning	Multiple criteria analysis, optimization and decision-making. Life cycle (monetary and natural) economy
2. Analysis of the needs of clients and users	Modular design method. Quality function deployment (QFD)
3. Functional specifications of buildings	Modular design method. Quality function deployment (QFD)
4. Technical performance specifications	Modular design method. Quality function deployment (QFD)
5. Creation and sketching of alternative structural solutions	Modular design method.
6. Modular life cycle planning and service life optimization of each alternative	Modular design method. Modular service life planning Life cycle (monetary and natural) economy calculations
7. Multiple criteria ranking and selection between alternative solutions and products	Modular design method. Quality function deployment (QFD) Multiple criteria analysis, optimization and decision-making.
8. Detailed design of the selected solution	- Design for future changes - Design for durability - Design for health - Design for safety - Design for hygrothermal performance - User's manual - Design for re-use and recycling

Sarja prefers a modular systematic because it allows systematic allocation and optimization of the target service life, life cycle ecology and economy of different parts of a building. He also emphasizes the importance of designing structural modules of the building for different performance requirements, such as design for future changes, design for durability, design for health, design for safety, design for hygrothermal performance, design for reuse and recycling (Sarja et al., 1999b; Sarja, 2000).

Lehtinen has designed a model for the hygrothermal design of buildings and building structures. In his model, the important phases included in preliminary study are making the needs analysis and specifications, gathering background information, determining the needed hyrgothermal design level and analyzing the suitability and potential of a possible existing building for a planned use (Lehtinen, 2000, p. 508; Lehtinen et al., 2001, p. 18).

Also, Zavadskas et al. point out the importance of functional considerations based on the assessment of the functions to be performed in a building to be designed, constructed and maintained. The expenditures associated with these functions are usually determined by taking into account the benefits of a function and the costs of its realization (Zavadskas et al., 1998).

It is very important to define the objectives of the users and owners in the early stages of a construction project. To cut overall costs during the lifetime of a building it is necessary to explore various cost-saving measures at all phases of the lifecycle, and indeed one acute problem has always been to determine the correct relationship between building brief, design, construction and maintenance expenses and the benefits thus obtained. Efforts are always being made to get the maximum benefit at the minimum expense, i.e. by optimizing the cost-benefit ratio. In order to ensure that all necessary perspectives for decision-making are included, it is important to gather all the stakeholders together in this process (Zavadskas et al., 1998.)

Once the goals have been defined, it is essential to find a competent project team for the designing and construction phases (Trivers, 1999a; Smith, 2000; Al-Hammad, 1997; Lehtinen et al., 2001; Gransberg et al., 1997). According to Gransberg, the team should consist of the owner's executive member and project coordinator, project manager, construction manager, design contractor team leader, construction contructor team leader, contracting specialist, tenant representatives and technical consultants (Gransberg et al., 1997). RIL also suggests that it is possible to achieve all the goals that have been set for the life cycle and technical life cycle of a building by using integrated life cycle design, in other words, the comprehensive design of the total building and its parts where the following two characteristics are taken into account: all the requirement groups should be taken into account and the whole design lifecycle, with all its features and time periods, should be taken into account in the planning phase (anon. 2001b).

When the investor/owner has defined the goals and demands for the building, s/he should then be able to choose competent architects, designers and constructors for the current project (Trivers, 1999a). Trivers points out that in choosing designers in a construction project, it is important to select an architect for the right reasons. The process of selecting the right architect begins, according to him, when a list of architects is developed based on the firms' demonstrated project experience in the project type. "Evaluating the architects' examples of work and project experience with your project's size (square footage) and scope (timeline, process, people, etc.)" helps to find potential architects. The constructor's or owner's visions and needs must be understood. In addition to assessing their understanding, verify their understanding with demonstrated project experience (Trivers, 1999a, IA p. 2; also Gransberg et al., 1997).

As Levin points out, especially from the perspective of IAQ (indoor air quality), it is important that designers and constructors are able to show how they have done similar projects before and achieved good IAQ results. "They have to be able to prove that their personnel is well trained and motivated and that they know what IAQ sensitive construction is and how it affects their work. They should work with a quality control plan and a systematic approach to ensure future building performance" (Levin et al. 2000, p. 17). Gransberg, too, emphasizes the importance of selecting the right project team, for the design team must be competent enough to satisfy the project's long-term goals. He says it is best to choose a customer-focused and results-oriented project team, which can achieve all the operational, budgetary and schedule goals that are set for the entire life of the building. The project team consists, for example, of the owner, constructor and technical consultants. The lead designer joins the life cycle project management team. In the pre-design phase a partnering session may be held to further reinforce the new relationship and ensure that the project needs of the

owner are fully understood by the team members. Gransberg notes that “excellence in construction management starts with excellence in project management” (Gransberg et al., 1997, p. 1). He also points out that life cycle project management is management of the entire life of a project, from conception to warranty-close out. Construction management is only one phase in what should be a “seamless project management process” (Gransberg et al., 1997, p. 1) That is, whereas traditional project management starts in the concept, design and feasibility study phase, continuing through the design phase to the construction, commissioning and closeout warranty activities, this new life cycle project management includes the whole series of phases before starting the design (Gransberg et al., 1997).

Pekkala focuses on the role of the owner, demonstrating that the owner/ investor wants to be in a central position all through the construction project, able to supervise all of its phases. Furthermore, the owner/investor wants to be in direct contact with all the parties in the construction project (Pekkala, 1998).

According to Gransberg, the concept-design-phase includes the following considerations (Gransberg et al., 1997, p. 4):

- Defining a minimum facility size or capacity.
- Discussing expectations for facility aesthetics in relation to its surroundings.
- Quantifying the expected life and provision of features to allow expansion for future growth of the activities contained within the facility
- Calculating the expected life cycle costs parameter that must be met for operations and maintenance costs
- Identifying the impact of future technological advances that may have an impact on the facility during its life
- Analyzing environmental impacts, etc.
- Identifying short-term issues, such as the length of the construction period.

Trivers considers the types of questions which should be addressed after the design team has been chosen: “How many people will work in the facility? Who communicates with whom? What are the conferencing needs of the team? Does the organization need large or small conferencing spaces or a combination of both? What central services--copying, fax, etc.--are needed? Staff roles and responsibilities demand an efficient workplace equipped to promote productivity, creativity and teamwork” (Trivers, 1999c, IA p. 2).

Zavadskas also refers to the large number of tasks in the design stage: “Design stage includes technical and architectural calculations, drawings, specifications, estimate preparation, etc. At this phase, maintenance strategies and objectives as well as the means to be used to achieve them should be determined. The extent and efficiency of maintenance depends on the volumetric-planning and design solutions, as well as on the quality of materials, structures and engineering services, the capacity to satisfy the requirements of a user and other factors. A maintenance specialist should be involved at the design stage of project realization to ensure that maintenance problems are taken into consideration at the very beginning of design work” (Zavadskas et al. 1998, IA, p. 4).

In the design phase, the hygrothermal structural drawings and other documentation must be defined in co-operation with a structural designer. In Lehtinen’s hygrothermal design model, the design phase includes the following tasks and documents (Lehtinen, 2000, p. 509-510; Lehtinen et al. 2001, p. 18):

- Design documents and implementation instructions. The overall functional drawings and details for structural joints and sections must be included in the final design.
- The hygrothermal calculations, analysis and descriptions of hygrothermal assumptions must be documented.

- The necessary quality control tests and measurements must be defined and carried out.
- The necessary weather protection of building materials and structures during construction must be defined.

Levin et al. and also Lehtinen et al. emphasize of the importance of quality control during construction, for even at this phase there are critical details in the building which should be inspected, and such inspection is not possible if the areas are covered. Such inspection points include, for example, the integrity and thickness of the moisture barriers in bathrooms, as these must be verified before tiling. Also, the proper operation of the drainage system must be verified before backfilling of the foundation. These inspections should be commissioned during the construction phase (Levin et al., 2000; Lehtinen; 2000, Lehtinen et al., 2001).

In the design phase, the project team meets periodically in order to ensure that the design will be done according to the owner's long-term objectives. Also, construction team selection and the type of the contracting mechanism are important decisions connected to achieving the goals. After selection, the construction team members should be included on the project team (Gransberg et al., 1997).

According to Levin et al., the "pre-bid conference," whose aim is to explain IAQ (healthy building) objectives and reduce uncertainty among potential bidders, is very important. It is critical to the potential bidders to understand the importance of indoor environmental quality and the aspects of construction that will affect the quality of construction and the indoor environment of the completed building. The potential bidders should also be familiar with the nature of the products and processes that will be needed (Levin et al. 2000, p.17). There are many ways, according to the literature, to carry out construction work. The contracting method in the construction phase should be defined according to the actual need (Pekkanen, 1998; Pernu et al., 1999)

The hand-over-phase of the building is very critical from the perspective of its technical life cycle. In this phase, it is important to make sure that the whole construction project is carried out, taking into account all the technical life cycle demands and goals for the building. Gransberg writes about "commissioning" as follows: "Commissioning the building is much the same as commissioning the battleship"(Gransberg et al., 1997, p. 6). In a construction project all the plans and documents developed in the previous phase are implemented at this time. The people who must make the facility work must understand the design parameters – and must be involved in this phase" (Gransberg et al., 1997, p. 6). In addition, there are numerous components and performance criteria that may require testing in the commissioning phase, such as the HVAC-system, the tightness of an envelope, the resistance of structures to moisture intrusion, window and door leakage of air and water, etc. It is important that the party who does the verifications and commissioning is independent. The commissioners should be certified (Levin et al. 2000, pp. 17-23).

7.2.3.2 Utilization phase of buildings – usage and maintaining

It is necessary to measure the performance of existing real estate both from the perspective of view of the occupier organization and the owner. Bottom points out that especially the building design and associated qualities, along with changing tenant (user) requirements, are features to be measured, as they are of particular relevance to the management of office portfolios and the investment risk assosiated with aesthetic, functional and social obsolescence. Building performance appraisal techniques consist of user-based apparaisal systems and expert-based systems. User-based systems focus on organizational or user satisfaction, measuring the physical aspects important to users. Expert-based techniques are based on the judgements of professional experts. From the user's perspective, factors related to building services and the tenants` work environment are the most important. In addition,

common space areas are also important. Appraisal techniques for assessing building performance are becoming an essential part of the property and facilities management process. Management attention may be focused on badly-performing buildings identified using data concerning physical building quality and/or tenant perceived performance. The measurement, storage, benchmarking and/or modelling of such detailed information, which has traditionally been excluded from formal investment decision-making approaches, will ultimately create value for both owner and users of the buildings (Bottom et al., 1998).

Benda also points out that the asset value of a building, the measure of its worth in financial terms, is related to how the building is designed, constructed, operated, and maintained. Technical life cycle management has an effect on both users and owners of real estate. For users, it is possible to offer healthy, safe, and flexible work environments which strongly support the organization's primary objectives; for owners, technical life cycle management in the long term has a clear effect on net profit (Benda et al., 2000, p. 697).

Another important issue is maintenance. According to Seeley, (Seeley, 1976, in Horner et al., 1997, IA, p. 2) maintenance of buildings is defined as "work undertaken in order to keep, restore or improve every part of the building, its services and surrounds, to a currently accepted standard and to sustain the utility and value of the facility."

Balaras et al. point out that that the number of existing buildings is greater than the number of new buildings and that proper maintenance extends the useful life of old existing buildings, so it is essential that real estate owners consider maintenance. In addition, the operational costs of buildings tend to grow with time and technical problems often become worse unless some actions are taken. The importance of maintenance, refurbishing or upgrading the buildings is obvious. In his overall evaluation of buildings there are three sectors included: construction and functioning of the buildings, energy consumption of the buildings and the quality of the indoor air in buildings (Balaras et al., 2000).

The objectives of building maintenance can be defined as follows (Alner et al., 1990, in Horner et al., 1997, IA, p. 2):

- To ensure that the buildings are in safe condition and fit for use
- To ensure that the condition of a building meets all statutory requirements e.g. safety, health and welfare provisions
- To carry out the maintenance work that is necessary from the perspective of the value of physical assets of the building stock
- To carry out the work that is needed from the perspective of quality of the building.

Zavadskas defines the importance of maintenance as follows: "Adequate maintenance should be provided throughout the entire lifetime of a building ensuring that a building and its facilities meet the requirements raised by the users and specifications" (Zavadskas 1998, IA, p. 4). Therefore, the optimization of maintenance actions is important. He points out that the relationship between building brief, design, construction and maintenance expenses and benefits must be defined and implemented in the different phases according to definitions and objectives (Zavadskas, 1998). Smith also emphasizes optimization: "How much maintenance is enough?" Too little maintenance, of course, saves money initially but invariably leads to higher maintenance costs in the long run. On the other hand, too much maintenance is not cost effective; it may reduce unplanned outages, but may also cut the savings from increased availability and outages. The secret, according to Smith, is optimization (Smith et al., 2001, IA, p. 1).

Some other definitions useful in understanding the purpose of the maintenance plan and process include (Flanagan et al., 1989, p. 175-177; Scarret 1995):

- Maintenance schedule: a comprehensive list of items and the maintenance required, including the interval at which maintenance should be performed.
- Maintenance program: a time-based plan allocating specific maintenance tasks to specific periods.
- Maintenance planning: deciding in advance the jobs, methods, materials, tools, machines, labor and time required, and timing of maintenance actions.
- Planned maintenance: maintenance organized and carried out with forethought, control and the use of records according to a predetermined plan.
- Preventive maintenance: maintenance carried out at predetermined intervals according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item.
- Opportunistic maintenance: maintenance of an item that is deferred or advanced in time when an unplanned opportunity becomes available.
- Deferred maintenance: corrective maintenance which is not immediately initiated after a fault recognition but is delayed in accordance with given maintenance rules.
- Emergency maintenance: maintenance which must be performed immediately to avoid serious consequences.

Horner et al. present a new approach to building maintenance strategy which aims at reducing the maintenance costs of existing building stock. According to Horner et al., ”Current building maintenance strategies, whether based on planned or unplanned maintenance, are most likely to be budget driven. Therefore the maintenance is not carried out according to actual need, but is dictated by financial priorities decided at the time or during the previous 12 months.” According to him the budget should be built up as a result of estimated needs – not according to figures of previous years (Horner et al., IA p. 4; 1997). In addition, when designing the building and planning the maintenance strategy, it is necessary to take into account that there may be reductions in visibility making it more difficult to check the condition of structures and/or reductions in the level of maintainability or replaceability of structures (Lehtinen, 2000, p.507-512).

Maintenance can be divided into 3 strategies (Horner et al., 1997, IA p. 2, see also Smith 2001):

1. Corrective or reactive maintenance – failure-based maintenance
2. Preventive maintenance - interval-based maintenance
3. Condition-based maintenance - predictive maintenance

Horner et al. points out that the strategic choice between these maintenance methods should be done according to the significance of the item of the building. Significant items are those whose failure affects health, safety, the environment or utility, including costs. Non-significant are those items whose failure has no significant effect (Horner et al. 1997).

Strategic planned maintenance together with strategic planned construction and strategic business vision planning makes it possible to maintain the real property. Tsang points out the importance of strategic planned maintenance: “Considering maintenance a purely tactical matter is myopic. It also has a strategic dimension covering issues such as design of facilities and their maintenance programs, upgrading the knowledge and skills of the workforce and deployment of tools and manpower to perform maintenance work. These decisions have lasting effects on the future operation and maintenance (O&M) of physical assets” (Tsang, 1998, IA, p. 1). He points out that with this broadened view, strategic issues that are related to the acquisition, improvement, replacement and disposal of physical assets will be disussed related to maintenance. This enlarged view also includes tasks such as routine servicing and periodic inspection, preventive replacement, and condition monitoring (Tsang, 1998).

According to Tsang, there are four steps in the strategic maintenance performance process (Tsang, 1998): 1) Formulating a strategy, 2) Operationalizing the strategy, 3) Developing action plans to achieve the strategic objectives, and 4) Periodic review of performance and strategy. The maintenance strategy should be linked to corporate strategy. He points out some examples of maintenance startegies like maximizing asset utilization, improving responsiveness or focusing on developing core competences. Al-Hammad et al. point out that the maintainability of a building should be taken into account already in the design phase of a new building: ignoring the availability of maintenance equipment and access for maintenance equipment may increase costs and efforts during the usage period of a building. Designers should consider the needed frequency of maintaining the elements of the building. Maintenance should be possible without interrupting the building`s operation (Al-Hammad et al., 1997, IA p. 2).

There are a number of factors relevant to the use of the building, factors, which can be relevant either from the point of view of the owner or the occupier. These factors may be summarized as follows (Flanagan, 1989, p. 39): physical deterioration, economic obsolescence, functional obsolescence, technological obsolescence, social obsolescence, locational obsolescence, legal obsolescence, aesthetic and visual obsolescence and environmental obsolescence.

Obsolescence is important for commercial properties since as buildings get older, they no longer perform as well financially, and their rates of rental growth slow down in comparison with trends in full market values. Refurbishment of the building includes adaptation, retrofitting, uprgading and rehabilitation. Modernization of the building includes minor work to modernize and improve a system or a property--much of this work is services connected to mechanical and electrical engineering. Maintenance includes replacing and repairing work and minor work to comply with legislation. Fitting out is usually a capital cost which involves adapting and finishing a building or system to meet a tenant´s needs (Flanagan, 1989, p.43).

When the life cycle of cost-effective ownership or the technical life cycle of a building ends, the owner considers the possibilities between developing the business idea, selling, renovating or demolishing a building. Such considerations are strategic for the owner (Nutt, 1992; Lundstöm, 1999; Flanagan, 1989; Gransberg, 1997; Trivers, 1999b). Therefore, before making any decision the possibilities should be reflected against the owner’s objectives (Aho, 1993; Flanagan, 1989; Gransberg, 1997). These decisions are related to investment analysis, which we discussed in 7.2.1 on investment analyses and technical analyses of buildings.

7.2.3.3 Renovating buildings

From the perspectives of ownership and usage of buildings, there are situations where the owned or used facility does not correspond to the objectives of ownership or usage anymore. The business idea for the building should then be developed, or the building should be renovated, demolished or sold.

A refurbishment project can also be seen as an investment. The expectations concerning investment are economic, so refurbishment also has to fulfill economic profit expectations. In principle it is easier to estimate incomes from the project, e.g. by selling the object after refurbishment. If the object is not going to be sold, the yield is gained over time as rental income or profit from activities located in the building. Also, the economy of the project is influenced by changes in maintenance costs (Aikivuori, 1994, 30-31).

Before a refurbishment project, the real estate owner needs to consider which actions and investments best serve the objectives (Trivers 1999c; Smith, 2000) and also the current state of the building should be described and the costs of various needed refurbishment works should be estimated (Caccavelli et al., 2000a, p. 159). Smith points out that before committing

to any kind of project, the real estate owner should work through his strategic needs and objectives. The stakeholders and professional advisers involved in the project initiation stages must understand that to asses the strategic needs of real estate owners (or other stakeholders) they will be involved in a complex, demanding and often unstructured environment. This process should involve as many significant stakeholders as practically possible (owner, managers/executives, facility manager, project managers, staff of employees, tenants, visitors, customers, etc.) (Smith, 2000).

According to Trivers, when thinking about a refurbishment or other project related to premises, the changed needs of occupiers leads to the following questions: Should you start from scratch and build new? Or should you renovate where you are at now? Sometimes the best way to fulfill the changed needs is to buy an existing building for sale (Trivers, 1999a). A precise strategic needs analysis helps to answer these questions (Smith, 2000). We discussed these issues more deeply in the chapter on investment analyses.

Trivers presents a list of factors that the project team of an owner organization should consider when considering the purchase of an existing facility or considering a refurbishment project (Trivers, 1999a). Zavadskas et al., Bottom et al., Smith and Flanagan et al. also present similar ideas (Zavadskas et al., 1998; Bottom et al., 1998; Smith, 2000; Flanagan et al., 1989). According to Trivers, to assess an existing facility--its usability--the project team should exhaust every effort to physically examine the facility. The team should not make any assumptions without careful on-site investigation. When considering the purchase or renovation of an existing facility, the team should determine generally whether the facility can meet current and future space requirements – if the building is large enough, or can the facility provide the spatial organization or flexibility required in the day-to-day operations of the user organization, can the building be expanded and is there sufficient land with the property to provide for current and future parking requirements or an expansion in the future? Also, environmental concerns may be important. The building should be surveyed for any environmental problems including asbestos, lead-based paint or other hazardous materials. In addition, possible contaminations should be assessed. It is also important to analyse to what degree the building requires modifications to meet the needs of the user: Does the facility require significant modification, especially major structural changes that may cost a lot? Studying the types of construction used when the facility was built may add value to the investigation. Sometimes a selective demolition provides a tangible reading of a facility's condition. In addition “to assessing structural, mechanical and electrical systems, the project team must determine floor-to-floor heights and check between ceilings and below floors. In addition to accommodating mechanical and electrical systems, today's technology demands sufficient space to run high volumes of cabling and raceways. This is especially critical when computer and media centers requiring advanced technology are included in the program.” Trivers points out that after finalizing the feasibility study, the project team will have derived figures based on the structure and its physical evidence. The debate over whether to purchase and renovate, or build new, becomes less gray, more black and white. However, the final decision is ultimately made on a case-by-case basis, and may not be completely based on economics. This is especially true when historical considerations are involved. If renovation is not a feasible option for reasons specific to the project for any of the reasons discussed, the building owner may elect to build new (Trivers, 1999b, IA, p. 2).

Also Brandt et al. point out that in considering upgrading solutions for a building it is important to asses the degree of physical degradation, extent of any degradation and extent and costs of the needed renovation works of the building (Brandt et al., 2002, p. 121). According to Allehaux et al. it is also important to study functional obsolecence. The criteria of functional obsolecence consists of the following issues: user needs, maintainability, divisibility and flexibility (Allehaux et al., 2002, p. 127-128).

Niemi et al. (1989, in Aikivuori, 1994, p. 27) present the phases, participants and necessary documents for a reutilization project in which an old existing building is taken into a new use (figure 7.4).

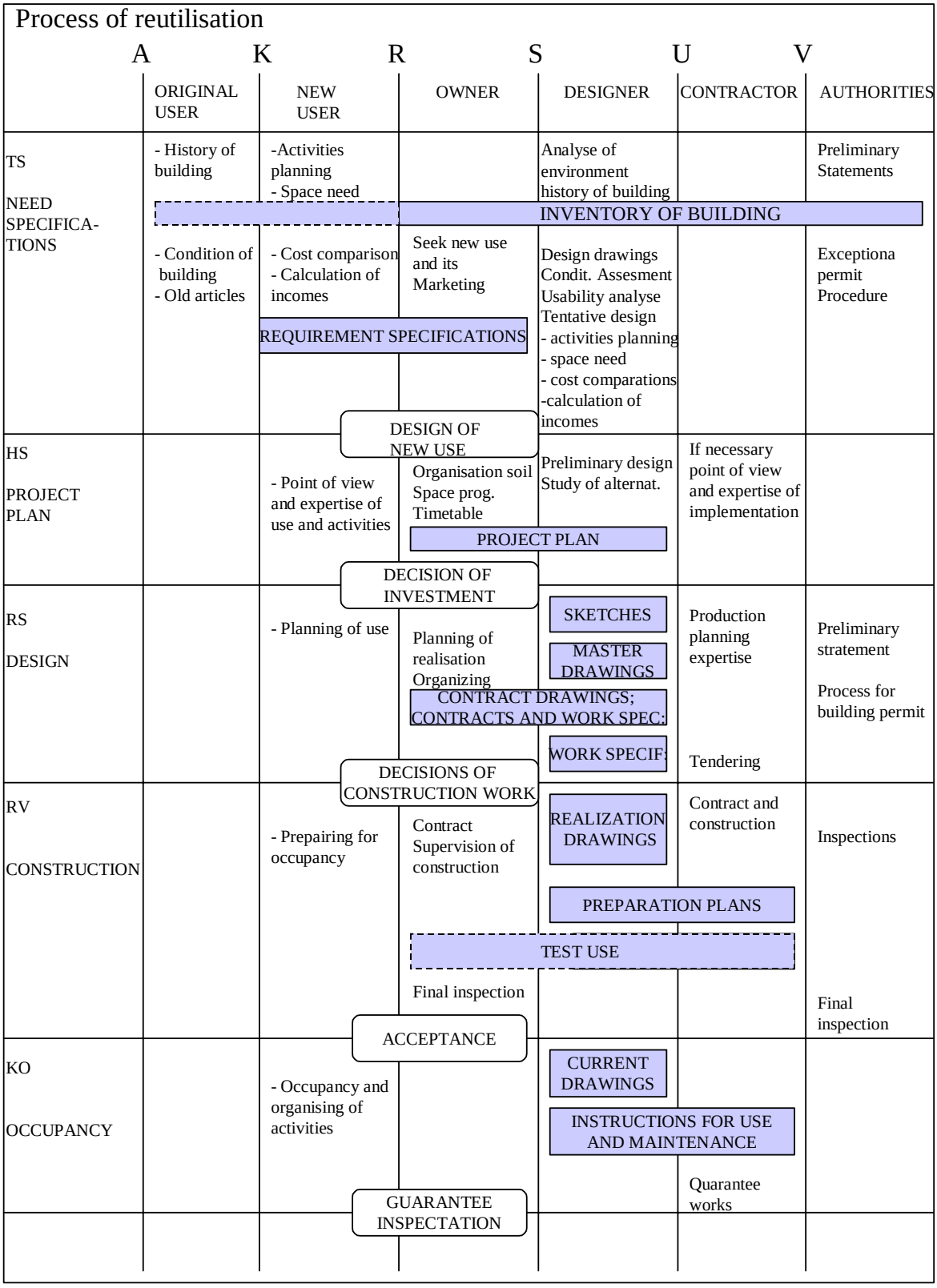

Figure 7.4 Phases participants and documents needed in reutilisation project (Aikivuori, 1994, p. 27).

Aikivuori points out that despite our modelling of decision-making processes, and theoretically involving all stakeholders in these processes, decision-making is not always based on optimal choices. For her, human behavior related to decision-making in refurbishment projects is not a clear case of seeking a technical-economical optimum, and lists the following causes which led to refurbishment decisions (Aikivuori 1994):

1. Failure in building due to deterioration: corrective refurbishment (17%)
2. Change in use: altering refurbishment (26%)
3. Optimization of economic factors: optimizing refurbishment (9%)
4. Subjective features of decision makers: pleasure refurbishment (44%)
5. Change in circumstances: opportunity refurbishment (4%)

The main reason for refurbishment projects is thus the subjective features of the decision-maker. The importance, for example, of failures in durability as the prime cause of a refurbishment decision was quite moderate, only 17%.

Sobotka points out the importance of sustainable development in the practice of building resources renovation. According to him, some of the goals of sustainable building are as follows: 1) Minimization of climatic changes and risks to people's health and biodegradation in consequence of economic activity, which mean 2) Optimum use of resources that are unrenewable (energy, land, minerals or other natural materials); 3) Employing renewable resources; and 4) Building such objects that will enable future generations to meet their needs in the domains of quality, durability, flexibility, adaptability and town planning. He points out that the designing of a sustainable building should be considered on three levels: strategic, tactical and operational. The process of renovating a building comprises the following stages: 1) Examining and evaluating the technical, functional, etc. conditions of a building; 2) Designing the renovation; 3) Executing the renovation. (Sobotka et al., 1998.)

According to Zavadskas et al. "maintenance and refurbishment of existing buildings have very distinctive features when compared with traditional construction methods. Building maintenance is usually a minor, short-term, discontinuous process, which is mostly performed manually. Consequently, building maintenance and refurbishment are the first among the branches of the industry for the use of manual labor, as a result of the difficulties encountered in mechanizing this kind of work. For this reason, building maintenance and refurbishment are considered to be more difficult and require less qualifications than new construction work. Therefore, more qualified workers are not attracted to it. Clients wish these jobs to be done quickly and with a rather high standard of quality. At the same time, they do not want any interference with the activities performed in the buildings being refurbished. This is why the prerequisites for workers and engineers engaged in this work are qualification, experience, reliability and the ability to solve problems which may arise on-site" (Zavadskas et al., 1998, IA p.4).

7.2.4 Value of a building - Life cycle quality

In this section, we define the concept of "life cycle quality," and also consider different factors affecting quality and their importance for different stakeholders.

According to the *Collins Co-Build English Dictionary*, the definitions of "*quality*" include an object's nature or character (how good or bad it is), and it can also mean that something is of a high standard (Sinclair, Harper Collins, 1995).

Sarja (Sarja, 1999a; Sarja et al., 1999b; Sarja, 2000; anon. 2001b) defines the main aspects of "*life cycle quality"* as follows: 1) performance of the building, 2) ecology, 3) safety, 4) health, 5) comfort and 6) economy (see figure 7.5). According to him, the most important

aspects of life cycle quality are social needs, economic needs, cost-effectiveness and the life-cycle economy, cultural needs and aspects, and ecology.

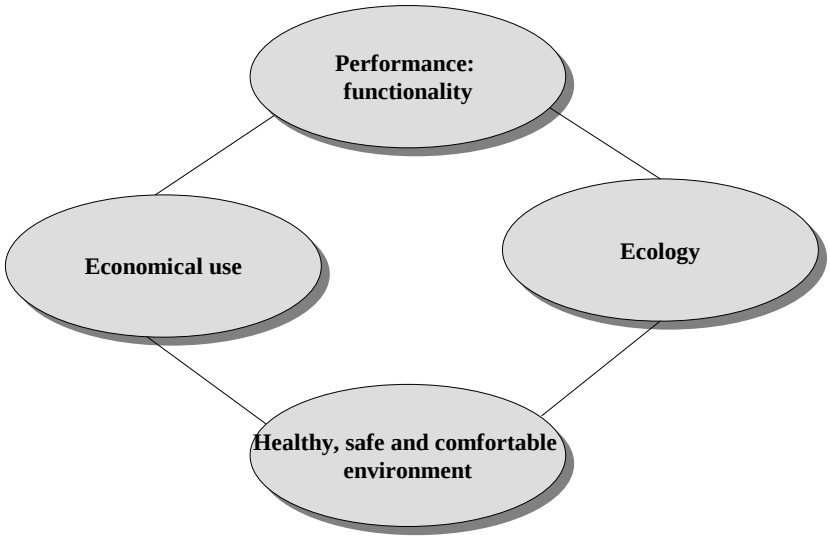

Figure 7.5. Main aspects of the detailed life cycle – quality design (Sarja, 1999a, p. 1; 2000, p. 2; Sarja et al.,1999b, p. 701; also, in anon. 2001b)

Ratcliff (Ratcliff, 1961, p. 58-61) suggests how the physical attributes of structural improvements influence the value of urban real estate. According to him, structural improvements must be done only after careful and detailed analyses. For analytical purposes, he grouped the so-called value-generating characteristics of a building as follows:

1) "Functional efficiency – the adaptation of the structure to the activities for which it is to be used. Functionality is related to use and thus, he points out, the functional efficiency of the physical property is judged only in relationship to the nature of its intended utilization. Different kinds of users have different demands according to their subjective needs – business life, living etc. In this analysis both efficiency and costs of operation and maintenance should be tested.
2) Durability – the physical qualities of the structure, which determine how long it can continue to render useful services, how long it will continue to be productive. The greater the resistance to wear and deterioration, the slower the increase in repair and maintenance costs, the higher the quality of services which can be maintained and the longer the economic life.
3) Attractiveness – the aesthetic qualities of the structure. The visual appeal of a real property is a factor in determining its market value. Visual appeal is related both to the exterior view and the interior of a structure."

How can quality be measured?

There are many stakeholders whose opinion has an effect on measuring quality. The yield from the building for the user is the totality of its characteristics, its quality that the user/tenant is paying for. From the owner's perspective, this payment is the yield. The different characteristics of a building, subjectively considered by users, as well as factors

related to its flexibility and technical characteristics, have an effect on the level of monetary payment (Aho, 1993).

Technical quality: Some of the characteristics of the building are technical**.** They are absolute and measurable, like durability, condition, air tightness, waterproofness, wall/roof connections and ecological use, energy efficiency, indoor air quality or technical risks related to expected use (Al-Hammad et al., 1997; Lehtinen, 2000; Lehtinen et al., 2001; Sarja, 1999b, 2000; anon., 2001b; Flanagan et al., 1989; Benda et al., 2000; Levin et al., 2000; Sobotka et al., 1998.) These technical characteristics, the technical quality of the building, can be measured using different condition assessment methods (Aho, 1993, Trivers, 1999b; Bottom et al., 1998.) By assessing technical quality, one can assess the remaining lifecycles of the structural parts and the relationship between design (structural and building physical design) and implementation, as well as the suitability of the building for expected use. Maintenance actions and usage also have an effect on the technical quality of existing buildings (Flanagan et al., 1989; Lehtinen, 2000; Lehtinen et al., 2001; Aho, 1993; Balaras et al., 2000). Technical quality is important from the perspective of cost-effective ownership, but it also affects use. For example, the maintainability or possibility to maintain the building without interrupting its operation have effects on usability (Lehtinen, 2000, p. 507-512, 2001; Al-Hammad et al. 1997).

The **functional quality** or functional efficiency of a building is mostly related to use. Therefore, the functional efficiency of the physical property should be judged only in relationship to the nature of its intended utilization (Ratcliff, 1961, p. 58; Bottom et al, 1998; McGregor, 2000; Sarja et al., 1999b; Sarja, 2000). For example, office buildings can be tested against the demands of business operations. This testing should cover not only efficiency, but also the costs of operation and maintenance (Ratcliff, 1961). Also, for example, the availability of public utilities or services at the site can be considered as locational functional quality (Ratcliff, 1961, p. 59; also Trivers, 1999b). According to Trivers, the possibilities for expanding, along with current and future parking requirements and possibilities, should also be considered (Trivers, 1999b).

Usability in expected use may include the objectives of both owner and user. For an owner, usability and flexibility may mean the possibility or ease of checking structures during the service life; maintainability and/or replaceability of structural components; and ease of rebuilding, modifying or organizing the infill and/or support structures of the building at an acceptable cost level (Lehtinen, 2000; Lehtinen et al., 2001; Ratcliff, 1961). For users, the most important characteristic of a building is its ability to create added value for the business (Bottom, 1989; McGregor, 2000; Ratcliff, 1961) This may include aspects of quantity, quality, diversity, location, flexibility, image and/or efficiency (McGregor, 2000; Trivers, 1999b; Bottom et al., 1989). In addition, for example, the available services in the area (Greer, et al., 1988) as well as aesthetic values may be important (Ratcliff, 1961, p. 58).

Aesthetic quality, according to Ratcliff, is related to the taste of the estimator, but though tastes change and architectural styles come and go, continuing market acceptance is most probable when the property meets reasonable standards of simplicity, harmony among the elements, and good taste. The exterior view of the property is a composition of structural design and its setting on the lot. Good architectural design and the tasteful use of exterior materials and colors are basic. The visual appeal of the interior of a building is dependent on the arrangement of space, natural and artificial lighting and interior decoration (Ratcliff, 1961, p. 61).

According to McGregor (2000), work environments and the demands of users are changing. Consequently it is clear that businesses´ requirements for the workplace will change in terms of quantity, quality, location, diversity and functionality. In response to the demands of

business, the property industry needs to develop a wide range of products for the market which are likely to require new approaches to the way property is funded, designed, constructed, maintained, equipped and provided – and used. If this is done according to principles of durability, buildings will be able to sustain and retain value (McGregor, 2000; Al-Hammad et al. 1997; Ratcliff, 1961; Lehtinen, 2000, Lehtinen et al., 2001).

In keeping with these definitions of quality, in our project quality is understood mainly as the characteristics of an individual building. In this way, the quality of one building may be good or poor according to the expectations set for the building. Therefore, the concept life cycle quality can be seen as life cycle characteristics, and objectives for quality are objective characteristics or expected characteristics. According to this definition, if the characteristics of a building fulfill the objectives, then the quality of the building is good for the expected usage and ownership. It is possible that the quality is not good for some other usage or ownership, however. The question, then, is what characteristics a building needs in order to fulfill the objectives set for it: yield expectations, life cycle expectations, IAQ-expectations, usability expectations in some specified usage or other expectations by the different stakeholders.

7.2.5 Summary of the additional literature review

Real estate analysis

The most important factors in investment analyses from the perspective of technical life cycle management are the following:

1. Risk analysis and the relationship between risks, particularly technical risks; and income expectations and the relationship between technical risks and a building's usability from the perspective of cost-effectiveness. It is important to 1) identify risks, 2) estimate their likelihood and consequences 3) prevent risks and 4) prepare for the consequences of realized risks. The technical potential of buildings in intended use can be evaluated in risk analyses and a risk management program can be defined when risks are identified.
2. Market analyses: availability of services, need of services and the relationship of technical performance and user needs in the market area.
3. Cash-flow analysis: expected and needed maintenance costs and their division during the expected service life of a building.
4. Technical analyses: usability of the building in intended use; flexibility of the building; aesthetic values and their improvement possibilities and costs; ecological use; economical use; the building's energy efficiency and its improvement potential and costs; the building's durability and the remaining life cycles of its structural parts; and the technical value of the building.

Life cycles of buildings

In addition to the total life cycle of the building, the total life cycle consists of different kinds of shorter life cycles, such as the life cycle of use, of ownership, of economic use, or life cycles of different individual parts of the building. The technical life cycle can be adapted to the life cycles that are appropriate for the objectives of the real estate business.

Since the technical life cycle process starts before the building is constructed, it is important that all decisions about design objectives and parameters be documented during the investment analysis phase. This background information may be important later, for example in situations where the building is going to be sold or purchased, renovated or even demolished: it is important to know what criteria have been used in designing, what the planned life cycles (support and in-fill) have been and for what kind of use the building has

been planned (IAQ, flexibility, etc.). These issues are especially important when analyzing the performance or usability of a building for a planned use.

New construction projects

From the perspective of this work, the most important and useful findings from new construction projects were as follows:

- Objective setting and needs considerations from the different perspectives of stakeholders in the very beginning of planned project is important as well as prioritizing of needs.
- Objective setting is in the first place the task of the owner.
- Maintenance needs and limitations in the implementation of maintenance should be considered in the early stages of a project, since maintenance has an effect on usage as well as on the performance of a building in the long term.
- It is important to make sure that designers and contractors understand the objectives and needs of the owner, usage and user.
- In the hand-over phase, is it important to make sure that design and implementation are done in accordance with the owner's objectives.
- Process should be practical, logical and comprehensive.

Maintenance and renovation of buildings

The maintenance strategy of a real estate is a means for achieving the desired quality level of structural characteristics and the durability of a building's structural parts. The strategy can be defined in terms of accepted cost frames and the chosen risk level. The maintenance strategy also affects the building's residual value.

- In order to be cost-effective, the strategy should be defined and carried out according to actual need. This need should be determined according to structural characteristics and according to the significance of the structural item of the building.
- In strategic planning of maintenance, several factors which are important from the perspective of use should be taken into account: physical deterioration, economic obsolescence, functional obsolescence, technological obsolescence, social obsolescence, locational obsolescence, legal obsolescence, aesthetic and visual obsolescence, environmental obsolescence.
- Maintenance planning should be done so that the life cycle objectives can be achieved.
- The maintenance strategy should be done on one hand according to the needs or restrictions of the users and usage of the building, but on the other hand also according to the needs and objectives of the owners.
- In optimization of actions, defining the cost-benefit ratio in life cycle and maintenance actions is useful.

Renovation and modernization, redevelopment phases in the life cycles of buildings, must also be seen as investments, so it is necessary to perform investment analyses about them as well. Since expectations about investments are economic, refurbishment also has to fulfill economic profit expectations. Before starting any investment actions related to a building, the real estate owner should work through her strategic needs and objectives. The needs analysis process should involve as many significant stakeholders as practically possible (owner, managers/executives, facility manager, project managers, staff of employees, tenants, visitors, customers, etc.).

It is better to consider total life cycle costs rather than only initial capital costs. In addition, life cycle costs should be compared to achievable benefits. Total real estate costs can be divided into costs of utilities and real estate costs. Real estate costs are capital costs, taxes and insurance, and maintenance costs, which are the costs of maintaining a building and costs of repairs:

- Maintenance costs should be budgeted according to actual need instead of using an annual budgeting method.
- By optimizing the characteristics of a building according to the owner's objectives and users' needs, it is easier to make choices related to life cycle costs.
- There are many concepts of value related to real estate and the real estate business. The technical value of a building is the value remaining between its replacement value (either in whole or part) and the decrease in value due to deterioration of characteristics important from the perspective of usage.
- Costs can be due to direct or indirect factors. Indirect factors can be related to IAQ and healthy buildings.
- In investment situations, the relationship between risks and required rate of return should be considered.

Life cycle quality

There are so called value-generating characteristics of a building. They may be grouped for analytical purposes as follows:

- Functional efficiency, the adaptation of the structure to the activities for which it is to be used.
- Durability, the physical qualities of the structure, which determine how long the building can continue to render useful services.
- Attractiveness, the aesthetic qualities of the building.

The life cycle quality of a building can be seen from the perspective of the owner or the perspective of the user or usage. For the owner, in most cases the building has to be a cost-effective investment. For users, usually the most important characteristics of a building are its ability to generate added value for the business and its suitability for the intended use.

7.3 Main criteria for the construction of a Technical Life Cycle Management Method

The following table (table 7.7) shows the "critical success" factors related to the Technical Life Cycle Management method, and includes the issues which should be taken into account and applied when defining the technical life cycle strategy for an existing building.

Table 7.7 "Critical success" factors related to the TLCM Method.

	Strategic level decisions				Risks and income expectations => tactical level			Characteristics of a building, Optimizing and setting of priorities is possible						Operational level		
Factors that have an effect on the technical potential analysis of a building	Strategic business idea	Owner's objectives for building / Criteria for cost-effective ownership	Decisions connected to real capital /Suitability of building for expected use (technically)	Use and users' needs	Forecasting cash flows/acceptable LC costs and cost effects	Risk analysis /technical risks /risk management / acceptable risks	Expectations for return of capital / productive value	Different life cycles	Physical durability and design/technical value and potential	Functional quality	Technical quality	Aesthetic quality	Costs for achieving the desired characteristics	Maintenance possibilities and needs	Maintenance limitations	Maintenance costs
Aho, 1993		x				x	x	x								
Al-Hammad, et al., 1997									x		x			x	X	
ASTM E 1765 98				x						x		x				x
Benda et al., 2000						x			x	x	x					x
Bottom et al., 1998				x		x			x	x	x	x				
Crockford, 1986						x										
Flanagan et al., 1989		x	x	x	x	x		x	x				x			x
Gransberg et al., 1997	x	x						x	x	x						
Greer et a., 1988				x	x				x	x	x					
Horner et al., 1997		x			x	x					x			x		x
Jaffe et al., 1986		x		x	x	x	x									x
Lehtinen et al., 00, 01			x	x							x			x	X	
Lundström, 1999	x				x											
McGregor, 2000				x						x						
Palojärvi, 1986						x										
Piirainen, 1996				x												
Ratcliff, 1961									x	x		x				
Ring et al., 1981	x															
Sarja, 2000		x						x	x	x	x	x				
Smith, 2000				x												
Sobotka et.al, 1998											x					
Spires, 1996	x	x												x		x
Trivers, 1999b		x		x						x	x					
Tsang, 1998	x					x								x		
Wong, 2000	x	x														
Zavadskas et.al, 1998		x					x				x			x		

Also the method should be practical, logical, and comprehensive (Kasanen et al. 1991, 1993, also practices in the construction sector, section 7.2.3).

The criteria for a practical and usable construct are summarized and presented below. These criteria have been collected through the literature reviews (chapters 4 and 7.2) and interview studies 1 and 2 (chapter 5). It is a summary of the "initial" and "critical" success factors for a well-functioning construct.

Criteria for a well-functioning TLCM Method based on literature. The Method:

- is **practical, logical, comprehensive and generic**.
- pays attention to the real **estate business as a totality**. The method should make it possible to connect the defined business plans more efficiently to maintenance strategies. The method should facilitate the strategic planning of technical life cycle strategies as a part of overall business strategies and implementation of technical strategies in practice.
- Makes it possible that the **cost effects** due to different technical life cycle strategies can be more accurately connected to long term planning. Long term planning could be done according to the objectives of owners. Life cycle costing considerations could be possible.
- should help in analyzing, predicting, planning and implementing **future decision-making,** and it should also be possible to consider future developments.
- pays attention to the **objectives of the real estate owner** and takes into account the changing **needs of the users** of the buildings. Real estate owner organizations should be able to define their business objectives and communicate them clearly to service providers.
- facilitates **objective-setting related to technical** characteristics
- helps **strategic planning and designing technical strategies** for the intended life cycle.
- facilitates focusing appropriate technical services and service packages in different situations. The method should facilitate the goal-setting and decision-making related to technical objectives of the real estate and also facilitate information systems in real estate organizations.
- facilitates the process of **purchasing** technical services. Technical possibilities and the costs due to different possible technical actions should be presented clearly and understandably. The causal relations related to different technical action solutions should be more visible.
- **facilitates co-operation**: The method should make communication easier between different levels of real estate organizations (for strategic, tactic and operational levels) and between real estate organizations and service provider organizations.
- pays attention to **risks** and the relationships between risks, costs and owner objectives; facilitates risk analysis related to technical risks and the suitability and potential of a building for ownership and usage.
- is related to **life cycle durability as well as technical, functional and aesthetic potential** in relation to life cycle costing
- makes it possible to set **priorities and optimize => is iterative**
- takes into account **costs, restricts and possibilities of maintenance**

These criteria were used as basis for a TLCM Method.

7.4 Developing the TLCM Method

We developed the method according to the needs and practices of the real estate and construction sector and according to the criteria related to constructive research strategy ("initial" and "critical" success factors). The method was developed step-by-step, presenting ideas to the executive group (see 6.4.1) or experts within the real estate and/or construction businesses. In order to find out if development of a TLCM Method is possible, and what it would require, we conducted:

1) Discussions and “mini-cases” in two service provider companies: We had several informal discussions with members of technical service provider companies already in the early stages of the construction phase, then again when version 2 of the TLCM Method was developed. Some of the later interviews are listed in appendix 2.
2) Executive group meetings and brainstorming meetings (tables 7.8 and 7.10).
3) Presentations of the method to the executive group, interviews and questionnaires related to the method, and development and improvement of the technical life cycle method according to their comments (Appendix 3).

7.4.1 Executive group meetings and brainstorming meetings

While the method was being constructed, the executive group, consisting of three members of real estate owner organizations and three members of technical service provider organizations, was very active. In every meeting, new suggestions and ideas related to the TLCM Method were presented, and the members of the executive group commented on these ideas and we discussed them. Proposals were written down and the method was developed and improved afterwards according to the comments. In addition there was one brainstorming meeting in which the checklists were discussed.

The aim of the meetings and brainstorming was to ensure that the method under development would be both usable and useful. Open discussions in these meetings made it possible to hear different perspectives and develop a comprehensive picture about the different needs, practices and possibilities of different stakeholders.

The following sections describe how the TLCM Method was constructed. These ideas are called “Version 1,” although at this point there was no real version--only the various parts and related ideas.

7.4.1.1 First phase: “Version 1”

We began developing the method by analyzing the relationships between different factors related to the real estate business collected from the literature. Also, because this TLCM Method is based on the life cycle phases of a building, we considered the different life cycles and related actions.

First we analysed the relationships between different related issues in the real estate and construction businesses. Figure 7.6 shows the issues.

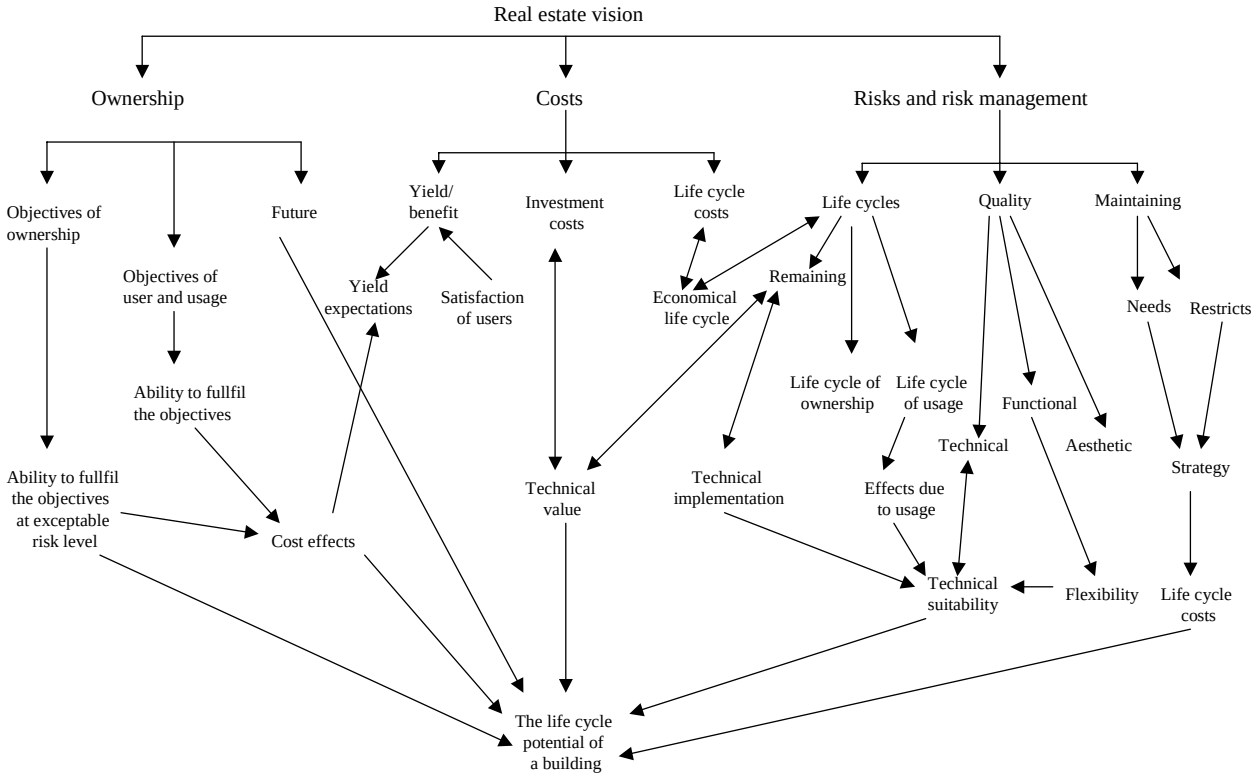

Figure 7.6 Relationship between different issues of technical real estate management, during the first phase of the construct.

Secondly the different actions and parts of different life cycle phases in a real estate were analysed, as presented in figure 7.7.

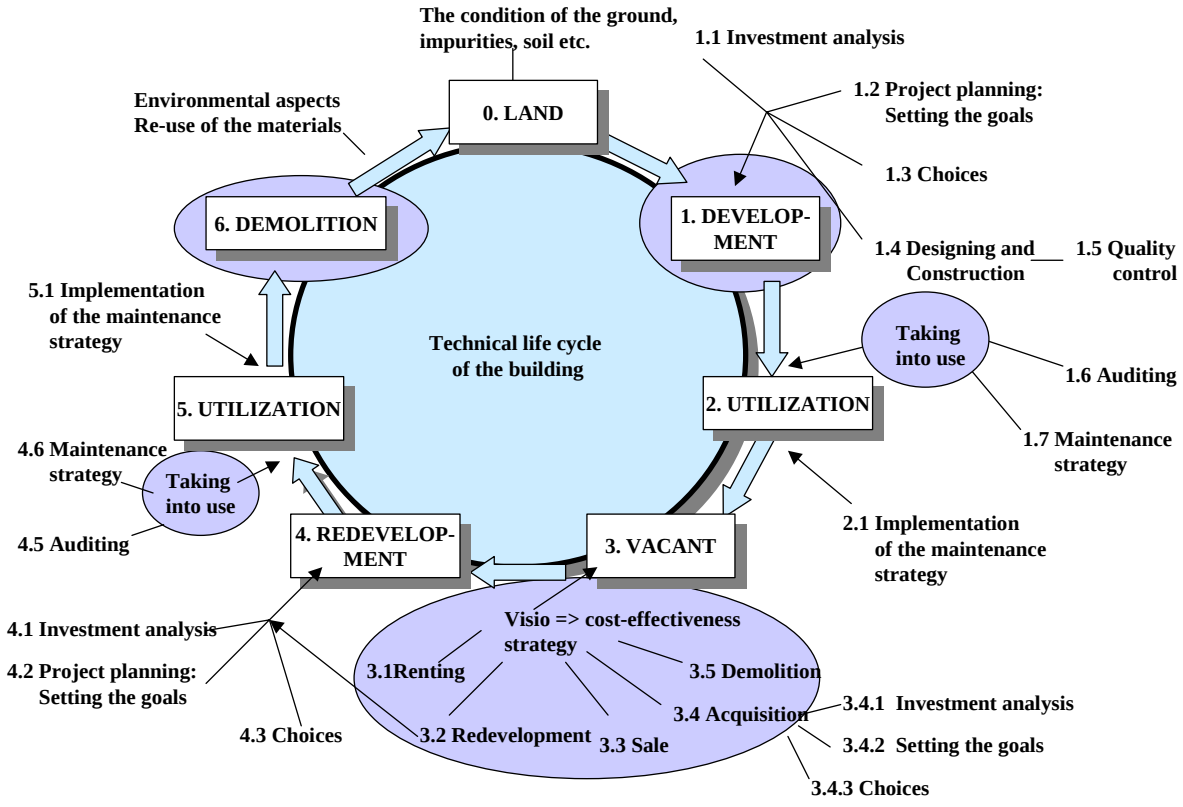

Figure 7.7 Life cycle phases of real estate and phases related to the different life cycle phases, in phase 1 of method construction.

Beginning with the second literature review, we began collecting checklists for the different phases of the technical life cycle of a building. We also developed a matrix of different levels of strategic planning of TLCM in different life cycle phases. In the first "version" of the TLCM Method, there were nine separate life cycle phases with individual checklists (figure 7.8):

1. Investment analysis
2. Project planning
3. Preliminary planning
4. Design planning
5. Construction
6. Auditing and hand-over
7. Maintenance and utilization
8. Quality control
9. Investment analysis for an existing building

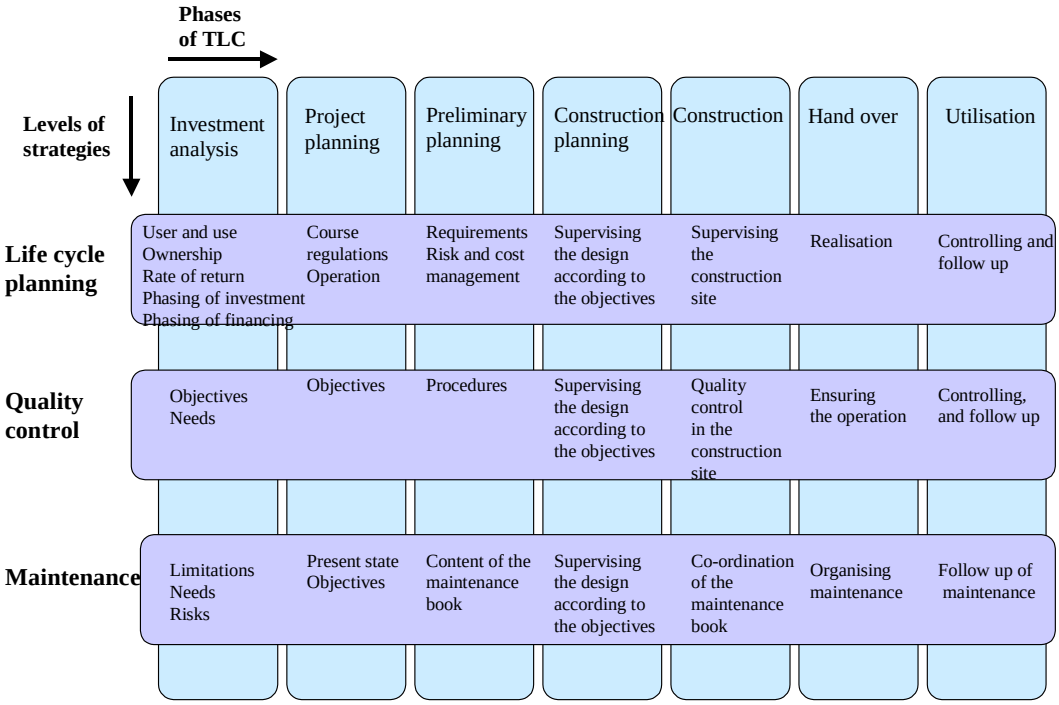

Figure 7.8 Controlling the technical life cycle. Critical technical life cycle perspectives in the beginning of the research project.

These ideas as well as the results of the literature reviews and interview studies 1 and 2 were presented in executive group meetings. These meetings and the subjects discussed are presented in the next chapter.

7.4.1.2 Executive group meetings during the construction of the TLCM Method

During the process of developing the method, ideas were presented in different participant groups, mainly in project executive group meetings. The following table lists the main meetings and their results (Table 7.8):

Table 7.8 Executive group meetings and the ideas presented in these meetings. Main comments and ideas for improvement.

Date of the meeting	What was presented/ subjects in meeting	The result, comment or improvement/development idea
Autumn 2000 => 2 group meetings	Discussions about needs and requirements related to technical life cycle management. Discussion about perspectives of different and different kinds of participants related to the real estate business and technical life cycle management First presentation of literature review 1: technical life cycle management and its role in the real estate business	- The owner organization should make the technical decisions and take responsibility for the technical condition of the real estate it owns - It is be necessary from the perspective of cost-effective real estate management to connect technical decisions and objectives more closely with other real estate business strategies. - Questions related to technical issues are interdisciplinary and complicated.
17.1.2001	Discussion about the concept of the technical life cycle, checklists and needs and responsibilities in the real estate business	- A real estate is an "instrument" of production. It is important to define the needs of today and the needs of a future core business of users. - The life cycles of ownership, usage and use should be connected to technical life cycles. - Technical actions should be determined by the needs of ownership, usage and user.
22.1.2001	Additional discussion of the technical life cycle concept, checklists and needs, roles and responsibilities in the real estate business	- Both the strategic and operative facilities of management should be in focus. - Decision-making related to technical real estate management is difficult and often subjective. Strong facts (like risk analysis) are needed to support decision-making. - Some issues related to the consequences of technical life cycle decisions are measurable, some are not. - In the real estate business, it is important to define the objectives of owners and users, to estimate the added value which can be achieved, and to set priorities. - It is important to analyze the technical potential of a building in relation to the objectives.
15.3.2001	Second presentation of literature review 1 (supplementary version) Brainstorming: The form of the method, different possible modules in the method.	- Continuing the literature review: More frames, models and methods from existing practices are needed and useful - A potentially useful method takes into account the whole real estate business - Everything is still possible in the investment analysis phase of a new construction project, but particularly for existing building stock models by which the strategies can be developed are very much needed and important. - Strategic planning and investigating the potential of existing building stock is very important; in new construction projects, everything is possible but the analysis of existing buildings would provide important information

4. -7.6.2001	Presentation of the ideas of the current method (Version 1). Discussions Development of ideas Comments on: - Checklists - Modules of the TLCM Method Presentation of Alicante conference paper. Browsing of check lists and their logic <= Separate meetings with executive group members	- Comments related to checklists => improvements and development. Division of lists into groups - In the real estate business, cost-effectiveness is the most important issue - Setting of priorities is important, since in a cost-effective business, it is not possible to achieve everything
27.7.2001	Discussion of the method and presentation of possible modules: analysis and strategy. Also, division of related issues into groups: requirements, expectations, possibilities, and limitations. The importance of different groups and their prioritizing was discussed Presentation of a method in the form of a balanced scorecard Presentation of matrices and how the matrices are related to checklists Presentation of the group: owner's objectives, users' objectives, life cycle costs, quality, durability, maintenance and the relationship between these issues and the division above: requirements, expectations, possibilities, limitations <= Meeting with 1 executive group member (real estate owner)	- On a general level, the method is acceptable => further development needed - The perspective of users or customers should be more emphasized - In the method, the owner perspective should be more emphasized, as it is in checklists - Follow-up during the period of utilization is important - Technical characteristics of a building from the perspective of different participants (owner, user, customer etc.) should be more efficiently analyzed - Technical characteristics of a building from the perspective of life cycle costs and cost-effectiveness of the real estate business is a good and important feature. It should perhaps be even more emphasized.
10.9.2001 9am-6pm	Brainstorming: Content, usability and logic of checklists Content, usability and logic of the method Use and usefulness of the checklists <= Brainstorming session, 5 persons from different service provider companies	- The logic of the TLCM Method was discussed - Checklists should be divided at least into the following groups: Life cycle durability, life cycle quality, maintenance, life cycle costs - There were too many phases in the TLCM Method and check lists (too many phases, too much data); simplifying was needed - Concepts should be defined - The idea is not logical enough - Analysis of risks is important. The real estate owner should be able to choose an acceptable risk level - The effect of risks and their realization on (technical) life cycles - The effect of risks and their realization on (life cycle) costs - The effect of risks and their realization on usage - The effect of risks and their realization on

		maintenance activities - Analysis of cost-effective ownership is good and important - Technical background information should be available at the very beginning

20.9.2001	Discussion of the method and presentation of the modules: analysis and strategy. Also division of the related issues into groups: requirements, expectations, possibilities, and limitations. The importance of different groups was discussed
	
	Presentation: how the method could be set to form BSC.
	
	Presentation of matrices and how the matrices are related to the checklists
	
	Presentation of the decision logic of the matrices.
	
	Presentation of the group: owner's objectives, users' objectives, life cycle costs, quality, durability, maintenance and the relationship between these issues and the division above: requirements, expectations, possibilities, limitations
	
	Presentation of checklists: content and logic
	
	Connection of different phases and modules of the method to checklists
	
	Presentation of the logical process description
	
	<= Executive group meeting
	
	Discussion, comments, suggestions
		- Checklists were accepted
		- The matrices will be further developed.
		- The idea of the TLCM Method works and is acceptable, but the process description should be refined:
		  - Which phases, modules etc. are essential?
		  - Would it be possible to further modularize the method?
		- Life cycle quality: different quality factors, quality from the perspective of owner and user (aesthetic quality, functional quality, technical quality)
		- Strategy as the will to do something.

10/2001	Telephone discussions about: - Modules - Situations in which the TLC (technical life cycle) modules are needed	Simplifying is still needed
29.11.2001	The following was presented in an executive group meeting: Modules and phases of the TLCM Method Logic of the phases and the modules The timing and the need for technical analyses Situations where the TLCM Method would be needed Current version of the checklists Current version of the matrices	- Strategy should be part of the maintenance book? - The greatest life cycle risk for a building is the user, therefore it is very important to consider the effects of use on the building, its structures and systems and plants, focusing on the suitability of a building for expected use - The life cycle of the building site; a building's location is important - Analysis of cash flows is important in optimization - Optimization and possibility to iterate is useful and important - It is important to be able to define the most important things, since "you cannot get

		everything." - The ideas and the TLCM Method needs to be crystallized so that an ordinary user, service provider or real estate owner is able to use it => The TLCM Method should be finalized and then tested in cases; all the important factors are already in the TLCM Method.

We still decided to present "version 2" of the method to each executive group member in order to collect possible suggestions for improvement before testing the method in cases.

7.4.1.3 "Version 2" of the TLCM Method

The TLCM Method was developed more generally, taking into account the comments gathered during the first phase (see table 7.8). Owner and user aspects and the optimization possibilities and possibility to prioritate the objectives were more effectively taken into account. The second version of the TLCM Method included:

1) Checklists in which the technical life cycle actions are presented in relation to different managerial perspectives: the owner's, user's, from the perspective of life cycle costing, from the perspective of life cycle durability (technical perspective), life cycle quality and from the perspective of maintenance.
2) A description of an interactive process, which included two modules: analysis of a property's technical potential as well as technical life cycle strategy development.
3) Matrices for evaluating the technical potential of a building.

We presented "version 2" of the method to the executive group members with the aim of ensuring that it was ready to be tested in real cases**.** Real case-projects are long-lasting, costly and require the participation of many persons, so it was important to be sure that the TLCM Method was ready for testing.

This presentation included informal open-ended interviews/discussions and a questionnaire given to interviewees after the meeting, with questions related to the expected usability and usefulness of the method. In collaborative executive group meetings, these ideas had already been discussed and therefore there was preliminary information available about the construct's functionality and usefulness all the time. Appendix 3 shows the interviewees and dates of the interviews as well as feedback on version 2 of the TLCM Method.

We do not present version 2 here because it was pretty close to version 3, as the later version only included a few improvements which are listed below. We also added task descriptions related to the different phases of the method and also the references in the task descriptions to check lists.

After version 2 of the TLCM Method was tested, the following comments and ideas for improvement were given:

- The TLCM Method could include a list of tasks for service providers and real estate managers for each phase, so it would be easier to analyze when adequate information has already been collected and when further information is needed.
- The necessary background information for each case could be listed somewhere.
- The central questions that must be answered in different phases of an analysis, including the strategy definition phase, could be clearly shown someplace.
- Users should be more closely involved in the maintenance strategy definition phase.

- Training before each case should be arranged.
- The connections between the checklists and process descriptions should be shown somewhere.
- The description of how results are reported should be improved.
- The user of the building is interested in the potential added value that could be achieved.
- The TLCM Method should be simplified and the concepts translated into understandable language.

A summary of the strengths and weaknesses of the TLCM Method, areas requiring improvement, and possible benefits of use are listed in table A3.2 in appendix 3.

The following table shows the process of developing the TLCM Method from the executive group presentation to the starting of testing in cases (Table 7.9):

Table 7.9 The rest of the executive group meetings and comments

Date of the meeting	**What was presented/ subjects in meeting**	**The result, comment or improvement/development**
12.-14. 2.2002	Presentation of the final version 2 of the construct: - Checklists, - Modules and phases - Logic Interviews & notes: checking of interpretation by e-mail Questionnaires => For getting comments for final test version of the TLCM Method => Separate meetings with the executive group members	See appendix 3: results of the interviews
2/3 2002	Improving and completing the TLCM Method according to the comments Telephone discussions	- References to the checklists: when they should be used and which parts of the checklists are useful in different phases of the analysis - Tasks of the different participants in different phases of the TLCM Method - Possible references to the checklists for different participants - Filling in gaps in the checklists based on the feedback received
18.3.2002 9-12-am	Presentation of version 3 of the TLCM Method. - Modules and phases of the TLCM Method - Tasks of different participants in different phases of the TLCM Method - Logic of the TLCM Method - Connections between different phases of the TLCM Method with the check lists - Logic of the checklists	- Iteration possibilities suggested: Iteration is one of the most important issues when considering usage potential, especially in cases related to property development. - "The TLCM Method is also suitable for new construction projects." => The TLCM Method is ready to be tested after refining it according to the comments
5/2002- 5/2003	Cases	

The following section includes the set of methods and characteristics of the TLCM Method for fulfilling the criteria presented in section 7.3, taking into account the comments and suggestions for improvement during its construction. It also presents version three of the TLCM Method.

7.5 Description of version 3 of the TLCM Method

The main purpose of using the TLCM Method is to connect the owner's *strategic, economic and operative goal setting and decision making* with the *technical potential* of an individual building: potential for fulfilling the objectives of *cost-effective* ownership and *satisfactory* usage. The additional purpose of using it is to facilitate purchasing of technical services and to increase learning between different participants of TLCM process.

We developed the construct using the following methods and characteristics, conducted from "initial" and "critical" success factors for a usable and useful method which had been identified through the literature reviews and interviews:

- The TLCM Method is a description of the *interactive* analysis and strategy definition process between the real estate owner, user of a real estate, TLC Manager (Technical Life Cycle Manager)and service provider(s) in which the *technical life cycle analysis, goal-setting and strategy development* is carried out.
- The method has a modular structure. It is systematic, logical and practical in use.
- The method describes the tasks of different participants
- It includes checklists for helping goal-setting and decision-making related to the technical life cycle of an individual real estate.
- It presents connections between phases and task descriptions.
- It presents connections between task descriptions and checklists.
- It provides clear instructions for use and a summary of the theory behind the construct is available
- The method is a general and comprehensive description, so users can choose phases according to their actual needs.
- The process makes it possible to optimize and set priorities for the building and its life cycle costs. Iteration is possible.
- The process takes into account different stakeholders and their needs.
- Cost, risk and needs-analysis are included into the process description.
- Training is included in the taking-into-use phase.
- The method is easy to use and it is possible to modify it.

The TLCM Method is a general action description in technical life cycle analysis and strategy development and deployment. It also describes the roles of different participants in the process. The extent to which the method, its phases or the checklists should be used varies case by case according to the situation.

In this work, the Technical Life Cycle Management of a building is defined as follows:

The "Technical Life Cycle Management" concept is principally formed of the
- Setting of *strategic goals,*
- Making *decisions* and
- Defining actions that are directed to
  - an individual real estate from the *investment analysis phase until the demolition decision*

  and that
  - affect the *physical characteristics* of the building, which are important from the perspective of cost effective ownership..

In real life situations, the period of time chosen for a specific analysis is in practice shorter than the whole technical life cycle. Therefore, the TLCM Method proposes that a real estate owner choose the period of time according to his/her business idea for which a technical life cycle strategy is to be developed.

7.5.1 Using the TLCM Method

There are several intervention points during the life cycle of a building when it is useful to use the TLCM Method, namely points where investment decisions are made.

Figure 7.9 presents the potential situations during the life cycle of a building for technical life cycle analysis and strategy definition processes. In figure 7.10, phases 2 and 3 are tested in this study.

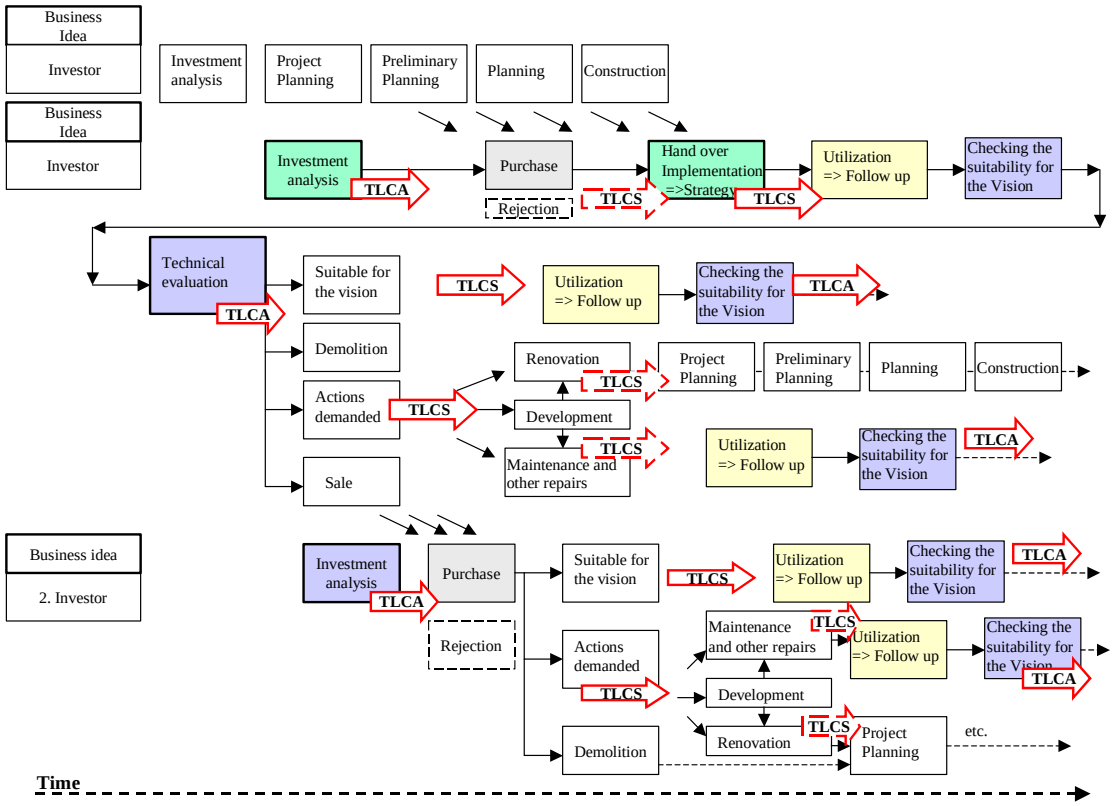

Figure 7.9 Phases for using the TLCM concept. TLCA is a technical life cycle analysis and TLCS is a technical life cycle strategy development.

Especially in the following situations using the method is possible:

1) In the investment and development potential analysis phase for an existing building (2 in figure 7.10).
2) If the technical strategy for an owned real estate has not been defined (3 in figure 7.10).
3) In a "vision evaluation point," when ownership of a given real estate is no longer profitable. There are several possibilities for actions, such as selling, developing, modernization, refurbishment, repairs or demolition (3 in figure 7.10).
4) It also may be possible to use the TLCM Method in the investment analysis phase for a new construction (1 in figure 7.10).

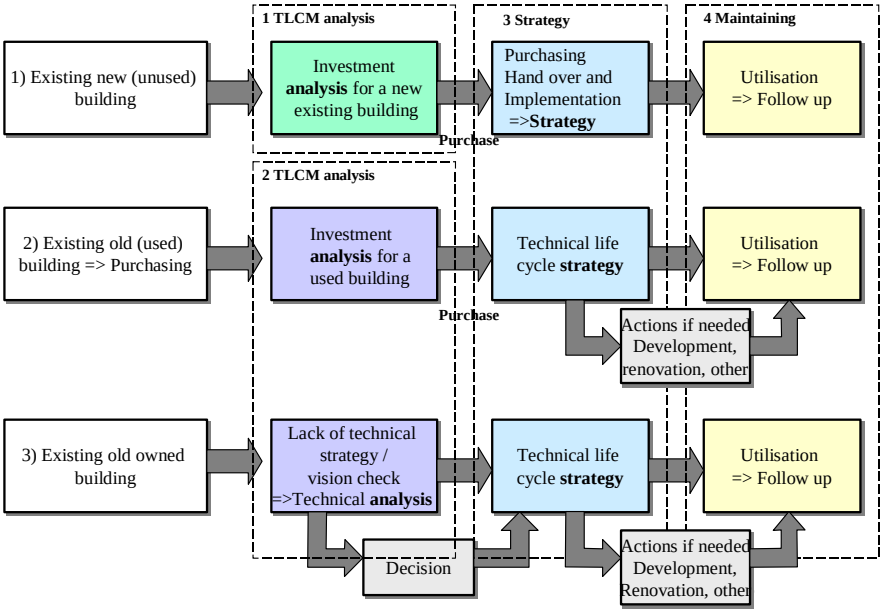

Figure 7.10 The three main starting points for analyzing the technical life cycle and determining strategies: 1) Investment analysis for an existing new building; 2) Investment analysis for an old building; 3) Technical evaluation of an old owned building in order to estimate the cost-effectiveness of ownership.

7.5.2 The TLCM process: Technical analysis and strategy development

The technical life cycle process is an interactive process between the real estate owner, user of a real estate, TLC Manager and technical service provider(s). Because the size and structure of the organizations in real estate owner companies varies, we did not want to define which party the TLC Manager should represent. The strategic role of TLC Manager demands specific skills and knowledge and quite deep understanding of building structural and physical issues (including HVAC techniques) as well as of the real estate business. Sometimes the role may be shared between some of these parties. The main focus was to describe the roles and tasks of different participants in different roles as well as describe the needed information during the process that the parties should provide.

The TLCM process consists of two modules: the technical (investment) and potential analysis (*TLC-analysis*) and the technical life cycle *strategy* development process (Fig 7.11). Both modules of the TLCM process are based on the goals of the owner organization. The objective of the *analysis* is to define the potential of a building from the perspective of cost-effective ownership and usage. Analysis is carried out when investment in a new real estate or the cost-effectiveness of an existing ownership is being considered. As a result of this analysis, the correspondence between a building's technical potential and the owner's objectives is defined. If analysis indicates that ownership is or can be profitable, a strategy is defined according to the requirements, limitations and expectations obtained in the analysis phase. The *strategy* is a technical action plan, the technical life cycle strategy, for achieving the goals of ownership, and optimizing the technical characteristics and costs of the building during the chosen period of time. The results of this analysis are used as input in the strategy

development phase, so it is necessary to do at least a brief analysis before trying to develop a strategy.

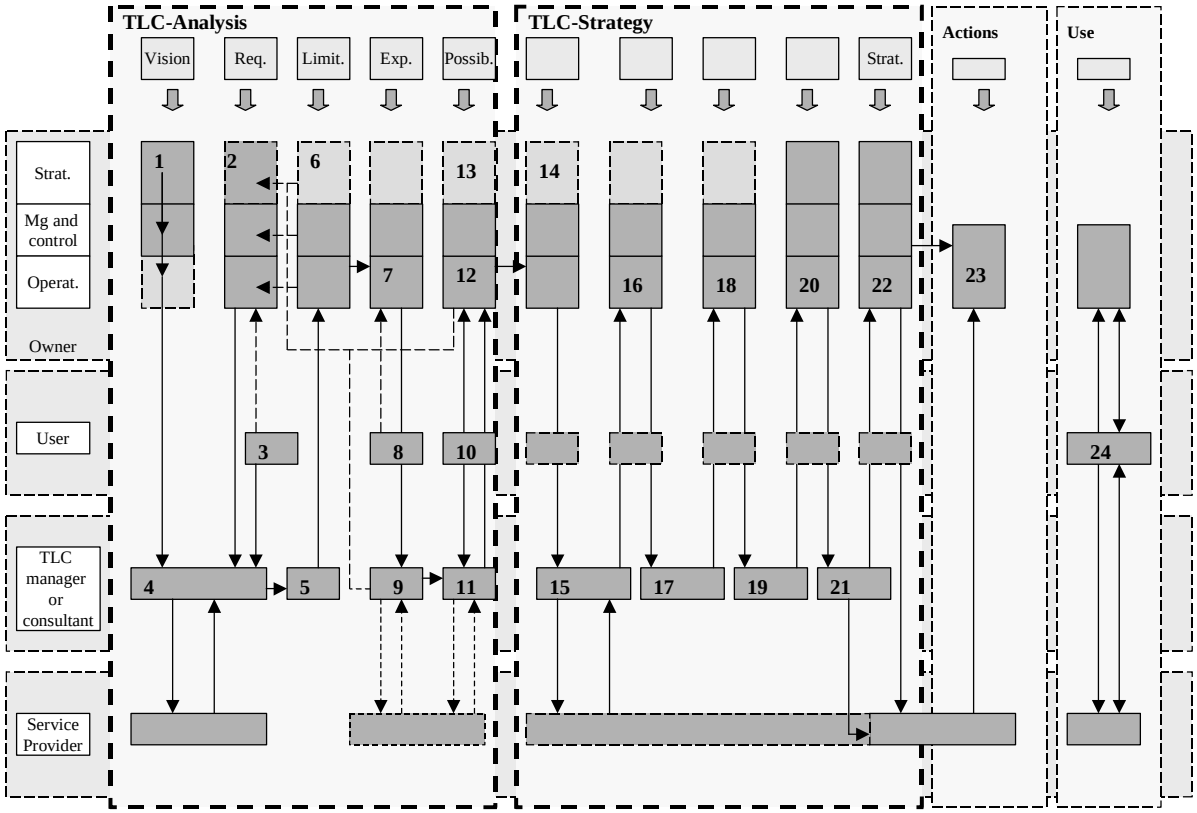

Figure 7.11 Schematic picture of the technical life cycle process: Analysis module and strategy development module. The numbers refer to the phases of the modules, presented in chapter 7.5.4 and 7.5.5. The phases describe the tasks of participants presented in left side column of the figure.

The TLCM process is an interactive multiattribute decision analysis between the owner, user, TLC Manager, and technical service provider(s) in which the main factors in decision-making are:

Requirements for cost effective ownership and use (Primary needs):

1) Strategic requirements and goals of an owner organization. (Phases 1 and 2)
2) The strategic needs of the user (if the user exists) (Phase 3)

Limitations:

3) The technical potential of the building for fulfilling the requirements: technical risks, costs due to risks and technical characteristics and acceptable risk level according to the most important needs of owner and user (taking into account the background information). (Phases 4 and 5)
4) The acceptable cost frames related to expected benefits, returns and risks. In this TLCM Method the focus is on technical risks. (Phases 5 and 6)

Expectations (Secondary needs):

5) Objectives connected to the life cycle and technical, functional and aesthetic quality expectations for the building. (Phases 7 and 8)
6) Potential of the building to achieve the expected quality and life cycle characteristics (possibilities and costs). (Phase 9)

Possibilities:

7) Means for achieving the acceptable quality and life cycle characteristics in acceptable cost frames: risk management, maintenance and construction works. (Phases 10 and 11)

In the strategy development phase, the technical characteristics of the real estate and how these are achieved are optimized, so the strategy is developed within the acceptable cost and risk frames according to the results of the analysis phase. Different parties of different decision levels of the owner organization are involved in this process.

7.5.3 Aspects of decision-making in a technical life cycle analysis

Analyzing the technical potential of a building is based on the following factors: Requirements, limitations, expectations and possibilities (figures 7.11 and 7.12).

"Requirements" represent those characteristics of a real estate which are most important from the perspective of cost-effective ownership. Requirements also depend on the planned use of the building. These requirements are such factors which make investment or ownership profitable and which make it possible for the owner to carry out his *business idea* in the building. The requirements may also depend on user and usage, and what characteristics are critical from the perspective of view of usage. (These are the preliminary objectives from the perspective of cost effective ownership. Number 1 in figure 7.12.)

"Limitations" are factors which must be taken into consideration when appraising the cost-effectiveness of ownership. Limitations are connected to risks (in this study technical risks), expected returns or outcomes and acceptable cost frames during ownership. (Number 2 in figure 7.12.)

"Expectations" are related to technical, functional and aesthetic quality and the life cycle characteristics of a real estate (life cycle of use or ownership, economic life cycle, technical life cycle, the life cycle of the location) that either exist or are possible to achieve within acceptable risk, cost and return frames. "Expectations" are hoped for, but achieving them is not critical. (Secondary objectives. Number 3 in figure 7.12.)

"Possibilities" is the margin in which the quality and life cycle characteristics can be optimized. "Possibilities" includes the maintenance required to achieve in acceptable cost and risk frames the optimal set of characteristics according to the requirements and expectations of owner and user. (Number 4 in figure 7.12)

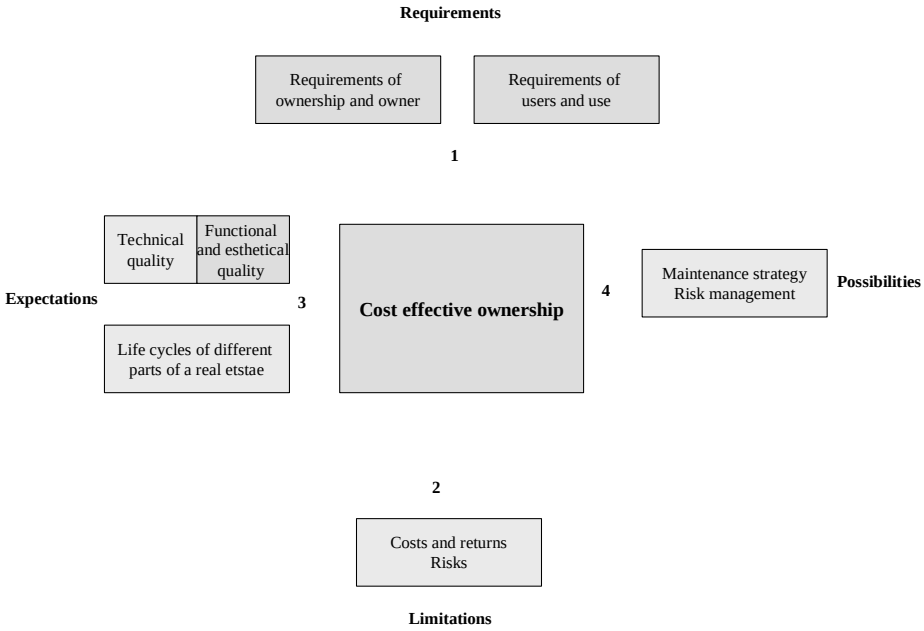

Figure 7.12 Perspectives for analyzing the technical potential of a real estate.

7.5.4 TLC analysis

The TLC analysis (Technical Life Cycle analysis) is a logical interactive process used to analyze the technical potential of a property for satisfying the business goals of the owner organization, with the objective of determining if ownership is cost-effective. The persons participating in this analysis are presented on the left side of figure 7.13. The owner organization itself determines who shall be responsible for the various tasks, with the important point being that all the issues included in the TLCM Method are addressed.

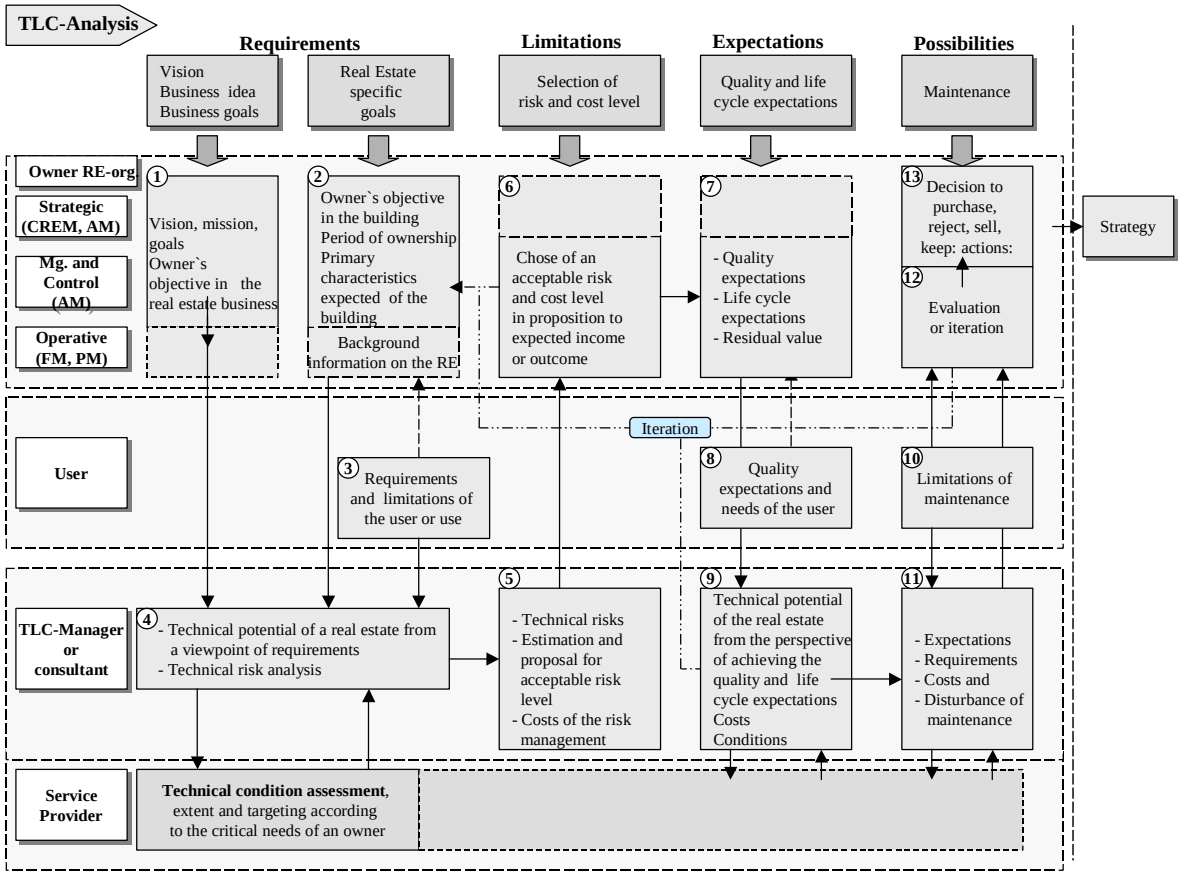

Figure 7.13 TLCM Method of an interactive process for analyzing a real estate.

In figure 7.13 numbers 1-13 refer to phases in which the tasks of different participants of the process is described. Also, decisions or background information needed from the owner organization, or actions of the TLC Manager or service provider: risk analysis and appraisals of the technical potential of a real estate for fulfilling the requirements and expectations of the owner and the user is described. The method also contains checklists and task descriptions (as follows) for helping decision-making in different phases. The checklists include more detailed information than task descriptions.

The step-by-step process is as follows: (The numbers refer to figure 7.13)

"Requirements" = the primary needs

The aim is to determine the most critical needs and requirements that are prerequisites for profitable, effective ownership

The real estate owner:

1 **Defines the vision, mission and goals of the company** (Strat. level of an organization)

Check list 1

- Main business philosophy
- Business idea for the real estate ownership
- The role of the real estate for the company

2 **Defines specific goals for a given real estate** (Strategic level, Mg. And control)**:**

Check lists 1 and 2

- Owner's objective in building

Economic considerations:

- Return and outcome expectations
- Forecasting of cash flows
- Financing environment
- Tax environment

Risks:
- Risks (national, economic, political, administrative risks and risks related to nature and the environment)

The owner also defines, possibly with TLC Managers or with some service provider:

Decisive factors for cost-effective ownership:
- Specific requirements for cost-effective ownership
- Selection of a period of time for analysis and strategy, the one on which decisions will be based (life cycle of: ownership, usage, user, location, monetary life cycle, technical, structural life cycle/cycles etc.)
- The timescale of ownership: how long the building is going to be owned.
- Most important technical characteristics in alternative possible usages

Market analysis:
- Provides possible alternatives for usage (according to own business idea)
- Lack of space in a market area
- Possibilities for land utilization
- Value of real estate services
- Legal and market environment

The owner (operative level) or TLC Manager also gathers all available background information on the property, including:
- Design values and parameters used
- Quality of the building's physical design
- Renovation and failure history of the building, if available.
- Maintenance strategy and its implementation
- Is there a maintenance book available?
- Former uses of the building and their probable effects on its technical value and condition
- Effects of location on building
- Possible limitations and/or requirements of different authorities

The user of the real estate (or assumed user and usage, if no current users):

3 Primary requirements of user /potential user(s) Check list 1.2

The user (or sometimes owner) defines the requirements for the technical characteristics of the real estate determined by the user's business needs:

- The technical factors or characteristics of the building that are required from the user or usage perspective.
- Setting priorities about characteristics that are required or desired.
- Effects of usage on building

If the user or usage is not specified in this phase, or for some other reason there is a possibility for developing a business idea for the building, the owner needs to know a building's technical potential in order to consider different usage possibilities. In these cases, users and usage can only be assumed, and hence the risk analysis is more difficult.

”Limitations” = restrictive technical or economic factors

The aim is to determine the technical potential of a building to fulfill the initial requirements of ownership and user/usage

The TLC Manager:

4 **Gathers all the important information and then performs a technical risk analysis**

Check lists 1.1.4, 2.2, 2.3, (3 and 4)

The extent of this risk analysis depends on the nature of the most critical requirements for the owner/ownership or user/usage (e.g. IAQ, Image, safety etc.). If several alternative users and usages are considered, this phase must be done more accurately (case: real estate development).

Result => Technical potential of the building to realize the objectives:

- Risks related to structural, architectural and building physical design and/or condition of a building
- Risks related to location and environment
- Risks related to former usage and maintenance activities
- The quality of previous construction work or/and refurbishment work
- Technical value of a building
- Locational possibilities and risks: city planning and the limitations it sets
- Risks related to primary objectives of owner, user and usage

Risks are reflected against the primary objectives

5 **Based on this risk analysis, the TLC Manager then taking into account the possible limitations and/or the requirements of authorities:**

Check list 1.1.4, 2.2, 2.3 and 2,4 (also 3 and 4)

- Recommends an acceptable technical risk level for assumed or current use/uses.
- Defines the relationship between technical risks and usage or user (technical design and the requirements of users or their business processes)
- Assesses the relationship between technical risks and profitable ownership (structural systems and their applicability, former usage and usage of maintenance, technical value of the building)
- Determines the influences on usage and on the building if risks are realized
- Estimates the costs of realized risks
- Suggests a risk management program
- Estimates the costs of required risk management
- Estimates the technical suitability of a building for assumed or current use/uses
- Estimates the costs and possibilities for achieving the requirements from the perspective of assumed or current use/uses

The selection of an acceptable risk level and cost frames. The relationship between accepted risks and expected returns:

The real estate owner:

6 **Selects an acceptable technical risk level and defines the cost frames so that they are consistent with expected and realistic profits and/or outputs**.
(Strategic, Mg. and control and operative levels of real estate organization)

Check lists 1.1.4, 2.2, 2.3, 2.4, (also 3 and 4)

- Is the planned usage profitable for the owner (taking into account technical risks, characteristics of the real estate and requirements of the user)?
- What are the possible alternative uses or strategies for profitable ownership?
- At what relationship between risks/returns in ownership profitable?
- Is it realistic to achieve this relationship?

Iteration point

If the relationship between technical risks and factors critical to the owner proves to be unacceptable and ownership is not profitable, the analysis can be interrupted and the owner may (according to the situation) decide:

1) Not to purchase / not to invest
2) To re-evaluate the critical factors (alternative use, critical requirements of ownership etc.) and return to phase **2**
3) To sell the real estate / with or without potential analyzing data and/or suggestion for TLCM strategy

In other cases the analytical process continues, and expectations for quality and life cycle characteristics are evaluated.

”Expectations” = the quality and life cycle characteristics of the real estate that are desired and/or that can yield added value for the owner or user – the secondary needs

The aim is to evaluate the relationship between quality and the life cycle expectations of the technical characteristics of a real estate and the technical potential of the building to achieve the expected characteristics.

The real estate owner defines the expected characteristics of the building: (Mg. and control and operative levels of a real estate organization)

7 **Technical life cycle expectations of owner** — Check lists 3 and 4

1. Technical and economical life cycle expectations — Check list 3.1
2. Value of trouble/failure-free use and disturbance of maintenance — Check list 3.2
3. Technical and building physical characteristics and the life cycle expectations of different parts, systems and structures of the building. — Check list 3.3
4. Flexibility of the structures — Check list 3.4

Technical quality: — Check list4.1

1. Structural and building physical realization — Check list 4.1.1
2. Value of the building’s energy efficiency — Check list 4.1.2
3. Value of the building’s ecological aspects — Check list 4.1.3
4. Indoor air quality and building physics — Check list 4.1.4
5. Flexibility of the building — Check list 4.1.5

Functional quality: — Check list 4.2

1. Usability — Check list 4.2.1

2. Indoor air quality and the correlation of building characteristics with worker productivity — Check list 4.2.2

Aesthetic quality — Check list 4.3

Quality of maintenance — Check list 4.4

=> **Prioritizing of different characteristics**

The user and/or owner:

8 **User expectations for building quality** — Check lists 1.2, 4.2, 4.3 and 4.4

- Definition of quality criteria
- Prioritizing of the objectives: quality requirements and their importance.
- Functional and aesthetic quality expectations of the user from the perspective of usability, the user and processes
  - Functional quality — Check list 4.2
  - Usability of a building — Check list 4.2.1
  - IAQ and productivity — Check list 4.2.2
- Aesthetic values and characteristics — Check list 4.3
- Disturbance of maintenance, quality of maintenance — Check list 4.4

The TLC Manager:

9 **The TLC Manager evaluates the technical potential of a real estate for achieving quality and life cycle expectations** (with service providers) — Check lists 2, 3, 4

Technical life cycle:

1. Potential for trouble-free usage
2. Quality of structural, building physical and architectural design
3. Former use, former maintenance, documentation => effects on technical condition
4. Remaining life cycles of different parts, structures and systems of the building
5. Technical value of the building
6. Flexibility of the structures and systems

Technical quality:

1. Structural implementation and technical risks => suitability for planned use
2. Energy efficiency of the building
3. Ecological use
4. Indoor air quality and building physics
5. Flexibility of the building

Functional quality:

1. Usability for planned usage
2. Indoor air quality and worker productivity

Aesthetic quality => potential for improving aesthetic quality

Quality of maintenance: previous and required maintenance

Result:

The potential of the real estate to achieve quality and life cycle expectations, taking into account the technical risk factors, return and/or outcome requirements and cost limitations

- Is it possible to achieve a specific quality level and ensure that specific characteristics of a building last as expected?
- The relationship between life cycle expectations and future costs.
- The timing possibilities of different alternative technical life cycle actions and their costs.
- Extent and amount of required actions for achieving different quality and life cycle characteristics.
- Availability of needed service providers at the location.

Iteration point

If the relationship between desired characteristics and "requirements and limitations" is not acceptable, the analysis can be interrupted and the owner may decide:

1. Not to purchase / not to invest
2. To re-evaluate the critical factors (alternative use, critical requirements of ownership etc.) and return to phase **2**
3. To sell the real estate / with or without potential analyzing data and/or suggestion for TLCM strategy

In other cases the analysis continues and alternative maintenance possibilities are analyzed.

"Possibilities" = technical means for optimizing life cycles

The aim is to analyze the cost-effectiveness of and possibilities for different maintenance measures which would help achieve the objectives (from the perspective of fulfilling the requirements and expectations within the existing limitations)

The user:

10 **Describes limitations on maintenance due to usage or the user.**

Check list 1.2

- Defines factors important to the user.
- Defines factors having an effect on usage
- Lists the disturbances caused by different maintenance actions

The TLC Manager:

11 **Weighs alternative maintenance possibilities and estimates their costs** (with service providers)

Check lists 2 and 5

- Analyzes the relationship between required maintenance, maintenance costs, alternative possibilities of maintenance, limitations on use due to maintenance and acceptable technical risk and cost levels
- Determines the total technical potential of the building to perform the "requirements" and "expectations" of the owner and the user. The evaluation is seen as a relationship between the level of acceptable risk and costs.
- Analyses (possibly in co-operation with owner or some service provider) available FM service providers at that location.

Results

The real estate owner:

12 Evaluates the results of the technical analysis, determining whether there is a good fit between the building's technical potential and the owner's goals.

Check lists 1 and 2

1. If ownership of the building or purchase is cost-effective, go on to phase **13**.
2. If ownership or purchase of the building is not profitable, there is an unsatisfactory relationship between the costs of achieving the desired quality and life cycle characteristics and the factors critical to the owner, the owner may decide:
   - Not to purchase / not to invest
   - To re-evaluate the critical factors (alternative use, critical requirements of ownership) and return to phase **2**
   - To sell the real estate / with or without potential analyzing data and/or suggestion for TLCM strategy

13 Decision

The real estate owner makes a decision as shown in figure 7.14, purchasing, keeping, improving, developing, using or selling the real estate according to the situation. If ownership proves profitable, the strategy developing process is carried out.

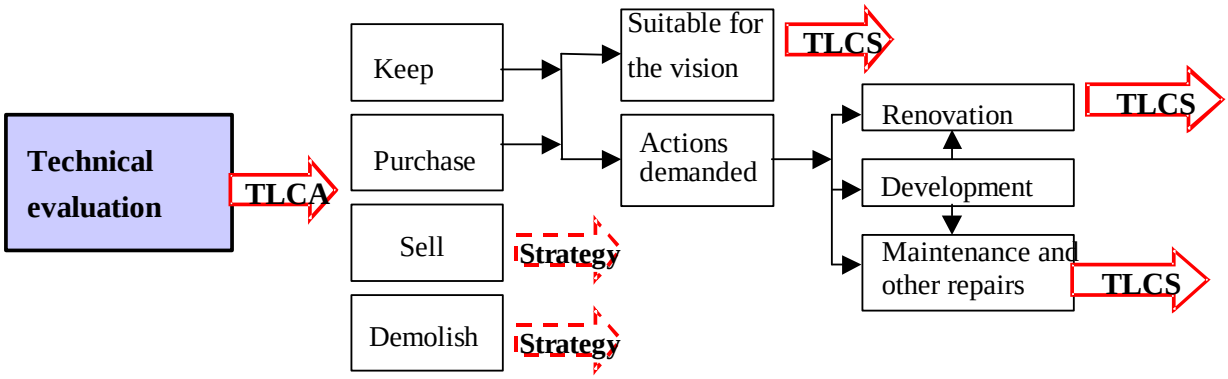

Figure 7.14 Possible decisions in the analysis phase (see also figure 7.9).

7.5.5 TLC strategy

It is necessary to develop a TLC strategy (Technical Life Cycle Strategy) when analysis indicates that ownership is profitable. Strategy development is an interactive process between the owner organization, the TLC Manager, user and service provider(s). The aim of the TLC Manager (with technical service provider) is to determine the best combination of maintenance actions or strategies for different parts of the building. This strategy provides an action plan for a real estate owner to manage TLC in a profitable way. In the strategy development process the results of the technical analysis act as the input. In figure 7.15 the TLC strategy is described.

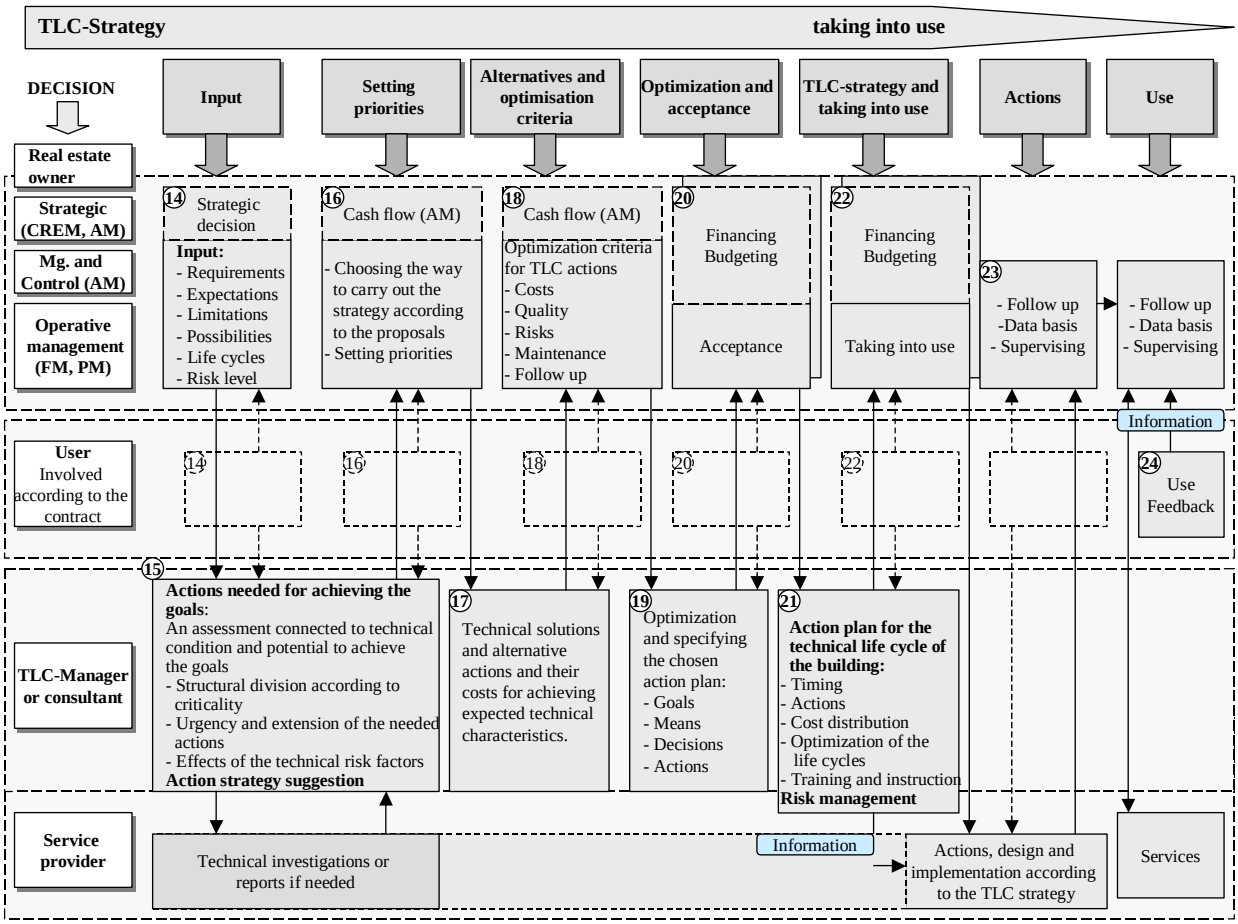

Figure 7.15 The TLC strategy development module is an interactive process in which an optimal and cost-effective planned maintenance program is developed. Optimization is done according to the owner's objectives, taking into account the building's characteristics. As a result of this process, the TLC Manager will have adequate information and criteria for developing a technical life cycle strategy for the building.

In the strategy development process, a TLC Manager defines a TLC strategy according to the owner's and users` needs using information provided by service providers. In the beginning of the process the general rules and frames for the strategy must be defined. The number of parties participating in this phase depends on the nature of the agreement between the user and the owner. Usually, the owner's main interest in the technical life cycle has to do with costs, though s/he is also normally interested in a building's residual value. Therefore, the owner participates in this phase regardless of who is responsible for different kinds of technical life cycle actions (owner or user).

The numbers in figure 7.15 refer to different phases of the strategy development module.

The strategy developing process is as follows:

Strategy developing starts with an interactive session(s) where the general principles and optimization criteria for developing the technical life cycle strategy are defined.

The real estate owner:

14 Outlines his/her objectives, a necessary input for strategy developing

The real estate owner appoints or hires a technical life cycle manager or consultant. The results of the analysis act as the initial data for the strategy developing process:

1) Determine the desired chain of actions:
   - keep in use => strategy development => implementation
   - develop the real estate or business idea => strategy development => actions => strategy updating => implementation
   - maintenance repairs => strategy development => actions => strategy updating
   - renovation or rehabilitation => strategy development => project planning and goal setting, preliminary planning and multi attribute optimization, implementation according to design and planning, TLC strategy updating => In the hand over phase, also strategy implementation

2) Choose a decisive life cycle (e.g.):
   - A life cycle of location
   - A life cycle of usage or way of usage
   - A life cycle of ownership
   - A life cycle of an economic use/estimation
   - A life cycle of a technical part: framework, envelope, etc.
   - A life cycle of renovations

3) Identify the requirements, limitations, expectations and possibilities according to the analysis:
   - Requirements
     - Requirements for cost-effective ownership (technical requirements of the desired usage of the real estate or usage possibilities)
     - Critical characteristics of the real estate according to this usage (e.g. flexibility, IAQ, safety Image)
   - Limitations
     - Cost frames for an initial investment and for technical life cycle costs (maintenance)
     - The acceptable technical risk level.
     - The relationship between risks and return or outcome.
   - Life cycle expectations
   - Quality expectations:
     - Technical
     - Functional
     - Aesthetic
   - Quality of maintenance

The TLC Manager:

15 **Determines the technical life cycle actions for achieving cost-effective ownership in accordance with the goals** (with service providers):

- As a result of the analysis, dividing all the building items (structural parts) into groups depending on their criticality, where the criticality of an individual part depends on the consequences of a possible failure. Critical items are the ones whose failure affects health, safety, environment, utility or costs. Non-critical items are parts which can be used until they break down without any significant risks.
- Setting priorities for the different structural parts of the building according to their criticality and urgency of repairs (Order of importance of repairs during the analysis period).
- Taking into account the technical risk factors and the chosen risk level in choosing actions, and setting priorities based on the probability of risks and consequences of failures. In this, one must consider:
  - the chosen acceptable risk level,

- expected returns, outcomes and costs,
- costs due to some failure,
- the decisive life cycle and the life cycle of renovations ,

The TLC Manager then proposes an action plan, including:

1) Indispensable measures. (Use is not possible at an acceptable risk level without these measures.)
2) An estimation of the costs and priority of these indispensable measures.
3) Necessary/needed measures, along with their timing and costs.
4) Alternative approaches to maintenance (timing, priority setting, maintaining/repairing, costs) according to the criticality of the part of the building.

The TLC Manager might also propose a structure-specific strategy or alternative strategies: the effects of alternative strategies on the condition, usability, residual value and long term division of costs of the real estate.

The real estate owner:

16 Chooses the general principles for strategy development:

- Decides how repairs and maintenance should be approached, including for example:
  - Immediate actions: repairs, partial modernization, and renovations
  - Maintenance: corrective, preventive or condition-based maintenance
  - Planned repairs for life cycles of different parts of the building
  - Choosing a structure-specific strategy according to the criticality of an item
- Sets priorities for the objectives and timing of actions among the proposed possibilities.
- Performs cash flow analysis.
- Investigates budgeting, financing possibilities.
- Checks the links to corporate strategy.

=> Chooses the criteria by which the TLC strategy development is to be optimized based on estimated cash flows, required actions, life cycle and quality expectations and the possibilities of maintenance measures.

TLC Manager:

17 Proposes technical solutions and alternative measures for the maintenance and repair program:

- Evaluates its effects on life cycle and quality objectives.
- Evaluates maintenance measures and disturbance effects.
- Evaluates the cost-effects of the action plan.

The real estate owner: (if necessary)

18 Defines the optimization criteria:

- Timing of the actions
- Costs
- Relationship between remaining lifecycles and the level and implementation of actions.
- Connecting cash flow analysis with the action plan

The TLC Manager:

19 Optimizes and specifies the alternatives presented in phase 17

- Life cycle planning of the different technical parts of the building.
- In planning these life cycles should be adjusted for the chosen decisive life

cycle by using the possible maintenance alternatives.
- Timing and order of the actions.
- Technical actions:
    - Connected to structures
    - Surface materials
    - Plans and HVAC systems
- The way to implement the actions
- Maintenance measures: Building management, repairs, replacements, annual repairs and renovation measures

The real estate owner:

20 Accepts the proposed program or new iteration

After the interactive session, the TLC manger draws up the Technical Life Cycle Strategy. If the building needs immediate preparations, or if a renovation is needed, then the final TLC strategy is taken into use after the hand over and the process progresses step by step.

The TLC Manager:

21 Formulates the Technical Life Cycle Strategy

1) Decisions
    - What decisions have been made?
    - Why have these decisions been made?
    - Technical risks related to these decisions.
    - Needed actions related to these decisions.
    - Possible causes of these decisions.
    - Possible costing consequences

2) What to do? An optimal maintenance strategy for the building:
    - Maintenance measures and building management: repairs, replacements, annual repairs, renovation and other necessary measures
    - Structure-specific maintenance program according to the criticality of a structure
    - Life cycle planning of the different technical parts of the building.
    - In planning these life cycles should be adjusted into the chosen decisive life cycle by using the possible maintenance alternatives.
    - When to do? Timing and priority setting of the technical life cycle actions
    - Based on the criticality of the structural parts or on the consequences of failure.
    - Based on cost frames and return and outcome expectations
    - Based on the acceptable risk level
    - Cyclic setting of the different life cycles of the structures into the main life cycle (monetary, technical, use, user, ownership, location etc.)
    - Regular checking periods

3) How to do?
- Instructions for replacement and maintenance repair work
- Instructions and criteria for maintenance and cleaning personnel
- Effects of the selection of materials, plants and systems on maintenance and cleaning work
- Instruction and training of the maintenance and cleaning personnel
- If repairs or renovation have been done, the effect of possible quality deviations on maintenance work or needed checking periods (updating of the

TLC strategy after the hand over)
- Maintenance instructions according to the maintenance requirements of the chosen design decisions

4) Who shall do?
- Responsibility for checking critical check-points of a building

5) Costs?
- Costs and cost division during the main life cycle
- Residual value after the chosen life cycle period

6) Risk management program
- If needed, define an action plan and instructions for acute situations.
- Possible interaction between different technical actions and existing materials, structures, systems and usage

7) Maintenance book and definition of the action processes

The real estate owner:

22-24 Implements the technical life cycle strategy
- Implementation of the TLC strategy: managing, budgeting, maintaining
- Technical checking at regular intervals according to the strategy
- Follow up
- Financing and budgeting according to the plan
- Gathering feedback from users (customers).

This continues as presented in figure 7.9, until re-analysis is needed.

7.5.6 Checklists

The TLCM Method includes wide checklists which consider different aspects of technical life cycle management. The technical life cycle issues of a building are reflected against cost-effective ownership, user satisfaction and user needs including changing needs of users, life cycle durability including ecological energy efficiency aspects, technical, functional and aesthetical quality of the building and technical life cycle, maintenance of a building and total life cycle costing considerations including initial capital costs and life cycle costs.

The contents of the checklists are as follows:

1. Ownership and use
    1.1. Requirements of the owner/ownership
        1.1.1. Vision, mission, business goals, main factors having an effect on cost-effective ownership
        1.1.2. Market analysis
        1.1.3. Use/user
        1.1.4. Risk analysis
    1.2. User requirements
        1.2.1.Strategic needs analysis of the user/potential user/ expected user
    1.3. Changes in working life and in the future
        1.3.1.Effects on ownership
2. Life cycle economy
    2.1. Return and output expectations
    2.2. Risk analysis
    2.3. Investment costs and the technical value of a real estate
    2.4. Maintenance costs
        2.4.1 Repair and replacement costs

2.4.2 Building management costs
2.4.3 Renovation, refurbishment
2.5. Economical use
3. Life cycle expectations
3.1. Technical and economic life cycle expectations
3.2. Effects of failures on use
3.3. Building physics and life cycles
3.4. Life cycle expectations related to flexibility
4. Quality expectations
4.1. Technical quality
4.1.1. Structural and building physical implementation/risks
4.1.2. Energy efficiency
4.1.3. Ecological level
4.1.4. IAQ and building physics
4.1.5. Flexibility
4.2. Functional quality
4.2.1 Usability
4.2.2 IAQ and productivity
4.3. Aesthetic quality
4.4. Quality of maintenance
5. Possibilities of maintenance and requirements for maintenance

The checklists were included in the TLCM Method description that was used in the cases of this research study.

7.6 Summary of constructing the TLCM Method

This chapter has described the whole process of how the TLCM Method was constructed, and also includes a supplementary literature review. The method was constructed according to the "initial" and "critical" success factors for a well-functioning TLCM Method, which had been collected from the literature and interviews. Finally, the version of the TLCM Method that was used in the cases was presented.

8 Testing the construct

In this chapter, we test and evaluate the Technical Life Cycle Management Method to determine whether it satisfies the criteria of practical functionality, usability, usefulness and novelty. First, the method is tested against the factors necessary for success as determined through the literature review (theory) and also in practice (interview studies 1 and 2, and discussions in executive group meetings while the method was being constructed). These factors include that the method should be practical, logical, comprehensive and generic. These criteria are summarized in table 8.1, and were first presented in chapters 2.2 (table 2.2), 4, 5 and 7.4. (See section 8.1, table 8.1).

In addition, this chapter also considers whether the method fulfills the criteria for the scientific method adopted in this research. In constructive research, the following must be proved:

- the construct's connection to existing theory (section 8.2)
- its theoretical novelty (sections 8.2 and 8.4)
- its practical relevance (sections 8.2 and 8.4)
- its proven use (section 8.4.2)
- its proven practical usability (8.4.1)
- its proven practical usefulness (8.4.2)

The TLCM Method was tested in five case studies (section 8.3). For this evaluation, participants were asked to use the method and afterwards fill out a questionnaire about it. Sixteen participants were also interviewed, along with 14 experts. These experts were either technical service providers or representatives of real estate owner organizations or public societies within the real estate sector. More emphasis was put on case studies and user interviews since people who actually used the TLCM Method would be best equipped to evaluate its practical functionality. The test results are presented in section 8.4.

The researcher participated in the user organizations as an expert and trainer, as this enabled her to gather important information on the use, usability and usefulness of the construct, to evaluate and validate it, as well as to find out how it needed to be developed. She also participated in almost all the meetings during the case projects (except in case 5, which was not carried out in Finland). She considered it important to participate in the projects, since this made it possible to gather the necessary information.

8.1 Relationship between the TLCM Method and factors necessary for success

Table 8.1 summarizes the criteria necessary for a method to facilitate technical life cycle management; it must be practical, logical, comprehensive and generic. The table also shows at what phase in the process each factor is taken into account. Finally, it lists the sources of these ideas in the literature or other sources of information.

Table 8.1. Criteria for a practical, logical, comprehensive and generic TLCM Method for facilitating technical life cycle management.

Criteria for a practical TLCM Method	**Connection to literature (theoretical) or other source of information (practical)**	**Phases in which the criteria is taken into account in the TLCM Method**
Practical, logical, comprehensive and generic	Applied information related to investment analysis, construction of new building and maintenance practices e.g. Flanagen et al., 1989; Lehtinen, 2000; Sarja, 2000; anon., 2001b; Horner et al., 1997; Schulte 2000b	Is a process description Task descriptions and check lists are included
Pays attention to the real estate business as a totality Makes it possible to connect defined business plans more efficiently to maintenance strategies. Facilitates the strategic planning of the technical life cycle as part of overall business strategies and implementation of technical strategies in practice.	Jaffe et al., 1986; Flanagan et al., 1989; Spires, 1996; Gransberg et al., 1997; Manning, et al., 1997; Horner et al., 1997; Tsang, 1998; Zavadskas et al., 1998; Trivers, 1999b; Smith, 2000; Wong, 2000; Sarja, 2000; Also, Brown et al., 1993; Loch, 2000 Interview studies 1 and 2	Phases 1 and 2 in analysis Phases 10 and 11 in analysis Phase 13 Phases 16-21 in strategy development
The cost effects of different technical life cycle strategies should be more accurately connected to long-term planning. Long-term planning should be done according to the objectives of owners. Life cycle costing considerations should be possible.	Jaffe et al., 1986; Greer et al., 1988; Flanagan et al., 1989; Horner et al., 1997; Bottom, et al., 1998; Benda et al., 2000	Phases 1, 2, 3 and 5 in analysis 4, 5, 9 in analysis Phases 16-21 in strategy development
The method should help in analyzing predicting, planning and implementing future decision-making, and also help when considering possible future developments.	Porter, 1980; Jaffe et al., 1986; Lopes et al., 1996; Zavadskas et al., 1998; Ratcliffe, 1999; McGregor et al., 2000; Gilbert, 2001	Phases 1, 2, 3, and 4 Iteration and decision points Checklists The whole process aims at strategic long-term planning.
Pays attention to the objectives of the real estate owner: Real estate owner organizations should be able to define their business objectives and communicate them clearly to service providers.	Jaffe et al., 1986; Flanagan et al., 1989; Spires, 1996; Trivers 1999b; Sarja, 2000; Smith, 2000; Barret et al., 1992a Setting of priorities => Project executive group in construction phase of the study	Phases 1 and 2 => Requirements Phase 6 => evaluation Phase 7 => expectations
Takes into account the changing	Greer et al., 1988; Flanagan	Phases 3, 8 and 10 in analysis

needs of the users of buildings.	et al., 1989; Bottom et al., 1998; Trivers, 1999b; McGregor et al., 2000; Lehtinen, 2000, Lehtinen et al, 2001; Sarja 2000	
The method should facilitate the creation of appropriate technical services and service packages in different situations. The method should facilitate goal-setting and decision-making related to the technical objectives of the real estate and also facilitate information systems in real estate organizations.	Al-Hammad et al., 1997; Gransberg et al., 1997; Trivers, 1999b; Lehtinen, 2000, Lehtinen et al, 2001; Smith, 2000; anon, 2000b	Analysis of a building's technical potential related to primary and secondary objectives: phases 4, 5 and 9 Interactivity and decision-making according to technical information facilitates information systems in RE organizations Task descriptions Checklists
Applies to the strategic, tactical and operative levels Facilitates co-operation: The method should make communication easier between different levels of real estate organizations and between real estate organizations and service provider organizations.	Christopher et al., 1987; Gransberg et al., 1997; Zavadskas et al., 1998; also Trivers, 1999a; anon. 2001b; Sarja, 2000 Interview 2	Interactivity Task descriptions
Facilitates the process of purchasing technical services The causal relations between different technical solutions should be more visible	Flanagan et al., 1989; Smith, 2000; Trivers 1999b; Barret et al., 1992a Interviews 1 and 2	Interactivity, logical structure, task descriptions and checklists Phases 5, 9, and 11 in analysis, also the final strategy, Phase 21 Phase 15 in strategy development
Technical possibilities and the costs of different possible technical actions should be presented clearly and understandably.	Flanagan et al., 1989; Caccavelli et al., 2000 Interview 2	Phases 4, 5 and 9 Task descriptions
Facilitates objective-setting related to technical characteristics	Interview studies 1 and 2 Ratcliff, 1961; Sarja, 2000; Lehtinen, 2000; Lehtinen et al, 2001; anon., 2001b; ASTM E1765–98	Interactivity Task descriptions Phases 1, 2 and 7 in analysis Phases 4, 5, 9, 11
Helps strategic planning and designing technical strategies for the defined life cycle.	Aho, 1993; Flanagan et al., 1989; Gransberg et al., 1997; also: Sarja, 2000	Phase 13 in analysis Phases 14 and 15 in strategy development, also 16-21
Should facilitate technical risk analysis and the suitability and potential of a building for	Jaffe et al., 1986; Palojärvi, 1986; Flanagan et al., 1989; Horner et al., 1997; Lehtinen	Phases 4 and 5, risk analysis Phase 9, technical potential

potential of a building for ownership and usage. Is related to life cycle durability as well as technical, functional and aesthetical potential in relation to life cycle costing	Horner et al., 1997; Lehtinen, 2000; Lehtinen et al., 2001; Ratcliff, 1961 Also: Project executive group in construction phase of the study	Checklists Phases 2, 3, 7, 8, in relation 4, 9 in analysis
Makes it possible to set priorities and optimize => is iterative	Zavadskas et al., 1998; anon., 2001b Project executive group in construction phase	Decision points in analysis, Phases 6, 9 and 12
Takes into account maintenance restrictions, costs and possibilities.	Lehtinen, 2000; Lehtinen et al., 2001; Al-Hammad et al., 1997; Flanagen et al., 1989; Horner et al., 1997	Phases 10 and 11 in analysis Phases 15-21 in strategy development

8.2 Links to existing theories

Since instructions or defined roles were not available related to the strategic planning of the technical life cycles of real estates, it was very important to try to lay a theoretical foundation using sources in related areas. Many books and articles related to the design of new buildings, investment analysis for buildings, needs analysis related to refurbishment and practices related to real estate maintenance and management and theories related to in- and/or out-sourcing services in the real estate sector were examined, and this information was then applied to developing the TLCM Method. As we constructed the method, we tried to consider the necessary criteria for successful strategic planning of TLCM, and to ensure that the method would function well.

The method has a modular and systematic structure, with the idea that a modular structure enables it to be used according to actual needs in different situations. Also, the TLCM Method is by nature general, also enabling it to be used according to case-specific needs. The method of technical life cycle management consists of 2 modules: 1) Description of technical life cycle analysis and 2) Description of strategy development process, defined tasks of different participants in phases of the modules and linked checklists.

The structure of the TLCM Method is presented in Figure 8.1. In section 8.2.1 the situations for using the TLCM Method and links to existing theories is presented. In section 8.2.2 we present the participants in the TLCM process and links to existing theories. In section 8.2.3 we present the analysis module and in 8.2.3 the strategy development module with links to existing theories. The numbers in the process description represent the phases of the method. In this section we provide the links of different modules and different phases of the method and also the roles of different participants in the TLCM process to existing theories.

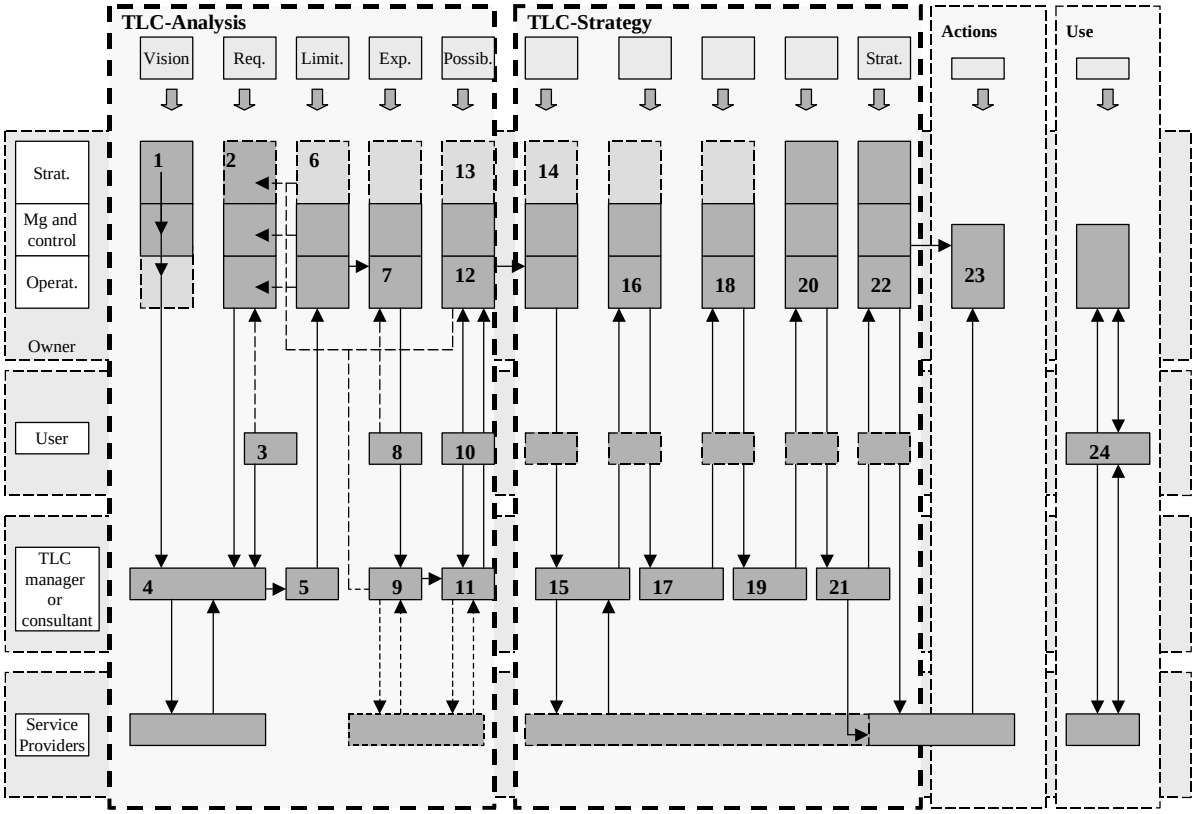

Figure 8.1. Technical life cycle analysis and strategy development. The numbers in the figure refer to phases of the method presented in chapters 7.5.4 and 7.5.5. Participants of the process are those shown on the left side of the figure.

8.2.1 Situations for using the TLCM Method

This strategic Technical Life Cycle method was intended to be used in situations where the real estate owner is making decisions related to real capital (Nutt, 1992; Lundström, 1999; Trivers, 1999b; Smith, 2000; Aikivuori, 1994), i.e., when acquiring real estate (in investment analysis), evaluating the technical potential of an existing building in planning a renovation project, or developing a suitable cost-effective maintenance program for a real estate (Horner et al., 1997; Zavadskas et al., 1998; Benda et al., 2000; Jaffe et al., 1986). Its main idea is to facilitate strategic business planning in the real estate business and allow a real estate owner to consider a building's technical potential and technical risks in terms of the main objectives of ownership (Flanagan et al., et al.,1989; Gransberg et al.,1997; Spires, 1996; Horner et al.,1997; Jaffe et al.,1996; Bottom et al.,1998; Benda et al., 2000; Palojärvi, 1986; Trivers; 1999b; Zsavadskas et al., 1998; Smith, 2000). It also aims to facilitate the owner's objective setting, the making of commissions with technical service providers, and also to improve the cost-effectiveness of the real estate business and the quality of technical life cycle management and risk management.

8.2.2 Participants in the TLCM Method

The parties shown in Figure 8.1 are the different levels of real estate organizations (strategic, management and control (tactical) and operative), customer (user of the real estate), TLC manager, and a service provider or providers and/or other technical professionals.

According to many sources, e.g. in new construction projects, it is important to involve as many stakeholders as possible when analyzing needs and defining objectives related to real estates (Gransberg et al., 1997; Trivers, 1999a, b; Sarja et al. 1999b; Sarja, 2000; Zavadskas et al., 1998; Smith, 2000; Levin et al., 2000; anon, 2000b). Therefore, the TLCM Method is defined as an interactive process involving different levels of the owner organization, the users of the building, the TLC manager or coordinator and different consultants participating in the process. Technical life cycle analysis can be seen as a part of strategic business planning (Jaffe et al., 1986; Smith, 2000; Brown, 2000) and should therefore involve all levels of real estate organizations (Christopher et al., 1987). As we mentioned above, interactivity is considered an important feature, for in order to succeed the method should make *communication easier* between the different levels of a real estate organization and between real estate organizations and service provider organizations. Indeed, many writers emphasize the need to make information more readily available (Loch, 2000; Tsang, 1998; Spires, 1996; Smith, 2000; Christopher et al., 1987 and also Trivers, 1999a,b; anon. 2001b; Gransberg et al., 1997). Also, it was necessary to improve purchasing practices of technical services (Benda et al., 2000; preliminary interviews).

Because the size and structure of the organizations in real estate owner companies varies, we did not want to define which party the TLC manager should represent, the real estate owner organization, technical service provider organization or some other consultant organization, as sometimes the role is shared between some of these parties. In any case, we put special emphasis on describing the role of the TLC manager since the connection between strategic needs and the technical performance of buildings was perceived as inadequate (Benda et al., 2000; Tsang, 1998; Spires, 1996; Flanagan, et al., 1989; Loch, 2000; Horner et al., 1997). The manager is responsible for coordinating and collecting the needed data in all phases of the TLCM process. This person is also responsible for ensuring that the real estate owner has all the necessary information at all decision points of the process, and also for ensuring that the appropriate services needed for decision-making are provided and analyzed. According to the interview studies in Finland, such a role as described in the method is currently lacking (Interview studies 1 and 2).

The process nature of the TLCM Method makes it possible to set priorities, analyze real estates according to these prioritized requirements, make decisions according to specified information and iterate the decision process if iteration is needed (decision points are included and presented in task descriptions) (Smith, 2000; Sarja, 2000; anon, 2000b). It also makes it possible to systematically collect information for the final decision, which makes the process systematic and logical (Kasanen et al., 1993).

8.2.3 Technical Life Cycle analysis

The different modules of the method, analysis (and strategy development), are based on the ideas of investment analysis and other real estate analyses. Also, the ideas of MADA (Multi Attribute Decision Analysis) for new constructions are applied (anon., 2001b, Sarja et al, 1999b; Sarja, 2000; ASTM: E 1765-98). Before decisions can be made and strategies (action plans) defined, adequate information related to the potential of the building from the perspective of the owner's and user's primary and secondary objectives should be collected (Bottom, et al. 1998; Greer et al., 1988; Ratcliff, 1961; Lehtinen, 2000; Trivers, 1999b; Sobotka et al., 1998). Therefore, in the Analysis Module:

1) The technical potential of an existing real estate is analyzed and considered in terms of the owner's main objectives (Trivers, 1999b; Smith, 2000; Bottom et al., 1998). The main objectives should be perceived, defined and prioritized, as they are the most important from the perspective of the owner's business idea and expectations for the building (Flanagan et al., 1989). Also, the main objectives of the user or usage of the building are evaluated. Is the building designed, constructed and maintained according to these objectives, taking into account e.g. the effects of previous usage on the building (Lehtinen, 2000; Lehtinen et al., 2001; Benda et al., 2000; McGregor et al., 2000; Barret et al., 1992a)? If this usage is not possible in a cost-effective way, then some other usage may be considered and/or the risks related to usage can be analyzed (iteration). => Phases 1-3 (Requirements in figure 8.2)
2) Technical risks and the probability that these risks will be realized, as well as the costs of realized risks, are also evaluated in the Analysis Module. Furthermore, the costs and possibilities of risk management are analyzed. These risks and costs are then reflected against the owner's income expectations as well as against the owner's and user's main objectives and usage of the building. In other words, technical measurable risks are identified, an acceptable risk level is chosen and the real estate owner is prepared to take these risks. Also, the cause-effect relationships related to risks are identified (Jaffe et al., 1986; Greer et al., 1988; Palojärvi, 1986; Hintikka, 1999; Benda et al., 2000; Bottom, et al., 1998). => Phases 4-6 (Limitations: Technical potential and technical risks in figure 8.2)
3) The potential of the building to achieve different value-generating characteristics is analyzed in the second part of the Analysis Module. This analysis is still done according to the needs and requirements of users and owners. Also, the cost consequences as well as needed maintenance activities due to different alternatives are evaluated (Smith, 2000; Trivers, 1999b; Benda et al., 2000; Ratcliff, 1961). => Phases 7-11 (Expectations and possibilities in figure 8.2)

Figure 8.2 presents the analysis module with its phases:

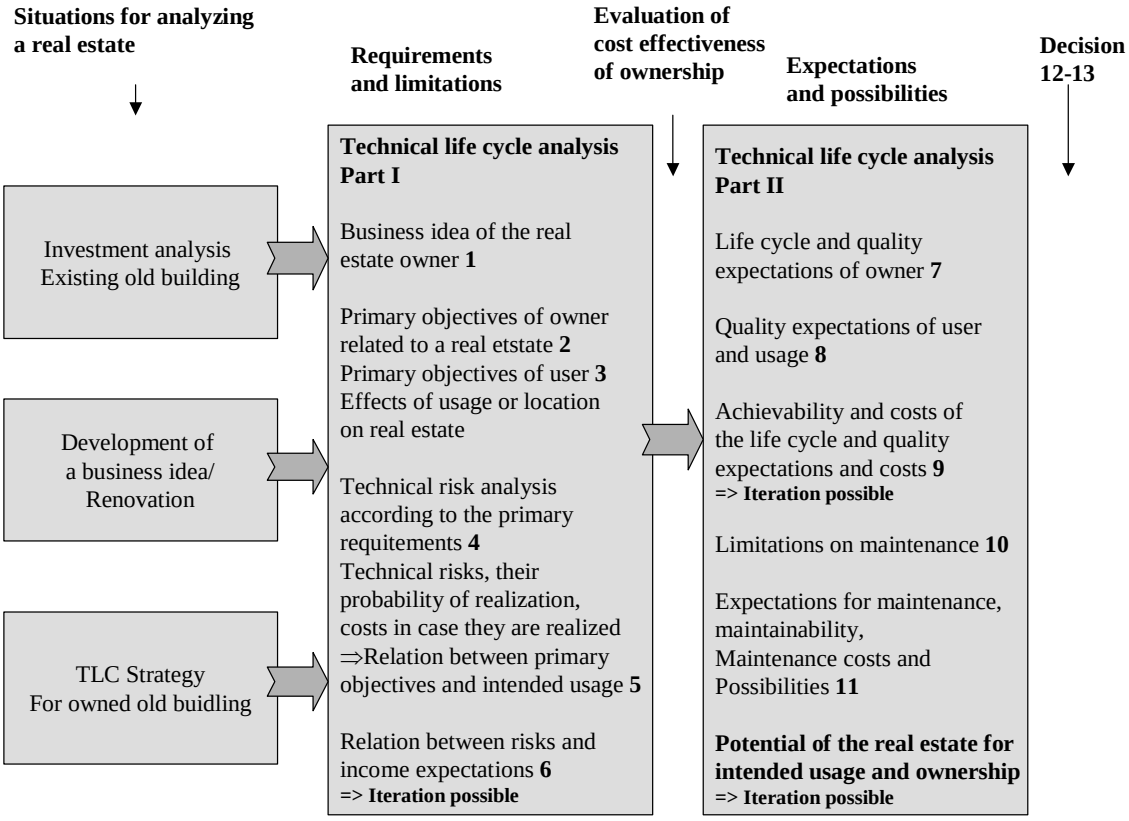

Figure 8.2. The Analysis Module in the technical life cycle process description. The numbers refer to the phases of the process (see also chapters 7.5.3 and 7.5.4).

8.2.3.1 Part I of the analysis –Primary needs

Primary needs, requirements, are those priorized technical factors that are most important for the owner for fulfilling the set objectives for cost-effective ownership related both to the business idea of an owner and real estate specific objectives of a real estate under consideration (Smith, 2000; anon. 2000b).

In part one, the cost-effectiveness of ownership is analyzed. In order for decision-making to be cost-effective, it is necessary to analyze a real estate before making any decision related to it (Smith, 2000; Trivers, 1999b; Flanagan et al., 1989). The analysis module is based on the primary objectives of the owner and ownership, the business idea of owning the real estate (Ring et al., 1981; Flanagan et al., 1989) (Figure 8.1, phase 1 and figure 8.2 part 1/1). Defining the business idea of ownership was considered very important at the very beginning of the process because real estate owners differ in their objectives for buildings. The objective can be e.g. short-term profit, long-term returns or satisfying a public need (Flanagen et al., 1989, p. 6, see also Ring et al., 1988, p. 509; Jaffe et al. 1986, p. 4; and also Lundström, 1999, p. 15). In addition, owners differ in their timescale for owning a building, how long they expect to own the building (Flanagan et al., 1989, p. 6). The first phase represents the strategic business process of an owner: defining the basic business idea. If others within the owner organization and perhaps also the technical life cycle manager were informed about the principles of this basic business idea, it would facilitate the analyzing process. Many authors have emphasized the importance of discussing the business ideas in relation to objective-setting and decision-making: Ratcliffe, 2000; Loch, 2000; Smith, 2000; Gransberg et al.,

1997; Lundström, 1999; Spires, 1996; Wong, 2000. This step is also related to an initial factor for success: “Real estate owner organizations should be able to define their business objectives and communicate them clearly to service providers. This would help focus the appropriate technical services and service packages in different situations.” This factor is also relevant in phases 2 and 7 (See figure 8.1).

In the second phase of the technical life cycle analysis (phase 2 in figure 8.1) the owner’s objectives for a single real estate are defined (Trivers, 1999b; Smith, 2000; Benda et al., 2000). Real-estate-specific objective-setting was considered important since these objectives are valuable in directing measurements and choosing the depth of the risk analysis. All information that affects the objective-setting and decision-making is important, e.g. information related to investment risk analysis, return expectations, investment value, market analyses and cash flows (Flanagan et al., 1989; Jaffe et al., 1986; Trivers, 1999b; Greer et al., 1988; Bottom et al., 1998).

In some cases (phase 3 in figure 8.1), it is critical to understand the requirements and needs of clients (the users of the building), partly from the perspective of the building: has it been constructed and designed taking into account the possible moisture or other loads affected by usage? (Lehtinen, 2000; Lehtinen et al., 2001; anon. 2000b; Al-Hammad et al., 1997.) There might also be critical needs of the users that affect the building’s usability in some specific use (Lehtinen, 2000; Lehtinen et al., 2001; McGregor, 2000; Trivers, 1999b; Smith, 2000). Some of the requirements and needs of users may have such a role in the strategic real estate business that it is necessary to take them into account as primary objectives related to the building (Benda et al., 2000; Bottom et al., 1998; McGregor, 2000; Trivers, 1999b and Smith, 2000).

When the primary objectives of the owner and users are made clear, the risk analysis can be focused according to those objectives. The objectives for a single real estate can be compared to the risks and technical potential of the building to fulfill these primary objectives. Such analysis may bring cost savings by helping the real estate owner avoid mis-investments. This risk analysis is based on the technical potential of buildings and the ideas are taken from the methodologies developed for new construction projects. We applied theories of defining the appropriate moisture physical design level in new construction projects, as well as theories related to multi-dimensional decision analyses (Lehtinen, 2000; Lehtinen et al., 2001; Sarja et al., 1999; Sarja, 2000; anon., 2000b; ASTM: E 1765-98; also Trivers, 1999b; Zavadskas et al., 1998; Wong, 2000; Spires, 1996; Gransberg et al., 1997 and Flanagan et al., 1989 refer to the importance of this phase). (Figure 8.1, phase 4). Whereas in the design phases of new construction projects, the quality and life cycle characteristics are defined according to existing or expected user and usage, in this method the main focus is on considering how the building is designed, constructed, maintained and used, what are the effects of time, usage, degradation, etc. on the building’s ability to fulfill the set objectives and what would it cost to achieve the needed characteristics. What kinds of technical risks does the building have due to the design and construction methods used and due to usage and maintenance activities during the past service life of an existing building? Also, ideas related to refurbishment projects are applied (Trivers 1999b, c; Smith, 2000). In addition, the technical performance of a building has an effect on usability and user satisfaction and the cost-effectiveness of ownership (Bottom et al., 1998; Benda et al., 2000; Trivers, 1999b; Smith, 2000; Zavadskas et al., 1998).

Technical risk analysis was considered very important since investment analyses and other real estate analyses always include technical factors. Still, in practice too often these technical factors were considered only separately, not in relation to the owner’s objectives and the users’ needs (Benda et al., 2000; Brown et al., 1993; Loch, 2000; Ratcliffe, 2000; Smith, 2000, Flanagan, et al. 1989; Preliminary interviews 1 and 2). Also, cost effects are considered in the risk analysis phase, and technical risks are considered as a totality, since identifying

risks and determing causal relationships between them are important (Flanagan et al., 1989; Crockford et al., 1986; Shirmans et al., 1985; Palojärvi, 1986; many in Hintikka 1999). In the TLCM Method, risks are considered: 1) purely technically - how some existing risks may affect the different characteristics of a building at its worst, what is the acceptable risk level, what risks are acceptable, what must be repaired immediately (Palojärvi, 1986; Horner et al., 1997); 2) in terms of costs - what are the costs of repairing, costs of risk management, costs of realized risk (Palojärvi, 1986; Horner et al., 1997); 3) from the perspective of the owner's primary objectives (Smith, 2000; Trivers, 1999b); and 4) from the perspective of the user's primary, most critical building-related needs (Trivers, 1999b; Smith, 2000; Bottom et al., 1998). This risk analysis is based on the suitable available theories as well as on the practical needs identified in interview studies 1 and 2 (e.g. Lehtinen, 2000; Lehtinen et al., 2001; Palojärvi, 1986; Horner et al., 1997; anon, 2000b) (Phases 4 and 5 in figure 8.1).

Decision-making rests finally with the owner (phase 6 in figure 8.1), so the owner needs adequate information. The owner should be able to decide at which cost, income and risk levels s/he operates, and also at which level the objectives can be achieved (Jaffe et al., 1986; Greer et al., 1988). This method provides owners the possibility to consider technical risks, and allows owners (investors) to do total life cycle costing and cash flow analyses regardless of the current situation: investment analysis, development potential analysis, analysis of a building under consideration, or technical life cycle strategy (action plan) development process (Flanagan et al., 1989; Aho, 1993).

If cost-effectiveness is not possible with the intended concept (within the frame of ownership-usage-user need) iteration may be needed (see table 7.9 in chapter 7, section 7.4.1.3). If, for example, the expected user is not paying adequately in relation to risks or risk management costs, some other usage with other user requirements may still be possible. Zavadskas et al. (Zavadskas et al., 1998) pointed out the importance of optimization in user requirements and maintenance actions if cost-effectiveness is to be achieved. In the method, user needs are considered alongside technical characteristics and risks, making it possible to optimize actions during the entire life cycle or the chosen period. Iteration must be possible in the analysis phase, so all the possible cost-effective usage/ownership possibilities can be considered, especially in situations where the potential for development is being considered (see table 7.9 in chapter 7, section 7.4.1.3). Iteration makes it possible to prioritize the primary and secondary objectives related to use, usage and technical risks of the building building and find the optimal solution (Applied from optimization and pritorities-setting of Zavadskas et al., 1998; anon., 2001b; Jaffe et al., 1986; Greer et al., 1988).

8.2.3.2 Part II of the analysis - Secondary needs

Secondary needs are those priorized expectations that are not critical from the perspective of cost-effective ownership or usage but provide added value for both (Ratcliff, 1961; also: Al-Hammad et al., 1997; Bottom et al., 1998; McGregor, 2000; Trivers 1999b).

Part two of the analysis involves potential analysis of a building to see if it can fulfill in a cost-effective way the quality expectations of different stakeholders, and is somewhat close to workspace management ideas (McGregor, 2000). The possibilities and costs of achieving the secondary objectives are considered.

This analysis phase is developed according to issues outlined in risk and investment analysis literature, and also applies methods and ideas related to new construction projects and theories related to in- and out-sourcing of services in the real estate sector.

In order to prioritize the different technical characteristics of a building (Bottom et al., 1989; Sarja, 2000; anon., 2001b; ASTM: E 1765-98; Zavadskas, et al., 1998), you have to first identify the most important ones. The secondary objectives, the so-called value-adding

characteristics of a building (Ratcliff, 1961), are considered after the primary objectives. These secondary characteristics are related to the secondary needs and expectations of owners and users related to the real estate. In the TLCM Method, these expectations are considered in terms of the costs of achieving them, or in terms of the maintenance activities needed if some special characteristics are preferred, with the aim of analyzing the technical potential of the real estate to achieve the desired characteristics (Al-Hammad et al., 1997; Benda, et al., 2000; Bottom, et al., 1998; Flanagan, et al., 1989; Gransberg et al., 1997; Greer et al., 1988; Ratcliff, 1961; Trivers, 1999b; Caccavelli et al., 2000).

In this part of the analysis, appropriate cost-effective alternatives to maintenance work are also considered, along with their cost effects (Zavadskas et al., 1998; Tsang, 1998; Spires, 1996; Horner et al. 1997; Lehtinen, 2000; Lehtinen et al., 2001).

8.2.4 Developing a Technical Life Cycle Strategy

In the strategy development phase there are ten steps, eight connected to strategy development itself. The main idea in strategy development is to define an action plan, a maintenance strategy, for each real estate according to the owner's objectives. In the strategy development phase, the results of the previous rigorous analysis serve as the input for strategy developing. During the process, the idea is to optimize actions and cash flows according to the objectives of a cost-effective real estate business. In optimization and maintenance strategy defining, the ideas of Zavadskas et al., Horner et al., Lehtinen et al., and Flanagan et al. have been applied (Zavadskas et al., 1998; Horner et al., 1997; Lehtinen, 2000; Lehtinen et al. 2001; Flanagen et al., 1989). In addition, some ideas from risk analysis, life cycle costing and input-output theories have also been applied (e.g. Palojärvi, 1988; Aho, 1994; Flanagan et al. 1989).

If the analysis phase is done rigorously enough, the strategy module may proceed quite quickly, since most of the decisions have already been made in the analysis phase and they can be used as input in strategy development.

The technical life cycle strategy consists of important information for managing the building in the long term, or at least during the life cycle period under consideration. The following table presents the contents of the strategy as well as its connections to theories.

Table 8.2. The contents of the technical life cycle strategy:

Part	Content	Connections to literature
1	**Description of decisions** - What decisions have been made? - Why have the decisions been made? - Technical risks related to the decisions. - Needed actions related to the decisions. - Possible causes of decisions. - Cost consequences	Related to interactive design of new construction and to risk analysis literature: e.g. Gransberg et al., 1997; Levin et al., 2000; Trivers, 1999a; Al-Hammad et al., 1997 Crockford, 1986; Greer et al., 1988; Palojärvi, 1986
2	**What to do? An optimal maintenance strategy for a building:** - Maintenance measures and building management: repairs, replacements, annual repairs, renovation and other needed measures - Structure-specific maintenance program according to the criticality of a structure - Life cycle planning of the different technical parts of the building. - In planning, life cycles should be adjusted to the "main life cycle" by using possible maintenance alternatives; adjusting planning to the main life cycle by means of maintenance	Based on ideas about analyzing the - Usage of the real estate, - Environmental loadings e.g. - Climate and location of the building, - Structural and building physical characteristics of a building - Performed maintenance, optimizing maintenance - Degree of obsolescence Horner et al., 1997; Lehtinen, 2000; Lehtinen et al., 2001; Aho, 1993; Flanagan et al., 1989; Zavadskas et al., 1998; Smith et al., 2001; Tsang, 1998; anon 2000b; Sarja, 2000, Caccavelli et al., 2000; also: Wittchen et al., 2002)
3	**When to do? Timing and priority-setting of technical life cycle actions** - Based on the criticality of structural parts or on the consequences of failures. - Based on cost frames and return and outcome expectations - Based on the chosen acceptable risk level - Cyclic setting of the different life cycles of the structures in the main life cycle (monetary, technical, use, user, ownership, location etc.) - Regular checking periods	Based on knowledge related to technical characteristics of the buildings and on risk analysis literature: Horner et al., 1997; Zavadskas et al., 1998; Al-Hammad et al., 1997; Levin et al., 2000; Palojärvi, 1986; Tsang, 1998
4	**How to do?** - Instructions for replacement and maintenance work - The effect of the selection of materials, plants and systems on maintenance and cleaning work - Instructing and training of the maintenance and cleaning personnel - If repairs or renovation have been done, the effect of possible quality deviations on maintenance work or needed checking periods (updating of the TLC strategy after the hand over) - Maintenance instructions according to the maintenance requirements of the chosen design decisions	Based on ideas related to development of new construction and maintenance strategies and implementation of maintenance work: Lehtinen, 2000; Lehtinen et al., 2001; Sarja et al., 1999b; Sarja 2000; anon., 2001b; Al-Hammad et al., 1997; Zavadskas et al., 1998; Levin et al., 2000; Flanagan et al., 1989; Trivers, 1999b; Horner et al., 1997 Also related to risk analyses: Crockford, 1986; Palojärvi, 1986
5	**Who to do?**	Based on ideas about analyzing:

	Responsibilities in checking critical checking points of a building	- The needs of the clients (e.g. Benda et al., 2000; Bottom et al., 1998) - The environmental requirements (Sobotka et al., 1998) - Effects of usage on the durability and maintenance needs and possibilities of the building (Lehtinen, 2000; Lehtinen et al., 2001; Al-Hammad et al., 1997) - Maintenance strategies (Horner et al., 1997)
6	**Costs?** - Costs and cost division during the main life cycle - Residual value after the chosen life cycle period	Based on life cycle costing and value considerations: Aho, 1993; Flanagan et al., 1989; Wallwork, 1998; Schulte, 2000; Jaffe et al. 1986; Greer et al, 1988; Zavadskas et al., 1998; Caccavelli et al., 2000a, b; also Wittchen et al., 2002
7	**Risk management program** - If needed, an action plan and instructions for acute situations is defined. - Possible interaction between different technical actions and existing materials, structures, systems and usage and between the timing of the actions and existing conditions/characteristics of different structures/parts of the building	Based on risk analysis information so that it becomes possible to take into account the consequences of realized risks, also based on theories of selecting the appropriate moisture physical design level in new construction projects: Crockford, 1986; Palojärvi, 1986; Horner et al., 1997; Lehtinen, 2000; Lehtinen et al., 2001, Al-Hammad et al., 1997
8	Maintenance book and the definition of the action processes	Horner et al., 1997; Tsang, 1998, Flanagan et al., 1989; anon, 2000b

In the checklists, multiple views of the different phases of the analysis and strategy development modules are taken into account.

8.3 Empirical testing by case studies

The TLCM Method was tested in five cases. Table 8.3 presents the main information about all five cases. In addition in this section short task descriptions are presented along with observations from the cases.

Table 8.3: A list of the cases used in testing the TLCM Method.

Case #	***Case 1***	***Case 2***	***Case 3***	***Case 4***	***Case 5***
Project description	Real estate business development project of an existing building. Refurbishment. Multiple development possibilities considered Iteration used in phases 1-6	Analysis of technical potential Technical life cycle strategy development Development potential with costing considerations applied	Analysis and technical life cycle strategy development Partial refurbishment Strategic TLC	Analysis and technical life cycle strategy development Development potential analysis of an existing building related to an extension project	Investment analysis in purchasing a real estate
TLC manager	Consultant as TLC manager	Owner as TLC manager	Construction company as TLC manager	Construction company as TLC manager	Consultant as TLC manager
Participants	4 persons from different levels of the real estate organization TLC manager Consultants from 4 different service provider companies	2 participants from different levels of the RE organization 2-3 participants from different levels of the TLC manager organization 1 FM consultant	1-2 persons from different levels of the real estate organization 2-4 persons from the construction company 2 consultants	1-2 persons from different levels of the real estate organization 2-4 persons from the construction company 2 consultants	1 person who represented the owner organization Multiple consultants from 2 consultant companies
Beginning of the case-project	Lots of open questions, real development case	Rigorous needs analysis of user was done	TLCM strategy for purchased hired real estate was needed Partial refurbishment needed	TLCM strategy for purchased hired real estate was needed Moisture physical problems Extension planned	Investor made a “technical due diligence” for a potential investment object
Role of researcher	Observation Technical support	Observation Telephone meetings	Observation Technical support	Observation Technical support	Telephone meetings Discussions
Successful issues during the project	Successful cost-effective solution	Procedures in the real estate company were stable and well-organized	Good relations between Technical service provider and customer	Good relations between Technical service provider and customer	The client learned to buy when he saw what he could get.
Problems during the project	Project team and project leader changed during the project Problems with timetables	Problems with timetables	Difficulties in role sharing related to role of TLC manager	-	Language

The following sections present short case descriptions. All of these have been sent to some key participant for comment.

8.3.1 Case 1

In the first case, the real estate was a historically-important partly-protected building which had some restrictions related to city planning. The assignment was to analyze the potential of the building in order to develop the business idea: all the main usage possibilities were analyzed. Iteration was done several times within phases 2-6 of the TLCM Method. The owner's main requirements were clear but the user needs were not since there were many possible users and usages. A technical risk analysis was carried out and an acceptable risk level for different usage alternatives was defined. The owner decided on an acceptable risk level, set the cost frame and chose the most potentially profitable usage alternative. We then proceeded to phase 7, where the real estate owner invited his own architect and HVAC designer to participate in the analysis process. Technical consultants, the TLC manager and participants from different levels (strategic, tactical and operative) of the real estate owner organization participated in the process until phase 13, where the main decisions were made. The strategy development module proceeded quite quickly: it was decided to totally renovate the building, and multi-attribute decision analysis was done in the analysis phase. Nevertheless, the strategy development module was used phase by phase, and the TLCM strategy for the building was created.

Participants

All the necessary organizational levels of the real estate owner company were represented in the project. The service provider company was also well represented. Both the strategic and operative levels were involved. After phase 6 of the TLCM analysis, some additional service providers participated in the process. These consultants were involved in the design phase when the renovation project started.

In this project TLC manager was one of the participants from the technical service provider company.

Preliminary preparations and the first meeting

Material related to the TLCM Method was distributed to all participants before the meeting so everybody could get acquainted with the method beforehand. Service providers were also given the model ahead of time, and were trained separately. One of the participants from the real estate owner organization and one from the service provider organization were acquainted with the method (members of the project's executive group), but the others had not been trained. At the first meeting the method was presented to all the participants.

How the project went: problems, the researcher`s role in the project

The project started in the beginning of June 2002. Therefore, one after another, the participants had their summer holidays during the project, which made it difficult to organize meetings. Still, most of the participants were able to participate in almost all of the meetings. The strategic manager of the real estate company was able to participate in all the meetings and the researcher also observed all of them. Her presence did not seem to disturb the project. On the contrary, it facilitated the use of the method, as the users seemed to really want to use the method because she was there. The memo material was available to everyone all the time. Memos were distributed by e-mail.

According to the service provider, participants representing the lower level of the real estate organization were not well enough prepared for the first meetings. The strategic manager of

the real estate owner organization was not sure if the other participants from the organization were fully aware of the project's objectives, though they themselves said they were.

Other observations

Nobody had used the method before, and there were some problems in the beginning of the project in organizing the different roles. All the parties did not understand their roles and therefore all the information or material needed in the process was not available at the right time in the first meetings. One of the service providers pointed out that the real estate company had not really prepared well ahead of time: the participants did know about the objectives, nor did they prepare things for meetings as they should have. This experience demonstrates the importance of appointing the TLC manager, whether from the owner or service provider organization, right at the very beginning of the project. In this case, the owner organization supposed that the service provider would coordinate the activities of the TLC manager, but for the service provider this was a new role. Still, at the end of the project, when everybody was already familiar with the method, the opinion was that the meeting practices advanced the model's use. In every meeting, we pointed out what had been accomplished, where we were now, and what were the aims of the next phase.

According to one participant, there was prejudiced opposition to using the method at the beginning of the project. One person pointed that the building project itself was not optimal, though most said that the case was perfect, difficult but suitable. Most participants said that there were no obstacles to using the method, though one did say that the material should have been simpler to use. He suggested using a Power Point presentation where the various stages of the method would be presented sequentially, but he also said that using the method was not difficult. One problem was that the process was rushed. There was not enough time to concentrate on the method; more time should have been used for presenting arguments in favor of using the model, in layman's terms.

In the middle of the analysis (after phase 6 in which the development direction was chosen), the owner asked his own service providers (architects and HVAC designer) to become involved in the project. Their involvement was very important because the primary objectives of the owner were related to the functional and aesthetical characteristics of the building. The TLCM Method was not presented to the new participants at first, since there was no time. However, after the method was presented and discussed after a few meetings, the new participants were willing to contribute to the process.

All the participants stated that they would use the method in the future, commenting that it was interesting and useful, but that it was also demanding: *"This has been an exceptional and extremely interesting project, both in terms of its demands and schedule" (AP12).*

8.3.2 Case 2

The second case was a TLC analysis and strategy development project for an office building located in central Helsinki. In this case, the main objective of the owner company was to analyze the building's development potential before a refurbishment project. For the owner the most critical need (the primary objective) was to keep the user (tenant) and therefore the tenants` needs were also the owner's primary objectives. On the other hand, the cost-effectiveness of ownership was also being considered. The owner had an ongoing project with a FM consultant in which the tenant's needs were being clarified, and this consultant participated in the TLCM process the entire time.

In this project, the owner wanted to define and analyze technical risks, the relationship between these risks and the tenant's needs, the probability that risks would be realized, and the costs of such realized risks. A rigorous technical risk analysis was done (phase 4 and 5),

and the TLC manager provided several technical alternatives for the owner to manage risks and choose an acceptable risk level. The owner analyzed the cost-risk relation, chose a suitable risk in relation to income expectations and then proceeded with the secondary needs of ownership and user. The process proceeded in accordance with the TLCM Method.

Participants

In the second case, the project group consisted of two members of the owner organization (tactical and operative). In addition, two strategic managers were interviewed (group expert interviews). Other participants were one service provider (responsible for user needs), who was interviewed in group expert interviews and two service provider company participants from two different service provider organizations. The owner took the role of TLC manager, though the service provider developed and wrote the final technical life cycle strategy. They co-operated within the described role. All the necessary organizational levels were represented in the project.

Preliminary preparations and the first meeting

The TLCM Method was presented to all the participants in a meeting before the project started. We also discussed the objectives of the TLCM analysis and strategy developing process several times with the owner company. One of the members of the owner organization participated in the executive group of the research project. The material related to the TLCM Method was distributed to all before the first meeting so everybody could get acquainted with it beforehand. Service providers were presented the method ahead of time, and were trained separately.

How the project went: problems, the researcher`s role in the project

The researcher participated in the first two meetings (of a total of three) and she also had separate meetings with all participants during the project. She also had some telephone meetings with one participant from the owner organization. Then after the project she interviewed the participants. These interviews showed that there were no impediments to using the method in this project. Six months after the final interviews, the service provider company visited the real estate and met a group of tenants. The tenants were very motivated and satisfied, and also very interested in the way the project had been carried out. Also, the real estate company has used the TLCM Method in other projects.

Other observations

The researcher did not make observations all the time since she did not participate in all the project meetings. She participated in the first two meetings in which the primary objectives of the owner and the user were defined. The memo material and technical reports were available to her, however. According to the interviews, all the participants felt that the project was very successful. The method was actively used during the project. A few iteration loops were needed and therefore some of the phases were discussed more than once. Both parties used the checklists, though the TLC manager used them more than the members of the owner organization. The project included both the analyses and the strategy development of the real estate. None of those interviewed mentioned any impediments to using the TLC management method.

8.3.3 Case 3

The third case was an office building in the middle of Helsinki. The location was good and the owner wanted to define the technical potential of the building for developing the business idea in the future. The technical value of the building was important and the owner wanted to maintain it. The owner also desired a technical life cycle strategy in order to budget and

finance technical investments over the long-term, and also to optimize technical actions from the perspectives of cost and value. In addition, partial renovation actions were planned.

Participants

The strategic manager of the real estate company participated only in the first preliminary meeting in which the method was presented to the participants. The operating manager participated in all project meetings. Three service provider companies were involved. One of these, the TLC manager company, was represented by members from the strategic, tactical and operative levels. This company was responsible for developing the TLCM strategy. The other service provider companies were responsible for risk analysis and evaluation of the technical potential of the building. In this project, the party responsible for risk analysis only participated in the analysis phase, and services were purchased by the owner organization with the cooperation of the TLC manager company.

Preliminary preparations and the first meeting

There were several preliminary meetings before the projects started. Some of these meetings were negotiations regarding projects which might be suitable for case studies; one service provider and one person from the real estate owner company were involved in these negotiations.The researcher also participated in some of these meetings. The material related to the TLCM Method had already been distributed to everyone. In addition, before the projects started there was a meeting in which she presented the ideas of the TLCM Method to the different parties involved in the projects. There were two parties from the owner organization, the strategic/tactical and operative levels, six parties from the service provider companies, three of them from the service provider companies with expertise in the risk analysis of real estates. Material related to the TLCM Method was also distributed to these participants.

How the project went: problems, the researcher`s role in the project

There were some problems in the beginning of the third project concerning the roles of the different participants. In principle, either a real estate owner organization or a service provider organization may take the role of TLC manager. In this case, the owner did not assume the role, and all three of the service provider companies wanted to take it. Moreover, representatives of maintenance organizations also attended some meetings. Therefore, there were some problems with these organizations and with organizing the project meetings. In the end, the service provider companies who did the risk analysis were not involved in the strategy development phase, so only one of the service providers was responsible for developing the strategy according to the information produced in the analysis. The risk analysis was reported separately and used in the strategy development module.

There were also some problems in proceeding according to the task descriptions because the strategic manager of the owner organization was not participating in the meetings. The party who was involved was either not allowed or not willing to provide all the necessary information. It is also possible that the information simply was not available in the organization at all. More efficient interactivity would have facilitated the project. Still because the aim of this project was to develop a long-term technical life cycle strategy for the building, and because there was no idea in the short-term to develop the business ideas, the project was successful. The researcher participated in all the project meetings as an observer.

Other observations

The owner was satisfied with the case and cooperation with the TLC manager is still going on. In the future, this cooperation will be based on the TLCM Method. All the participants believed that it was important to maintain a confidential relationship between the TLC

manager and the real estate owner. All reports and memos were available at all times to the participants.

8.3.4 Case 4

The fourth case was an office building in the capital area of Finland. The location was quite good. Although the building was not very old it had some structural and building physical problems. The owner wanted to solve the problems in order to manage the life cycle and life cycle costs of the building, maintain its technical value, optimize investments, set priorities for the required investments and offer a satisfactory office building for users. The analysis was not carried out in order to determine whether ownership was profitable or not, but more in order to define the optimal technical life cycle strategy for the real estate. The project was related to an extension project which would be carried out in the near future.

Participants

This project was carried out with the same participants as in case 3. The operating manager of the owner organization participated in all project meetings. Three service provider companies were involved. The TLC manager company, responsible for developing the TLCM strategy was represented by members from the strategic, tactical and operative levels. The other service provider companies were responsible for risk analysis and evaluation of the technical potential of the building and they only participated in the analysis phase. The services were purchased by the owner organization with the cooperation of the TLC manager company.

Preliminary preparations and the first meeting

There was one preliminary meeting before the project started, a discussion of whether the project was suitable for being a case. One service provider and one person from the real estate owner company were involved in this discussion. The researcher also participated in this meeting. The material related to the TLCM Method had already been distributed to everyone. In addition, before the project started there was a meeting in which the researcher presented the ideas of the TLCM Method to the different parties involved in the projects (during the preparations of case 3). There were two parties from the owner organization, the strategic/tactical and operative levels, five parties from the service provider company and one party from the service provider company with expertise in the risk analysis of real estates. Material related to the TLCM Method was also distributed to these participants.

How the project went: problems, the researcher`s role in the project

This time there were no problems with organizing the project and the project meetings. The service provider companies who did the risk analysis were not involved in the strategy development phase, so only one of the service providers was responsible for developing the strategy according to the information produced in the analysis. The risk analysis was reported separately and used in the strategy development module.

There were also some problems in proceeding according to the task descriptions because the strategic manager of the owner organization was not participating in the meetings. Again, the party responsible for tactical and operative managing was either not allowed or not willing to provide all the necessary information. It is also possible that the information simply was not available in the organization at all. More efficient interactivity would also have facilitated this project. Still, the project was successful. The researcher participated in all the project meetings as an observer.

Other observations

The parties of case four were the same as in case three. Also, in case four the owner was satisfied with the case and cooperation with the TLC manager. As mentioned above,

cooperation is still ongoing and will be based on the TLCM Method in the future. All reports and memos were available at all times to the participants from the TLC manager company, real estate owner and the researcher.

8.3.5 Case 5

Case five was an investment analysis for a potential purchase. The TLC method was used by the owner (an American investor) and TLC manager (a Finnish consultant company with a Russian department). The method was used to analyze the technical risks related to the object in its intended use, and the investor made his investment decision based on the analysis. The same investor also used the TLCM Method to analyze a few other buildings he owned, in order to develop a TLCM strategy for them. In this thesis, however, only information related to the investment analysis case is used since this was the only one in the class "investment analyses."

Participants

The cases were carried out in Russia and therefore only one of the users was interviewed. The participant group consisted of a managing director of a TLC manager organization (the TLC manager in the case, and also the interviewed person), one project manager from the owner organization, members of the American owner organization (investor) and members of the Russian technical service provider organization. All the necessary organizational levels were represented in the project.

Preliminary preparations and the first meeting

In the kickoff meeting the TLC manager company presented the method to the participants (project manager and investor/owner organization group). The researcher did not participate in the project at all.

How the project went: problems, observations

According to the TLC manager, the method was used successfully. In answer to the question *"How did you feel about testing the method*?" he replied:

"I no longer think of this as an experiment, but as using the model. I've internalized the model and have already been along in the preliminary discussions on a number of previous cases, and now it has already been used in a number of projects. That is, we're using the model, not experimenting with it, and the model is working well." (FP17)

The service provider and owner organization have signed a frame contract saying that in the future their cooperation will be done using the TLCM Method. The method will be used both in investment analysis and in developing TLCM strategies for existing real estates and for future purchases.

According to the interview, the only problem in these projects was language: the TLCM Method itself is published in English, not Russian, and the checklists are only available in Finnish at the moment.

The researcher participated in the project as an observer by having telephone meetings and meetings with TLC manager company during the project.

Was the TLCM Method used / amount of use?

The method and checklists were used during the projects. The project discussed here was an investment analysis, and thus only included analysis of the technical potential of the building. The other projects included both analysis and strategy development modules. Strategy development will also be done for this property since the investor ended up purchasing the building.

Q: "Did the project proceed according to the described method?"

A (FP17): "We went just with the model: vision, mission, general requirements, risk analysis, aims, as well as the final risks in terms of the strategy. We went through the process just like this."

8.4 Practical functionality of the construct

Through these five case studies, and subsequent interviews, we tested the practical functionality of the TLCM Method. This analysis is divided into 3 parts:

I The content, structure and usability of the TLCM Method (presented in section 8.4.1).

II The amount of use and estimated benefits of use. This was analyzed more precisely using a questionnaire which addressed each phase separately, and only people who had used the TLCM Method answered this questionnaire. They were asked 1) to what extent the individual phase was used in the project and 2) how useful it was to use. If the phase was not used for some reason or other, we asked whether the phase would have been useful had it been used. During the interviews we also discussed the amount of use and usefulness of different phases and different modules, the analysis and strategy development modules, and also the task descriptions and checklists. We also asked how useful the users thought the method was, and what were the benefits of using it. During the expert interviews, we asked how useful they expected using the TLCM Method would be (presented in section 8.4.2).

II The general usefulness, novelty and generality of the TLCM Method. Here we wanted the interviewed persons to reflect on their experiences of using the method against their previous experiences related to analyzing the technical potential of buildings (presented in section 8.4.3).

In this chapter Q(1), Q(2), etc. refer to the interview questions.

8.4.1 Evaluation of the content, structure and usability of the TLCM Method

This section presents the interview and questionnaire data related to the usability, content and structure of the TLCM Method. Triangulation is applied: data from user interviews and user questionnaires was analyzed and compared with expert interview and questionnaire material. Also, triangulation is applied in evaluating differences between different cases, parties of users of the method, and between different organizational levels involved in the projects. In order to get a comprehensive picture of the method's perceived usability and the opinions of the users on its content and structure, we asked questions related to its basic characteristics.

Table 8.4 shows the questionnaire results about how usability was perceived, where 1 means "not at all" and 5 "very easy" or "very probably."

Table 8.4 Questionnaire questions related to easiness of usage and usability of the checklists. In the table U refers to users and E to experts

Question /Grade	1	2	3	4	5	Total	Av.
U: Was it easy to use the TLCM Method?		1	6	8	1	16	3.6
U: How usable are the checklists?				10	5	15	4.3
U: Will you use the method in the future?			1	8	7	16	4.4
E: Will you use the method in the future?			2	7	4	13	4.2

The ease of usage was generally found either "not easy or difficult" or "quite easy." Only one said it was difficult to use, and one said it was very easy. The checklists were considered useful, as all of the users perceived the lists as either "quite good" or "very good."

According to the questionnaire, 7 of 16 users were sure they would use the method in the future, 8 of 16 considered it "most likely" and only one did not know if he would use it or not. In the expert interviews the answers were parallel: 4/13 were sure that they will use the method in the future while 7/13 said that they would most probably use the method in the future. Only two were not able to say whether they will use the method or not.

Interviews

When asked in interviews whether they would use the TLCM Method in the future, all respondents either were sure of using the method or they considered it very probable.

Q (8): "How did you generally feel about using the TLCM Method? How easy/ difficult was it to use?"

Most of the interviewees considered the method totally new. Some of the users also described it as innovative and good, and some said that using it was easy. Most interviewees, however, pointed out that using the method was also quite demanding and that it took awhile to get familiar with it.

A/(AP13): "This is a completely new approach, and initially it requires a certain focus and weighing of matters from all parties, but on the whole, this will become an appropriate tool for owners and decision-makers of large business real estate properties. This model covers all the issues which they must bring up...but it also calls for their contribution in the ensuing projects..."

A/(AP11): "In my opinion, this modeling provides a comprehensive way to approach real estate properties, whether the issue is an existing or new property. . . these days a project's success often depends on whether the commissioner has a clear strategy, or a clear picture of the project, such that the expectations and aims would go through the entire project. I would argue that the realization of building projects today is perhaps different from what the real estate owner's demands were at the beginning . . . this is a clear hierarchical system, which makes it possible to manage information throughout the entire construction process. Using the model requires us to change our ways of thinking, but this isn't difficult."

A/(CDR21): "Of course, with the first cases you're still learning how to use the model, but yes, I believe it would be very good if we would do the same process with all new real estate projects."

A/(CDP16): "It would certainly require certain things...a bit of studying and becoming more thoroughly familiar with certain things in order to use it confidently."

At the beginning of the projects, the method was presented to all participants and the related material distributed. Since the method was new for all users, we wanted to know whether this information and material about the method and its objectives was adequate:

Q (10): "Was the presentation of the TLCM Method and training at the beginning of the project adequate?"

Generally, respondents felt that technical life cycle management of real estate as a whole was very extensive, and therefore the method was also demanding. Some of the interviewees desired more, and more specified material. Other users, by contrast, said that further information was not needed since only after using the method once was it possible to use it effectively and understand its real benefits. The best way to become familiar with the method was to use it systematically.

A/(AR13): "At first it seemed enough, but at the beginning you couldn't guess how comprehensive it gets. Only afterwards did one realize that this is actually a pretty extensive process. "

A/(CDR21): " It took me some time to figure it out, but then when we had gone through it orally, it began to open up . . . by reading the paper . . . it didn't. . Yes, it had to be opened up first."

A/(AP13): " Yes, I think so. In fact, there was more information than one could initially master...you cannot take in everything at first, but as far as I understand, as we went on we got enough information..."

Usability and structure was evaluated by multiple questions, 11, 12, 13, 14, 18 and 19:

Q (11): "Is the idea of the TLCM Method logical and understandable (systematic process in which the requirements, risks, limitations, expectations and possibilities are considered)"

Generally the method, its idea and structure were considered successful. The interviewees especially pointed out that it is very important to be able to consider all aspects of real estate management systematically from different perspectives. Also, it is very important to analyze different technical life cycles, as well as different objectives and different possible decisions.

There were no differences between real estate owners and service providers and no differences between cases or between case interviews and expert interviews. Only the service providers gave more specific comments on the idea. Some of the interviewees said that it is not possible to compare the method to anything since there are no other methodologies available.

A/(AP12): "Yes... this is quite unique, there is nothing that this can be compared to. It has been good in this project."

A/(AP11): "...From a logical viewpoint, it proceeds pretty well: first the risks of a larger magnitude… and questions… and then gradually there is more focus on the systems and hardware level... so, as a hierarchical system this is successful.

A/(CDR21): "Yes, and that's the order in which it goes . . . it's very logical."

A/(E3C1): "The way of describing is clear and logical. The process is clear. I think this is good…very good. The best thing is the task descriptions, clear description of the tasks that each participant in the project must do and take responsibility for… and you can clearly see that the process will not go on if for example after a consultant has produced the needed information the real estate owner does not make a decision on that."

Q (12): "Was the structure of the TLCM Method usable?"

The structure of the TLCM Method was found to be quite usable.
A/(CDP23): "Yes, in my opinion the model is usable. . . it teaches you to think and do things in a specific order . . yes, it rationalizes the work..."

There were some suggestions for improvement, related to using colors, or simplifying the method. Some of the comments were more related to cases themselves and the actions of participants in the cases:

A/(AR14): "Yes . . . when it's used frequently. It would require the addition of colors, to make it easier to read."

A/(AP11): "..Actually, what I previously said about simplifying is related to this. When you begin to implement this in practice, you have to simplify and. . . well, . . . yes, the method has to be like this one. Then, when you have internalized the process and understood the contents of the schematic diagrams, you can simplify it (on a case-by-case basis). A thorough basic description is necessary . . . as a theoretical description this is of the right type."

A/(CDP32): "… if you could link to the model an example of how to print it out, that would facilitate its use, or even a table of contents. . . to tell you how to print it out."

The experts also considered that the structure of the method was successful and systematic, though they were a little more uncertain in their answers and a few of them asked if the method could be modified according to the user organizations and real estates. They did point out, however, that if they had used the method themselves there would have been no need for such questions. Also, they pointed out that using the method would require a preliminary understanding of technical life cycle questions.

A/(E12R6):" My opinion is that the described path is very important from the viewpoint of discussing the right things at the right time and making the needed decisions…But are the all important issues taken into account in this method…yes the ability to modify this must exist."

Q (13): "Were the task descriptions and descriptions of the needed input from different participants in different phases described adequately?"

The answers were two-sided. Some of the interviewees said that the model is, and also must be, very general so that it is easy to apply in different situations. Some of the users, by contrast, said that more specified descriptions would make it easier to use the method. Some of the interviewees remarked that they had only concentrated on the task descriptions that they themselves were responsible for. There were no differences between different organization levels or between different cases in the answers.

A/(AP11):"... it isn't even possible to come up with a precise description, since everything depends on the consultant, the project, the clients, what kind of a group you have… and the lists and task descriptions can change accordingly. Used as an example, they are like this, these issues must be dealt with... different issues belong to the tasks of different parties... there is enough representativeness here."

A/(BR31): "Yes, I think it contains all the most essential things for ownership and users' activities. Of course, everything always depends on the building in question. Some more unusual things might come up, and similarly users might have their own atypical functionality requirements. It does not really make sense to try to include everything possible in a list ... Yes, the desired end result does emerge."

A/(BP15): " Well ... I haven't really concentrated on all the boxes ... more on these TLC manager's tasks ... yes, I have felt that there is quite enough here."

For experts, this question was difficult, and they were not really able to answer it after the short presentation of the method. One of the experts said that there is no absolute level since everything depends on how capable the users are, as well as on the real estates in which the method is applied.

Q (14): "Was the idea and objective of analyzing technical potential in order to develop the technical life cycle strategy clear to you after the presentation?"

All those interviewed said that they themselves were fully aware of the objective of the project and of using the technical life cycle analysis and strategy developing method. Still, some of them said that the idea became clearer during the project and afterwards the whole process seemed very logical and clear. Some of the interviewees wondered if other participants had understood the idea of the analysis or not. One person did not answer the

question. Those who participated in the executive group were more aware of the objectives than those who only participated in the projects. Those who participated in more than one project were better able to understand the objectives and they also better understood the whole idea of the TLCM Method than the others. Still, all the users said they understood the idea, if not at the first meeting then at least during the analysis process.

In the expert interviews the answers and comments were more specific and many-sided:

A/(E8R2):" ...A good, knowledgeable real estate owner makes money precisely like this, by understanding these ideas, and if you are capable of using this method and these ideas you can make a beneficial difference with this. If you are not capable of using these ideas you are like the others, and the profit will be the same as in normal business cases."

A/(E7R1):" ...yes…an interactive analysis of different life cycle phases of a real estate… setting priorities for related issues and then making decisions… by which the strategy is possible to develop…by which the life cycle actions can be defined…yes these phases support each other. This process description is like a path according to which you must be able to make decisions. Too often these decisions are not taken…"

A/(E2C1): " Yes I fully understood the idea. By using this kind of method we are able to achieve a more planned and managed business culture in the real estate sector."

Q (18-19): "How do you perceive the logic of the checklists, were they good? Did they include adequate information?"

The lists were generally considered adequate and good. The users pointed out that one case was not enough to evaluate the lists since only after multiple cases does it become possible to identify lacks. The checklists were considered normative and in this respect the information in them was considered adequate. There were some comments related to architectural and HVAC-technical questions that could have been included more in the lists. One expert pointed out that further information related to user needs was needed. One of the case interviewees did not like the structure: in her opinion it was frustrating to browse the same things over and over again from different view points. On the whole, however, people found this feature, the ability to look at things from different perspectives, to be good and successful: if you look at things from different perspectives it clears up decision-making related to technical questions. According to interviews, service providers used the lists more than real estate owners, though there were no differences between organization levels or cases. The experts acknowledged that evaluating the lists was difficult without cases, but they also thought that the logic and structure of the lists seemed successful.

A/(CDP32): " As I said earlier, I felt you could have combined things more. I don't know if some other way of dividing things up would have been better when the issue probably is that different people think about things from different perspectives and have different ways of working."

A/(BP15): "Yes, it is pretty good ... but assimilating it all, since it has the same things over and over again ... but when you look at things from more than one perspective you end up thinking about them ... the structure is pretty okay. Well, the biggest shortcomings are in the area of building technology [talotekniikka] ... here the concentration is more on structures and building technology ... however, it is an area which also needs to be assessed in older buildings. In this area, I would have wished for more checklists."

A/(E10R4): "Yes the lists are many sided. You can look the things from different viewpoints and it seems to be reasonable..."

We also asked the users and experts about their **general opinion** of the TLCM Method in order to find out if the previous questions had enabled them to evaluate the **structure, contents and usability** of the method as a totality.

Q (20): "What is your opinion of the contents of the constructed method?"

The method was considered logical, thorough and good, even complete, but also difficult and broad. Some pointed out that the method is quite new and there is no other method to which the TLCM Method could be compared. There were no differences between service providers, service providers and real estate owners or between owners, or between case interviews and expert interviews.

A/(AR13): "The model is quite thorough, and in this sense good. If it's taken into use, it becomes simpler in practice . . . there might be some things which are already present at the start which are said here, when we're thinking about long-term builders, these things become easier. The processes which benefit from this sort of approach are highlighted."

A/(AP12): " This was all new, so I can't compare it to anything. This is a good tool, the final format will grow out of the way it's used. The model does include the right things. The model is suitable for a wide range of different properties and is generally applicable. This particular case was a little bit different, though nevertheless this model was also applicable here. There couldn't have been a more difficult pilot project."

Some of the comments were related to the interactivity of the method, which people considered good:

A/(CDP31): "Uh... in my opinion it is good because it brings into the discussion things from a wider perspective, so that things are considered from many sides, and you take into consideration the economic issues, issues that arise from the ownership of real estate as well as issues that emerge in use. .. more than you would get just with a technical analysis, as is done today. This broadens the basis for discussion, which is good."

The method is also being taken into use (5/2003) and has been used in several projects already:

A/(FP17): "At least I wouldn't complain about it, since I've already started using it; it sits well with my way of thinking. Indeed, I might have a conflict of interest when assessing the model, as I've already discussed these issues at such depth and am committed to it."

We were also interested in how people thought the method **could be improved**, since the method was a general description, a paper version of a method for developing technical life cycle management performance in real estate companies.

Q (21): "How could the method be improved? What changes would you make? What would a better working method be like?"

Most of ideas for improvement were related to the complexity and extent of the concept. PowerPoint presentations and other tools which could facilitate usability were thought necessary. Some of the interviewees pointed out that the whole theme is so extensive and difficult that it cannot be presented in a more simplified way; you just need to understand the idea and get trained to use the method.

Other ideas included using a computer, using some kind of software or developing a software version of the method. Other ideas were to develop different forms for facilitating the use of the model, and developing the forms for reporting the strategy.

A/(AP11): "It should be clarified, hierarchically, by levels, by simplifying it."

A/(BR32): "I do not know this well enough to say what [could be improved] ... the diagrams are already so extensive that it comes to mind whether I would have the energy to familiarize myself with them, but, yes, as such they are clear if one just acquaints oneself with ... and, as it were, only depicts that very process which is underway."

A/(BP15): "Perhaps ... the lists could be available as forms or something that you fill out in advance."

We also simply asked whether the users and experts thought the method was **usable**.

Q (35) "Is this method usable?"

All the case interviewees, as well as all but one of expert interviewees, considered that the method is usable. One expert said that she is not capable of answering the question since she had no technical understanding at all. According to one case interview, the usability was considered so good that the TLCM Method was going to be taken into use:

A/(AP11): "Yes, it is useful. . .so useful, in fact, that we are going to adopt it in our own operation."

In the construction phase of the research, based on the initial literature review and interview studies, we developed a set of methods and charactersistics of how a well-functioning method should be constructed and what it should look like (chapter 7.3). We wanted to find out if the users and experts found these characters and features of the method, which we considered important, good. Therefore, we also included one rather open question, asking users and experts to mention one thing that is exceptionally good in the method and also one thing that they consider a weakness or lack, from the perspective of content, structure and usability.

Q (25) "What are the strengths of the constructed model?"

Q (26) "What are the weaknesses of the constructed model?"

Table 8.5 shows the answers.

Table 8.5 Strengths and weaknesses of the TLCM Method, first according to the real estate owners and technical managers who used the model in cases, and then according to the real estate owners, experts and technical managers who were interviewed.

	Strengths of the TLCM Method in terms of usability and content	Weaknesses of the TLCM Method in terms of usability and content
Case / Real estate owners (7)	- Especially the ***first item*** from the perspective of the real estate owner, the one which analyzes what the owner really wants. This should be clearly communicated to all participants so that everyone knows what this is about. -... the same thing which makes it difficult***: its comprehensiveness***, you have to have a response for everything.... - Its ***systematicity*** - This ***helps us consider our demands and aims,*** as well as our risks…in my opinion this is really important. - The ***checklists.*** - These things are not routine in this field, so I think it is good that models are emerging which assist in dealing with things.	- ... as far as time management, each and every one of us should have forced ourselves to think even through the first item more thoroughly ... and, perhaps, ***visualizing the model*** ... so that it would have been easier for all to comprehend ... what we are up to here. - …in a way ***colors would be useful***, so it would be easier to read - There is nothing missing. Of course, it would be good if the model could be customized, so we could bypass the things which are unnecessary in our organization. ***Simplifying it***. - Assessing potential is difficult, but this isn't necessarily a bad thing - How can you make this work in practice? - At least in connection with this one pilot, I did not find any shortcomings
Case / service providers (9)	- ...you can't find an organization who could say that this wouldn't be of any use to us... - ***Interactive*** process - The ***figures and tables*** - Its ***logical structure*** - Its ***comprehensiveness***, the ***diagrams*** - Its ***logical structure, the checklists*** - ***It is good***. It is the first model which takes into account all of these things, so using it helps our activities. - What is good is that ***the property owner begins to think about these matters*** ...	- Perhaps its form, or at least making it ***simpler;*** there could be some sort of format for this - Everything always has room for improvement...this is the first (modeling) done on such a large scale...this cannot be compared to others...in addition, I'm not the right person to make such comparisons; I do not see any particular weaknesses. - ...the most difficult thing is the real estate owner's commitment, so they would understand that the old ways of working… could be examined - ***Its extensiveness*** - It is ***difficult to visualize***, comprehend the overall picture - The only bad side is its ***general nature***, which makes it a bit clumsy. But streamlined for everybody's individual needs, it becomes an outstanding tool. - You could add a bit more still on HVAC technology.
E – Owners (6)	- Considerations from ***different viewpoints…the content*** - That requirements, possibilities, restrictions and expectations are part of a ***logical process***…and it works. A good idea - It is ***systematic*** - You can manage technical life cycles with this…***systematically***…taking into account all the important things… - ***The risk management*** part is the best one…and that the focus is on connecting the technical lifecycle issues to usability and usage… income expectations. - The best feature is that ***the starting point*** is the owner and responsibilities and needs of the	- ***Learning of new things*** is always difficult… - Difficult ***to get people motivated*** - Nothing bad but it is ***challenging*** to take it into account… - Is the modeling flexible enough? - Nothing in the model…but strategic life cycle planning as a whole is difficult… - No lacks…

	owner…and also that all the important parties are involved	
E-Service providers (6)	- The best feature is that ***the starting point is strategic enough,*** you start from business goals…also, the risk management part is very good . Good is its ***systematicity*** - Good is that there are ***multiple viewpoints*** and…that the model includes ***descriptions of everybody's tasks*** - The ***total life cycle considerations*** in the model are good - The ***interactive process***... - Good…***iteration possibilities*** and the ***systematically***…multiple phases	- It is not a lack…but the modeling…the ***whole thing is quite wide*** and needs lots of considerations…. - For being able to understand it ***you have to understand the principles of process thinking*** - It includes ***very much new information*** - It may be ***not very easy to take it into use*** - I can not find lacks - It is ***difficult the evaluate the total cost*** in the early stages of the analysis
E-experts (2)	- Good…***the connecting of different life cycles together*** and ***starting from the owner's needs and objectives*** - It is a ***common "surface"*** for taking into account all the necessary aspects related to the real estate business	- How will the process continue after the strategy is first developed? - It includes very much material…***quiet heavy to work through***

The interactiveness and logic of the process was considered good, and people also felt the process was systematic (a logical process with task descriptions and checklists). In addition, people felt that the first part of the process was exceptionally good, where the owner's and users' objectives were analyzed and prioritized, and then these primary objectives were taken into account when doing the risk analysis.

Weaknesses of the method were mainly related to its extensiveness and the amount of new information. Because of its comprehensiveness, it was considered difficult to use, demanding a great deal from users. On the other hand, this comprehensiveness was also considered a strength: it is possible to take all the important issues into account. Visualizing the totality was also considered difficult. Since people resist change, it might be difficult to take the method into use.

In summary, two interviewees praised the interactive process description, seven mentioned the modular and systematic structure, one liked the checklists, four praised the possibility of iterating, setting priorities and optimizing (characteristics especially prominent in the first six phases of the method), four mentioned the possibility to analyze risks and costs, and three said the best thing was the ability to take into account the different stakeholders and their needs.

A summary of the testing of the content, structure and usability of the TLCM Method is presented in Chapter 9.1.

8.4.2 Amount of use and usefulness of the TLCM Method

In order to evaluate the usefulness of the constructed TLCM Method we first wanted to find out how much the modules of the method and different phases of the modules were used in practice. Section 8.4.2.1 presents the results of amount of use of the method and section 8.4.2.2 results of perceived usefulness of the method. In both sections we first present the questionnaire results and then results of interviews. From the perspective of triangulation similar questions were asked in both data collecting methods.

8.4.2.1 Amount of use

This section presents the questionnaire and interview data on how much the different phases of the TLCM Method were used, as well as analyzes the most important factors affecting the amount of use. This section focuses on the *user's* perception of the amount of use, and so

presents “cross-case/user analyses,” showing the differences between different cases, parties and organization levels.

Table 8.6 presents how much each phase of the TLCM Method was used, using a scale of 1 to 6, where 1 is ”not at all” and 6 is ”very much.” The interview results are analyzed case by case in this section as well.

Table 8.6 Amount of use of different modules and phases of the TLCM Method.

The phase of the construct and amount of use	1	2	3	4	5	6	Total Answers	Average score
1. Business idea: Vision, mission and goals of the company		1	2		7	4	14	4.8/6
2. Real estate specific goals of the owner + gathering of background information		2		1	4	5	12	4.8/6
3. Requirements for the technical characteristics of the real estate caused by the business needs of the user	1	2	1	3	3	3	13	4.1/6
4. Technical risk analysis			1	3	5	5	14	5/6
5. Technical risks, acceptable risk level and costs due to risks and risk management	1		1	2	7	4	15	4.7/6
6. Selection of acceptable risk level and relationship between risk and income /benefits	1	1		2	6	2	12	4.4/6
7. Technical life cycle and quality expectations			1	2	4	6	13	5.2/6
8. User's expectations for quality of the building	1	2	1	1	4	4	13	4.3/6
9. Technical potential of a real estate for achieving quality and life cycle expectations			2	2	3	6	13	5/6
10. Limitations for maintenance due to usage or user		1	3	3	5	1	13	4.2/6
11 Alternative maintenance possibilities and their cost effects		1	1	1	7	3	13	4.8/6
12 Evaluation of the results of the technical analysis.				1	3	4	8	5.4/6
13. Decision								
14. Input for strategy developing				1	3	5	9	5.4/6
15. Needed technical life cycle actions.					7	2	9	5.2/6
16. Choosing the general principles for strategy development				2	1	6	9	5.4/6
17. Technical solutions, and alternative measures and actions	1			3	3	2	9	4.4/6
18. Definition of optimization criteria by owner if still needed				3	5	1	9	4.8/6
19. Optimization and specification of the alternatives presented in phase 17				2	6	1	9	4.9/6
20. Acceptance of the proposed program or new iteration		1	1	3	2	2	9	4.3/6
21. A technical life cycle strategy was formulated in all projects								

According to the questionnaire, the different phases of the TLCM Method were used a great deal during the projects, with average scores of 4.1-5.4. Phase 3, "Users' requirements for technical characteristics of the real estate due to their business needs" was used the least, but even it was used quite rigorously in some cases. The most used phases were 12, "Evaluation of the results of the technical analysis," 14, "Input for strategy development" and 16,

"Choosing the general principals for strategy development." Also, phases 9, "Technical potential of a real estate for achieving quality and life cycle expectations," 7, "Technical life cycle and quality expectations" and 4, "Technical risk analysis" were used much according to the users. There were some differences between cases and also between parties in perceived amounts of use. There also were differences between different organizational levels. The differences between parties were related to cases in which some were unaware of the roles of different participants, so that those who were not involved in some particular phase evaluated the use of that phase with lower scores than those who actually were involved with it. Also, in cases involving investment analyses or analysis of the development potential of a building, the first three phases were gone through more rigorously than in cases where the TLCM strategy for an owned existing building was developed. In general, however, all the phases were used a great deal, as the lowest average score was 4.1.

In the interviews we asked whether the method was used, whether it was used according to the process description, and whether it was used according to its internal logic, with the task descriptions and checklists. We also asked whether the checklists were used.

Q (1): "Was the TLCM Method used in the case project?"

According to the interviews, the method was used in the projects. There were not any fundamental differences between cases, between the parties involved in the cases or between the different organizational levels involved. There were some small differences, however. Some said that usage was not 100%, while others said that the TLCM Method was used step by step. There were slight differences in the perception of the amount of use between two users from the same organization, at the same organization level and within the same case, though these were not significant: "*Yes, we used it, but not 100%" (AR12)* and *"Yes, we used it with good results"(AR13).* In the same case, the perceptions of two service providers from different organization levels agreed: *"The method was used more on the service provider side than on the commissioner's side. The model made clear to everyone what we were doing"(AP12)* and *"The case was based on using the model, so yes it was used"(AP11).*

Q (2): "Was the TLCM Method used systematically according to the process description?"

All the users thought that the TLCM Method was really tested and used phase by phase, systematically, in the projects.

A/(BP15): "Yes, we followed it. We digressed a little so that we kind of did a couple of loops in the earlier stages ... those demands ... because the make-up of our group changed a little along the way, more people came in ... so we backtracked. But it didn't matter, we got more information out of it."

Q (3) "Were the checklists used during the project?"

Almost all the users said that the checklists were used during the project, although there was one participant who was not sure whether the lists were used or not. According to one user from an owner organization, the lists were used during the whole project by all participants but perhaps more by the service provider.

A/(BR31): "Yes, we used those as well. They were perhaps used more by the consultant; in any case, they were included in the process."

All the service providers involved in the projects used the lists irrespective of what level of the organization they represented. The lists were used in different phases of the projects in different ways.

A/(AP11): "Yes, we used the checklists. Different persons involved in the process used them for different purposes."

A (AP12): "Yes, we used the checklists, especially at the end of the project they were extremely useful; they functioned as a list of things to do."

Q (4): "Did the participants of the case project follow the logic of the TLCM Method (phases, task descriptions and related parts of the checklists)?"

Almost all the users agreed that their projects proceeded more or less precisely according to the process description of the TLCM Method. There were no significant differences between cases or users.

A/(AR11): "More or less ... next time we use it we might be able to better pay attention to the importance of the order in which things should be done."

A/(CDP32): "Well, in this case we very much just emphasized the technical analysis of these properties. . . that, eh, . . . this commissioner did not wish to speak about these strategic issues in this forum. . . so, for instance the visions were not dwelled upon much. I do not know how you intend to present this material, but it seems to me that there is still a certain lack of trust. Whoever acts as the TLC manager, the owner of the property should be able to completely trust this party for this method to be fully applicable."
Q: " Would it be useful if it could be fully applied?"
A: "Yes, it is a pretty essential part of the whole deal."

A/(FP17): "We went just with the model: vision, mission, general requirements, risk analysis, aims, as well as the final risks in terms of the strategy. We went through the process just like this."

A/(BR31): " Mostly yes. It is possible there were some digressions... when preparing the renovation of the building ... but, in principle, it followed those steps."

A/(BP15):" Not all the way from beginning to end, but we had a strict fact-phase, where I attempted to go through things according to it. To some extent, however, we also discussed matters a bit more freely."

Q (5): "Were both the analysis and strategy development module included in the case project?"

In all the projects except one (the investment analysis case), both the analysis and strategy developing modules were included. In two projects, two service providers were only involved with the analysis phase, so the question was not relevant for them, but they also felt that both modules were used.

We also wanted to know whether there were any impediments to using the method during the projects.

Q (6): "Was there anything preventing the usage of the method during the project?"

Most of the users did not identify any issues preventing the method from being used, though others did identify some problems. One user said that the method was perfectly suitable.

A/(FP17): "Nothing, indeed just the opposite: when there are a lot of different projects, the model works just as it is, both during the investment analysis phase, as well as during the phase where acquisitions were made for the client."

A/(BR31): "In my opinion...however, I did not attend all the meetings, but in my view the model supported the whole process; it is a pretty successful concept. For my part, I did not see anything that would have prevented us from using it."

Nevertheless, some problematic issues were also identified. One user pointed out that people's attitudes were sometimes an impediment to using the method. One mentioned that there were some difficulties allocating roles during the project. One service provider pointed out that in the case project he participated in the impediment was mainly the owner, who did not want to reveal his own strategy. One of the real estate owners also said the same thing:

A/(CDR21): "Well, nothing in that way. . . Well, I cannot tell you everything since they are confidential business secrets. . . I cannot provide detailed information about this…"

Also, the fact that the method was new to all the participants was also a slight impediment, as nobody had used it before.

A/(CDP32): "Well, . . . there was perhaps not enough information about all the factors and then. . . this began in a somewhat uncontrolled fashion. It could perhaps have been managed more like a project. But perhaps this was because it was the first project of this kind. All of us were trying to learn to understand what we are doing here and what is involved and how to do it all. If we now were to do this same thing with another property I think it would go quite differently and better. . . we know so much more about it now."

When we asked what would facilitate taking the method into use, there were several ideas and suggestions.

Q (7): "If there was something that prevented usage of the TLCM Method during the project, how would usage be facilitated?"

Even though we asked users to provide feedback on how to develop the method, many of their comments were related to features that were actually already included, such as the idea that "using the model allows one to see the project on a broader scale – to see what comprehensive management is all about." Another commented that the model had good instructions, and that "there has been a clear procedure and clear questions which need to be answered." Also, meeting practices were considered good.

Some users (all service providers from different levels of the organization and different cases), however, identified issues that could be developed. Some of these comments were related to advance preparation for the TLCM project.

A/(CDP23):" The only thing would be if you were able to tell ahead of time what is done and why and what benefits the real estate owner could get if he went through the process. "

A/(BP15):" The use of model would be advanced by general awareness of this system. Clients do not necessarily know what they are commissioning. In this case, as soon as we got going and the client realized what they were getting, they were very well along in it."

A/(AP11): "The model would work if the organization commissioning the work would think about the different roles and the division of labor, would decide about its own project manager and so on…"

In one project, language was an impediment:

A/(FP17): "The language, but the model itself does not lack anything which would impede its functionality." [The properties are owned by an American client interested in making purchases in Russia; some of the service providers are Russian].

In short, in order to improve the method, it would be necessary to ensure that users were better acquainted with it before they began working. Also, it is necessary that roles be clearly defined at the onset. Finally, if the method is to be used outside of Finland, it should be translated.

The summary of the results of this section is presented in chapter 9.2.

8.4.2.2 Usefulness of the construct

This section considers the usefulness of the TLCM Method, focusing on the projects and users, but also including information from expert interviews and questionnaires. The main areas of interest were 1) the usefulness of different phases of the method in case projects; 2) the usefulness of the analyses from the perspective of cost-effective business management in

real estate owner organizations; 3) the usefulness of the checklists; and 4) the benefits of using the TLCM Method.

Usefulness of different phases of analysis and strategy development modules of the method - questionnaire results

Table 8.7 is connected to table 8.6. Table 8.6 shows how much the different modules and phases of the TLCM Method were used, while table 8.7 shows how useful they were thought to be. The scale of perceived benefits of a single phase is 1 to 6, where 1 is “no benefit” and 6 is “significant benefit.” If somebody had not used a certain phase at all or only ”very little” (see table 8.6), they were not supposed to score its actual usefuleness, but to estimate what they thought the benefits of using it would have been. We did this because not all participants were involved in all phases, and therefore were not able to estimate either how much it was actually used, or its benefits. We still wanted to ask this question, however, because those involved in the case projects were anyway acquainted with the ideas and way of using the TLCM Method.

Table 8.7 Benefits of using the individual phases of the method, in analyses of a real estate and strategy development module, where 1 is "no benefits at all" and 6 is "significant" or "very large" benefits ("Av"=average score and "Total" = Total number of answers)

The phase of the construct =>	**1**	**2**	**3**	**4**	**5**	**6**	**Total**	**Av.**
1. Business idea: Vision, mission and goals of the company				3	6	4	13	5.1
2. Real estate specific goals of the owner + gathering of background information				1	10	5	16	5.3
3. Requirements for the technical characteristics of the real estate caused by the business needs of the user		1	3	5	2	5	16	4.4
4. Technical risk analysis				3	8	5	16	5.1
5. Acceptable risk level			1	5	7	3	16	4.6
6. Selection of acceptable risk level and relationship between risk and income /benefits			1	5	6	3	15	4.7
7. Technical life cycle expectations				2	8	5	15	5.2
8. User's expectations for quality of the building		1		4	5	5	15	4.9
9. Technical potential of a real estate for achieving quality and life cycle expectations			1	3	8	4	16	4.9
10. Limitations for maintenance due to usage or user			1	8	4	3	16	4.6
11 Alternative maintenance possibilities and their cost effects				2	12	1	15	4.9
12 Evaluation of the results of the technical analysis.				2	2	4	8	5.3
Decision								
14. Input for strategy developing				2	5	4	11	5.2
15. Needed technical life cycle actions.				2	4	5	11	5.3
16. Choosing the general principles for strategy development				3	2	6	11	5.3
17. Technical solutions, and alternative measures and actions		1		2	3	5	11	4.6
18. Definition of optimization criteria by owner if still needed			1	4	2	4	11	4.8
19. Optimization and specification of the alternatives presented in phase 17				3	4	4	11	5.1
20. Acceptance of the proposed program or new iteration			2	4	2	2	10	4.4
21. Formulation of a technical life cycle strategy								

Since not all participants were involved in both modules of the TLCM Method, only those who were involved evaluated their benefits. The average score related to the usefulness of the phases was between 4.4 and 5.3. Phases 1 and 2 both averaged over 5, and there were no scores under 4 at all. Phases 4 "Technical risk analyses" and 7 "Technical life cycle expectations" were also considered important, with an average score over 5.

Also, the phases at the beginning of strategy development scored well, with average scores over 5 in the following phases: 14 "Input for strategy developing," 15 "Needed technical life cycle actions" and 16 "Choosing the general principles for strategy development". Also, "Optimization and specification of the alternative technical solutions and measures and actions" was considered very important (average score 5.1).

The average score was lowest for phase 3 "Requirements for the technical characteristics of the real estate caused by the business needs of the user," though even it averaged 4.4.

Perceived usefulness of TLCM Method in general – questionnaire results

The TLCM Method was constructed for facilitating TLCM processes in the real estate sector, and as we have already said, we constructed it based on perceived needs or lacks within TLCM processes identified in the literature or in practice. In the questionnaire, then, we also asked how using the TLCM facilitated those issues for which it was developed. Table 8.8 presents these results.

Table 8.8 The usefulness and usability of the TLCM Method in the projects, according to users and expected usefulness and usability in expert interviews ("Av"=average score and "Total" = Total number of answers).

Usefulness and usability of the construct in the projects where it was used							
Question	**1**	**2**	**3**	**4**	**5**	Total	Av.
How useful was the TLCM Method in making decisions related to the technical life cycle of a building?				6	10	16	4.6
Benefits for the owner			1	3	12	16	4.7
Benefits for the user			3	10	3	16	4
Benefits for the service provider			3	6	7	16	4.3
Does the construct facilitate the purchasing of technical life cycle services?				7	9	16	4.6
Do you think it is possible to improve the cost-effectiveness of decision-making related to technical decisions by using the analysis phase?				3	13	16	4.8
Do you think that developing a technical life cycle strategy according to this model facilitates the cost-effective management of real estates?				10	6	16	4.4
Does using this construct facilitate risk management?				6	10	16	4.6
Usefulness and usability of the construct in expert interviews	**1**	**2**	**3**	**4**	**5**	Total	Av.
How useful would the TLCM Method be in making decisions related to the technical life cycle of a building?				5	9	14	4.6
Benefits for the owner				5	9	14	4.6
Benefits for the user			3	10	1	14	3.9
Benefits for the service provider			3	8	3	14	4
Dos the construct facilitate the purchasing of technical life cycle services?			2	6	6	14	4.3
Do you think it is possible to improve the cost-effectiveness of decision-making related to technical decisions by using the analysis phase?			2	8	4	14	4.1
Do you think that developing a technical life cycle strategy according to this model facilitates cost-effective management of real estates?			4	6	4	14	4
Does using the construct facilitate risk management?			2	4	8	14	4.4

First, users and experts were asked to evaluate the method's usefulness. The average score both for users and experts 4.6/5, with 10/16 users and 9/14 experts rating it 5, with the remaining users and experts rating usefulness at 4. In terms of who benefits from using the TLCM process, both groups (users and experts) felt the real estate owner benefits most, with an average score of 4.7/5 in the user group and 4.6/5 in the expert group. Both groups considered that users benefited the least, yet these average scores were nevertheless quite

high, 4/5 in the user group and 3.9/5 in expert group. Also, both groups felt that service providers would benefit a lot from using the method(average scores were 4.3/5 and 4/5).

The TLCM Method was also considered useful in the purchasing of technical life cycle services, with an average score of 4.6/5 in the user group and 4.3/5 in the expert group. The method also improves the cost-effectiveness of decision-making related to technical decisions in the analysis phase, with an average score of 4.8/5 in the user group and 4.1/5 in the expert group. Developing a technical life cycle strategy according to the TLCM Method was considered useful, and both users and experts said that it facilitated the cost-effective management of real estates (average score of 4.4/5 in the user group and 4/5 in the expert group). Participants also felt that risk management would be easier using the TLCM Method (average score 4.6/5 in the user group and 4.4/5 in the expert group). Nobody scored any item below 3, and there were also no significant differences between users and experts or between owners and service providers.

Interview results related to usefulness of the method

The interview data confirms that the TLCM Method is useful. The questions related to usefulness were more specified than in the questionnaires.

Q (15): "How does the interactivity of the TLCM Method affect decision-making and information?"

The interactivity of the model was considered very good and useful, and indeed some of the interviewees even considered it the most important feature. Interactivity also increased users' understanding of the process and logical thinking. On the other hand, a few pointed out that even if interactivity is the fundamental prerequisite for technical decision making and technical life cycle strategy development, it would be difficult to establish true interactivity, confidential co-operation.

A/ (AR11): "Yes, quite fundamentally. It brings increased understanding: what an investor should take into account from an investment viewpoint, and conversely, what kinds of problems arise if specific matters are not taken into account. This works both ways."

A/ (AR12): "... Absolutely. The benefits will come specifically from the model having done your thinking for you in terms of what needs to be taken into account. At least with us, decisions have been based too much on intuition, and what this model does is that it makes you systematically think about things from various perspectives, and I am sure it will be of great help in decision-making."

A/(AP11): " This is the most essential thing connected with the use of the model. In a building project, the management of the entire process and all of the process information is essential. . . at least in this present pilot, on the real estate owner's side there participated both people responsible for creating strategies and people responsible for practical real estate management. In addition, all the planners participated in the final stages. Everybody participated. When all the participants in the project are along at this stage, then when the process is over everyone is clearly knowledgeable about the goals; what issues need to be taken into account, which risks must be managed etc…this modelling is also a very efficient tool for project planning. If everybody does not participate but information is only shared in the traditional way, one loses a lot of the potential which the use of this model offers…"

Q: "Do you believe that the interactive process in the TLCM Method facilitates decision-making and information?"

A/(E12R6): "Definitely. Today real interactivity does not exist. "

This lack of adequate interactivity in present TLCM practices was also considered problematic in the interviews, as some mentioned that although it would be important, such interactivity was difficult to achieve:

A/ (CDP23): "…If real estate management commits to the project and wants to benefit from it, then it's much easier . . . they're forced to think of answers . . but if they're not committed, then there won't be interaction."

A/ (CDP32): "… I was disappointed in that I felt that I would have liked more discussion and interaction in the project. It often just happened that we only went over what someone had done and then did not get all that much feedback from property management. I would have wished for more feedback…"

Some also pointed out that the method requires real commitment from all parties in the TLCM process. If all are commited, and the TLCM process is taken into use, real estate owners could understand that the old ways of working do not lead to cost-effective decisions.

Q (16): "How useful was the analysis module in the TLCM Method related to the planning of purchasing, making contracts and focusing the purchasing of technical services?"

The general opinion was that when needs are classified and prioritized, it always helps purchasing. A prerequisite for this, however, is increasing interactivity. Both real estate owners and service providers thought that using the TLCM Method would facilitate the purchasing and provision of technical services in the future.

A/(AR13): "Yes, it defines at least what is bought from what types of producers, in other words it provides a base for deciding what sorts of demands are made on the different participants. Previously, purchase decisions have been more based on technical considerations, but this provides a way of looking more broadly at all sides, how wide ownership is and what ownership includes. Modelling makes it easier to set individual priorities for each location and makes it easier to choose vendors."

A/ (AP11): "it clarifies them as long as the owners of the real estate know what they want and need, and on the other hand the consultant also understands what the client needs... very often it happens that supply and demand do not meet as to their contents. This is due to the buyer of the service and the provider, the consultant, not seeing things in a similar way…. this, however, is an issue which will be rectified through practice when these kinds of approaches are commonly adopted… absolutely, this model offers possibilities for the commissioner to quickly commission an analysis as a very compact package, to include risk assessments and other essential initial information upon which to base their decision making. With the modelling, these things are accomplished much faster than when using more traditional approaches.
Clarification of issues related to purchases... managing services, specialist consultants… in my view the purchase of managing services is most difficult when the commissioner of the service does not have clear visions and missions. I think this is something which requires a lot of cooperation between the commissioner and the consultant… practice… in any case, the model has created a hierarchy for what needs to be purchased at what stage, and as such the model makes the purchasing situation easier.
The description gives a picture of the level of information needed at each stage… in that sense it also facilitates the conceptualization and selling of the service provider's services, that is absolutely clear. . . but a precondition for this is that the consultant is aware of the process as a whole."

A/(CDP31):" Yes, it makes it easier, because this makes it more interactive."

A/(CDP32):" I would guess so since by using the model you know your needs better. As a service provider this helps you to understand your client's needs, and when clients know what they want, that is extremely important to us. It makes it easier for us to deliver what the client wants."

Experts had slightly different ideas about the benefits of using the TLCM Method in the planning of purchasing, making contracts and focusing the purchasing of technical services.

Q:"Do you think that the analyses module in the model facilitates the planning of purchasing, making contracts and focusing the purchasing of technical services?" (16)

A/(E13R7): " I can`t figure it that concretely."

A/ (E7R1): " Yes, if you know what you need have you better chances to get it and not only what the service provider offers. The question is essential…."

Q (17): "How useful were the checklists during the project?"

The checklists were used in the case projects. Interviewees pointed out that checklists are always useful. In one case, some users representing the operational level of their organization said that they were so familiar with their real estates that they did not need lists. Some desired more specific information on the lists, though others said that they must be general, usable in all cases and therefore included too much information. Table 8.9 briefly lists the responses; there were no differences between users and experts and no differences between service providers and real estate owners.

Table 8.9. Usefulness of the checklists. (See also appendix 7)

How useful were the checklists during the case project? /How useful would the checklists be in real cases?	**Real estate owners/ specialists**	**Service providers: TLC managers and consultants**
Answer/ cases	- In the pilot, they were perhaps given less attention… but the checklists are a very important and great thing - They were useful - In my opinion I already knew this particular property very well from before, but for the other participants the checklists were probably useful - …at some level it is difficult to follow them slavishly, but as such they were good. - In my opinion yes…they helped us go over and discuss things well. - Lists are always useful - Yes, you must anyway take all these issues into account.	- Very useful - More useful for those who are responsible for reporting than those who will get the report - Going through it helped us answer the questions correctly. - At first they were lists of things to do, but at the end when we were creating our strategy they were helpful. - Very useful - Very useful - Very useful - Leafing through them facilitated the process - Very useful - Very useful
Answer/ expert interviews	- They are useful. In the lists the related factors are taken into account in a many- sided way - They are useful - They are useful - Lists are always useful - They give a principle direction for the project, how the things should be handled - They are always useful - They are steering the process and they still will improve in use. They are a good tool for learning more about TLCM. The whole process proceeds more quickly	- Very useful - Very useful - They are essential - Very useful - Very useful - Essential…without the lists it wouldn't even be possible to use the TLCM Method

A/ (AP11): "Yes, they were useful. These checklists are quite extensive, and that can cause some items to be lost in the crowd. Some issues are perhaps not included, but these lists are intended to serve as guidelines, and as such they prompt the user to think about what issues in general should be taken into account. On the other hand, the role of building physics is emphasized here, which is a plus in the present environment. . . I think these lists are good and perfectly usable. . . every user would add to them over time as new kinds of problems are encountered . . ."

In these interviews, we were also interested in learning more about the perceptions of different potential users of the TLCM Method, what they thought about the actual status of technical life cycle management in the real estate business, and whether they thought it would be possible that managing the technical life cycle of buildings could contribute to overall business management in the real estate sector. Therefore, we asked the following questions:

Q (34): "Do you think that using this method facilitates development of a technical life cycle strategy for a real estate?"

To this question, the most common answer was simply "yes." Nobody disagreed. All the interviewees stated that the method clearly facilitated strategy development. One said that there are probably other ways to develop the strategy as well. Others, by contrast, disagreed, saying that at present there are no other ways for developing technical strategies as part of overall business strategies in the real estate sector.

A/(AP12): "Well, yes. Based on my experience, I cannot understand how else these strategies could be created . . . in any other way besides systematically going through all these things."

A/(FP17): "I don't know whether there is another way available which would allow us to make lifecycle management strategies."

In answer to the question on practicability and usefulness, one of the experts said:

A/(E8R2): "...I do believe the method is usable for the professional for whom it was developed. "

Q (23): "Does the method and resulting technical life cycle strategy facilitate the development of total real estate strategies, and also vice versa?"

The most general answer to this question was simply "yes." The answers were quite uniform: all the experts and users stated that technical and other real estate strategies support each other. According to the interviews, the method was clearly a good tool for facilitating decision-making related to strategic business planning. One of the users even stated that technical strategic planning should be the starting point in overall business planning in the real estate business. One, by contrast, said that technical questions are not the most important ones in the real estate business, but still important. Some pointed out that since technical decisions can be made systematically, this should be done, especially given that not all decisions in the real estate business can be made in a systematic way. People thought that using the method would improve real estate management, especially since in many real estate companies the person who makes the final decisions is not fully aware of the effects of technical quality and characteristics on cost-effectiveness, at least in the long term.

A/ (AR11): "They support each other, and they should also facilitate the use of a maintenance book ... overall, the use of the model promotes better real estate management."

A/ (AP11): "In my view this is essential. . . from the perspective of the long-term profitability of the real estate business and for avoiding risk-related costs, this is an absolutely essential tool."

A/ (AR14): "Yes it is useful, if I understand this correctly . . . in many of these real-estate organizations, the final decision-makers are not the people with real-estate training."

A/ (FP17): " This is a strategic way of working, and when you work with this model you are forced to think of technical lifecycle management as a strategic thing. In this sense, this is good, since before TLC strategies weren't made."

Benefits of using the TLCM Method

According to this research, several issues were important in developing the TLCM Method, and we also wanted to ask how successfully these issues were addressed.

Q (27-31): "Does using the TLCM Method affect the following issues? If so, how?"

1) Making commissions with technical service providers and providing services for real estate owners.
2) Decision-making related to technical issues.
3) The quality of technical life cycle management.
4) The cost-effectiveness of technical life cycle management.
5) The management of technical risks.

Everybody agreed that there were many benefits of using the TLCM Method. Generally, it was considered useful. Making commissions and specifying services and service levels would be easier when using it, and it would also be easier to make the commissions uniform. The criteria for choosing service providers would be more developed, and bidding would also be easier because the method helps real estate owners understand the commissioner's starting points better. Similarly, the provision of technical services would be facilitated if the method were used, as this would clarify and unify practices in purchasing technical services.

The TLCM Method helps real estate owners achieve their objectives and make decisions related to technical life cycle questions, since a better context is provided for making decisions and decisions became more conscious.

Most of those interviewed in both groups said that it would only be possible to improve the quality of technical life cycle management by using the method. They also pointed out that using the method would make TLCM more reliable and also make it easier to define the needed quality level case by case, making it possible to form quality frames.

Q: "How would using the model affect the making of commissions with technical service providers?

A/ (CDP32): "First on a more general level… I was personally quite surprised about the final outcome of this strategy process. The table we made was really clear, one could immediately see what the condition of the property was. In very little space... these things this year and… everything was compiled clearly and logically into a tight package. Usually assessments of the technical condition of a building are thick as phone books and nobody has the energy to read them, but this managed to include even the smallest things and it was easier to see where the problem areas of this particular property were and what needed to be fixed…"

The cost-effectiveness of TLCM would also be improved, at least in the long term, since using the TLCM Method makes it possible to optimize repairs and anticipate their cost effects. One of the interviewees pointed out that if the method were used it would require more resources, yet despite this the cost-effectiveness of TLCM would be improved.

Using the method forces real estate owners to take technical risks into account, and therefore has a positive effect on risk management: risks are known and do not come as a surprise, so it is also possible to influence how they are managed.

Q: "How does using the model affect the managing of technical risks?"

A/(E2C1): Using it would have a great effect on risk management, a great positive effect. Until now, risks have been concealed and then transferred…to the next owner…"

As a summary of the short questions presented above table 8.10 shows the answers to questions on the benefits of using the method. Answers of real estate owners and service providers are presented separately as well as answers of users and experts. (Also in appendix 7)

Table 8.10. How using the TLCM Method affects: 1) making commissions with technical service providers, 2) decision-making related to technical issues, 3) the quality of technical life cycle management, 4) the cost-effectiveness of technical life cycle management and 5) the management of technical risks.

Question	**Answers**	
How using the TLCM Method affects:	**Real estate owners and 2 experts in expert interviews.**	**Service providers**
Making commissions with service providers? (Additional question for service providers: How would using the TLCM Method affect the provision of services?)		
Answers/ cases	- Facilitates - Facilitates - No effect - Develops the criteria - Makes it easier - Facilitates -Makes it easier and unifies the procedures - It does help - It clarifies and coordinates practices.	- Facilitates decision-making - Facilitates the making of commissions - Increases the number of commissions - Makes the commissions clearer - Facilitates - The bids would be more specified - Facilitates - According to this it is possible to proceed - It would facilitate that quite a bit. It would also influence the provision of services, since it would mean that the property owner would have a clearer view of what they want from the service provider.
Answers/experts	- Facilitates and improves - The services would be better specified - Affects the contents of services - Facilitates - Facilitates the specifying of services - Facilitates asking the right questions - Develops the techniques of making contracts - You would choose the partners that are able to understand the ideas of TLCM	- Facilitates and systematizes - Usage would help in specifying the commissions - Would make them clearer - Facilitates… harmonizes practices and helps the real estate owner to achieve his objectives
Decision making related to technical questions?		
Answers/ cases	- Facilitates - Facilitates - Affects decision-making - You would consider the decisions better - Facilitates budgeting and also would improve actions – makes actions more sensible - You would be more aware of the decisions and their effects - It clarifies and unifies practices - Decisions become more conscious - Coordinates and clarifies.	- Facilitates decision-making - Provides cost frames - Make decision-making easier and provides bases for making better decisions - Facilitates - Facilitates - Makes clearer - Facilitates - Acts as an iterative loop - It facilitates it. One can present much better arguments for decisions than one could without this kind of modeling.
Answers /experts	- It would bring added value - Improves - More deepness in decision-making - Facilitates the setting of priorities - Facilitates - Positive effect - Facilitates	- Positive effect, usage would open the eyes of real estate managers - Facilitates - Facilitates - Facilitates - Facilitates

	- Cost savings and increased usability of buildings	
Quality of TLCM?		
Answers/ cases	- Positive effects - Improves quality - Improves quality - No great effects - Improves quality - Makes the quality more reliable - Improves quality - Makes it more reliable - I'm sure quality will improve.	- The quality can only be improved - Facilitates the defining of quality expectations and setting of goals - Measures the quality - Raises the quality - Makes it better - Makes it better - Makes it better - Makes it better - Helps you make informed decisions about the lifecycle - I believe it improves it, since here you go over important, critical factors influencing it.
Answers /experts	- Improves quality - Helps in managing - Facilitates predictability - Improves quality - Positive effects case by case - Forms the frames for quality - Improves quality	- Then we could start talking about real TLCM - The usage would equalize the quality - Improves quality - Savings in life cycle costing - Improves quality
Cost-effectiveness of TLCM?		
Answers/ cases	- Positive effect - Improves - Improves cost-effectiveness - Positive effect - Great positive effect - Makes cost-effectiveness more reliable - Improves - It has an essential impact. It becomes more reliable; all the factors which must be considered are considered - That will surely also improve.	- In the beginning the costs might increase but in the long term they would decrease if the TLCM Method was used - Improves cost-effectiveness - Improves in the long term - Improves cost-effectiveness - Improves - Improves - In the beginning the costs might increase but in the long term they would decrease if the TLCM Method was used - This client is particularly focused on cost-effectiveness, which can be achieved using the model. - Well, of course a system like this should improve it ... I do believe that if you go far enough with it, it would bring costs down. With certain measures to optimize repairs it is possible to bring costs down.
Answers /experts	The means for achieving the cost-effectiveness of TLC management would be: - Specified - Specified and structured - Facilitated and improved - You can anticipate the cost effects - More resources would be needed. More sensible TLCM would be facilitated - Usage would decrease the variation in TLCM costs - Improves cost-effectiveness	- Improves - In the long term, lower costs - Improves in the long term - Improves - Improves - Positive effect

Managing of technical risks?		
Answers/ cases	- Positive effect - Improves quality - Improves - Positive effect - Positive effect - Forces you to take the risks into account - Improves - Well, specifically there it has an effect ... in that area this is excellent, it forces one to consider them thoroughly - I'm sure risk management will improve.	- All the significant risks could be anticipated and managed - The risks would be noticed and managed - Positive effect on risk management - Facilitates taking into account the risks - Improves - Risks would be taken into account - Risks would be noticed - Improves - Well, here you chart the risks, and that facilitates their management...
Answers /experts	- Makes it possible to better take them into account - Risks would be noticed and considered -Using the TLCM Method would reveal the risks - Facilitates - Facilitates the anticipation of risks - The effect of using the TLCM Method is greatest on risk management - The benefits of using the TLCM Method depend on how long you intend to own the real estate, and also depend on your primary requirements and expectations - Improves risk management	- Great positive effect on risk management - Usage would decrease risks and make it easier to anticipate them - You could have a comprehensive view of risks and risk management - Improves - Facilitates risk management - Positive effect

In summary, using the method facilitates real estate owners in making commissions with technical service providers and also facilitates the decision-making of real estate owner organizations related to technical decisions. The interviewees perceived that usage of the method improves both the quality and cost-effectiveness of technical life cycle management and facilitates risk management of real estates. There were no significant differences between perceptions of users, experts, real estate owners and technical service providers.

8.4.3 General usefulness, novelty and generality of the TLCM Method

In this section we present the results of questionnaire studies and interviews related to general usefulness (section 4.8.3.1), novelty (section 4.8.3.2) and generality (section 4.8.3.3) of the TLCM Method.

Questionnaire results

We developed a questionnaire and asked the users and experts to evaluate various statements on a scale of 1 to 5, where 1 was “I fully disagree” and 5 was “I fully agree.” we used a 5-point scale, because this way it was also easier to evaluate the “negative” and “positive” opinions. This questionnaire was related to the novelty, generality and general usefulness of the method in the real estate business.

Table 8.11 presents a summary of these results.

Table 8.11. The opinions of users and experts related to the general novelty, generality and general usefulness of the TLCM Method. (In table: "Av"=average score and "Total" = Total number of answers)

Novelty, generality and general usefulness of the TLCM Method							
Users in cases							
Statement / Score	**1**	**2**	**3**	**4**	**5**	**Total**	**Av.**
This kind of method is needed.				6	10	16	4.6
The idea and content of the model differ from previous methods for doing the same thing.		2		7	7	16	4.2
Using the method would provide new knowledge for developing TLC strategy and analyzing a real estate from the technical point of view as part of overall real estate strategy.				4	12	16	4.8
It would be useful for a real estate owner to use the method.			1	1	14	16	4.8
Using the method facilitates the purchasing of technical services.				7	9	16	4.6
Using the method facilitates the objective-setting of real estate owners.				8	8	16	4.5
Experts							
Statement / Score	**1**	**2**	**3**	**4**	**5**	**Total**	**Av.**
This kind of method is needed.				1	13	14	4.9
The idea and content of the method differ from previous ways of doing the same thing.			2	7	5	14	4.2
Using the method would provide new knowledge for developing TLC strategy and analyzing a real estate from the technical point of view as part of overall real estate strategy.				7	7	14	4.5
It would be useful for a real estate owner to use the method.			1	4	9	14	4.6
Using the method facilitates the purchasing of technical services.			1	9	4	14	4.2
Using the method facilitates the objective-setting of real estate owners.			2	3	9	14	4.5

The average score for the statement "This kind of method is needed" was 4.6/5 for users, and 4.9/5 for experts. Only one expert scored this item as 4, while all the others perceived the need as high as 5.

For the second statement, that the method differs from previously available methods, the score for both users and experts was 4.2/5.

The next statement, on the whether the method provides new knowledge for developing TLC strategy, was also given a high score, 4.8/5 for users and 4.5/5 for experts.

Both users (4.8/5) and experts (4.6/5) thought that it would be useful for real estate owners to use the method, and were also in fair agreement that using the method facilitates the purchasing of technical services (4.6/5 for users, 4.2/5 for experts). Both groups (4.5/5) felt that using the method facilitates the objective-setting of real estate owners.

8.4.3.1 General usefulness

In the interviews we asked from which perspective technical life cycle management is important, from the perspective of and owner or users.

Q (32-33) "Do you think that analyzing the technical characteristics and technical condition of a real estate is important for owners and users?"

The general opinion was that both owners and users benefit if the technical performance of a building is analyzed. Many felt, however, that such analysis is even more important for owners in order to ensure long-term cost-effective ownership and maintain the value of buildings. The interviewees also noted that technical performance is also becoming more and more important for users, both from the perspective of the business itself and also from the perspective of health and safety. One of the interviewees thought that the point is not to maximize performance by analyzing the building according to the TLCM Method but to be able to make decisions according to the actual needs of owners and users – optimizing performance. Some pointed out that much depends on the time scale of ownership, while others pointed out that even if technical performance is very important for an owner, it is still not the most significant issue in the real estate business. There were no significant differences between the answers of users and experts, or service providers and real estate owners.

A/(AP11): "It is a very significant and essential thing for the property owner. As a result of the analysis, he knows which property it is worthwhile to invest resources in at which stage and also sees, can estimate, how long it will take for that investment to pay off. If one does not attempt to analyze the changes of the world around us and their potential, on the one hand, and the technical and functional potential of the property, on the other hand, but only decides to invest, let's say, in renovation, it might turn out that the investment completely misses its target. Then one cannot maximize a building's potential profit."

A/ (CDP16): "Yes, it is very significant. I would even say it is so significant that the owner of the property does not necessarily understand it. In some cases, a single (mis-)repair could double the repair costs for a ten-year period, so from a cost viewpoint these issues are highly important."

A/(E12R6): "Yes, if analysing technical potential does not inevitabely lead to trying to maximize it, that's how the designers always see the technical issues. Sometimes it is cost-effective just to find out the things that must be done and the aim of the potential analysis in those cases should be to find out th[is out]."

A/ (AR13): "It is a basic requirement of ownership that you know your own property… Users are interested in conditions, not necessarily in how these conditions are created, so in this sense this is an important matter."

A/ (CDR21): "Extremely significant. We're not talking about petty cash here . . . repairs are expensive. Q: " and for users? A: "Also for them. . . there could be annoyance and disturbance to the users. . . even the business itself might be affected. "

Q (24): "Is a construc like the TLCM Method needed on the market?"

According to the questionnaire (see table 8.11), a method like this is needed. All parties at all organizational levels in both groups, users and experts, said that the method was very important and that there is a clear need for such a construction on the market. Some emphasized that such understanding is especially needed for the decision-making of strategic managers. Some of expert interviewees suspected that there is a lack of strategic planning in real estate organizations and this lack may delay the taking into use of the method.

A/ (AP11): "This kind of approach should be used with each and every property and it means that you have to do an analysis, create a technical life cycle management strategy for it and describe it. Then you have a tool for the management of the life cycle of that real estate…to some extent, this process must be done with every property. There is a need for this kind of modelling – the management of information in real estate is fragmented and causes extra work for consultants and real estate management. . . information is often lost. This kind of modelling has enormous potential as a system for systematically accruing, processing and disseminating information."

A/ (CDR21):"In my opinion there is a great need for this and it would be really wonderful if this would have already been done for the next property which comes to us, so we would know where we're going…but really…if a real estate agent would show me this I might react sceptically, but at least it's something…"

8.4.3.2 Novelty

We also studied the novelty of the TLCM Method, since we wanted to know (after the case study and after the presentation in expert interviews) if the users have used such a method before and how they normally managed things related to the TLCM Method. We also wanted to know how they perceived the TLCM Method in general and what kinds of support it provided.

Q (22): "Have you developed a technical life cycle strategy before in which the objectives and actions are determined by the business goals?"

Five of the 14 (15) experts interviewed had tried to develop a technical life cycle strategy, but not as systematically or taking into account all the perspectives and stakeholders as in this technical life cycle model. Those who were involved in such processes represented both real estate owner organizations and service provider organizations.

Of those interviewed for the case projects, one of 16 had developed a technical life cycle strategy. Seven had tried to do so, but their analysis of the technical potential and development of a TLCM strategy was not systematic or on the same scale. The other eight had never participated in this kind of project before.

A/ (BR31): " In principle I must say that in our strategies something like this has been included, but by using this, the process becomes more conscious. We do have all of these parts, but here they have been brought up very systematically..."

A/ (BR32): " In practice things like this are done ... not formally, so that they would be written down, but these things are thought about."

A/ (AP11): "A year and a half ago we tried something like this with a new building project. . . we started with a blank slate and were not able to proceed this systematically. . . if we could have used this modeling then, it would have made our work faster and more systematic."

Q (36): "How does the model differ from previous ways of managing the technical life cycles of buildings?"

The TLCM Method differed from previous ways of managing the technical life cycles of buildings in several ways. For one, the participation of different stakeholders as presented in the TLCM Method was new. Also new was its interactivity, along with the task descriptions and roles. According to the interviewees, using the method made it possible to make decisions according to actual needs, taking into account risks and all the important issues related to the technical performance of a building. Also, cost considerations related to risks and different TLCM alternatives were considered new. This kind of approach was considered important also from the perspective of improving the competence of all the stakeholders.

A/ (AR11): "The most essential difference is the participation of all the various parties ... of getting all the important matters available to everyone in a condensed form at one go. This kind of an approach improves the competence of all parties. The owner understands the strategies better..."

A/ (E1C1): "…There has not been any real interaction between the parties before."

The method was also considered more systematic and logical that any other way of managing the technical life cycles of buildings. By using the method it was possible to make conscious decisions, not just decisions based on feelings. When the objectives of the owner and ownership are rigorously defined, this also facilitates the provision of technical services.

A/ (AR12): "This is more systematic, more logical...previously, we have acted more by "feel" and not this systematically. The really good thing about this model is that if you follow it, you pay attention to all these things."

A/ (CDP16): "It differs radically...previously, the service provider has received strategic information only in bits and pieces. At times, analyses and estimates have been conducted without knowledge of the objectives of the real estate owner, whereby the planning of repairs and renovations can have missed its target by a wide margin."

Also the hierarchic nature of the TLCM Method was considered good. The user's ability to set priorities was new as well.

A/ (AP11): "Nobody has had any kind of a systematic approach before, an approach where the starting point would specifically be hierarchic. . . where you first have these general aspects, changes of the operating environment etc. and then you gradually proceed to technical aspects and risks. As a way of thinking and operating, then, this is new. None of us have encountered anything like it before, not among the consultants, service providers or property owners."

A/ (CDR21): "This method is very systematic. All areas are considered and compiled and clearly presented so that it is possible to prioritize and see what you are doing and when. Of course, there will always be surprises, something you cannot predict, but this modelling nevertheless allows you to predict things. In my view, it would be very good if this could be available for all properties."

Both real estate owners and service providers pointed out that the TLCM Method helps users consider the business as a totality, which was not possible previously.

A/ (AR13): "… as I said … it opens everyone's eyes to the big picture… what is the whole project that we are doing… so you can't just look at it from your own narrower point of view.

A/ (CDP31): " It broadens our point of view, and places different perspectives on the same table.

A/ (E8R2): "This focuses more on things related to functionality and usability. Also the risks are taken better into account. The viewpoint is not just the technical one…

A/ (E15E2): "…in this you consider the things as a totality…the tailored needs…not from the viewpoint of a real estate but fromownership and usage…"

All the users said that the TLCM Method was more advanced than previous methods of technical life cycle management. Still, some considered that using it makes demands on users.

Q (37) Have you used a similar method or any other method for creating a technical life cycle strategy before?

Nobody had used a similar or other model before. One of the users said that s/he had heard similar thoughts and needs for such a tool before, but nobody had developed one.

Q (38): "Did using the TLCM Method shape the project (cases) somehow?"

All said that using the TLCM Method shaped the projects (cases) to some extent. Some pointed out that the systematics was new, that a systematic approach reached all parties at once. According to some interviews, nobody has done TLCM before so systematically. Many users pointed out that the method shaped the whole course of the project:

A/ (AR13): "Yes, it certainly shaped it – we considered things more deeply."

A/ (AP11): "Yes, it shaped both the course of the project and our ways of thinking. Initially the most important thing was that when we set out to evaluate the potential of the property, the use of this modelling allowed us to very efficiently collect a large amount of essential data into a compact form. . . . the commissioner was also surprised to see that. . . this was perhaps a result of having a clear goal and a definition of what each of the boxes (stages) contained"

A/ (CDP32): "This served as a guideline for the project."

A/ (FP17): "In our relationships with clients, it has shaped both the ways service is provided as well as the ways clients purchase properties."

A/ (AP13): " The model provides structure for the entire course of the project."

A/ (BP15): "It steered the course of the entire project. It also functioned in guiding the project planning. If we would have used traditional project planning, we would have handled things quite differently and the end result would have been quite different. Using this model thus radically shaped the course of the project, and also influenced client satisfaction."

There were also other perceived differences between the old ways and the TLCM Method. Some pointed out that mapping the building's potential and the reporting practices were new. Some said that meeting procedures became more goal-oriented, since project follow-up, scheduling, and the whole project was based on the model. Also, using the method helped in looking at the project from a broader perspective, making it easier to prioritize different actions and helping to stay focused on the matter at hand. According to interviewees, everybody knew during the project where they were and where they were heading.

One of the interviewees pointed out that especially the risk analysis at the very beginning of the analysis phase was different:

A/ (BR31): "Yes, it did shape it ... things that normally, for example in the area of technical risks, would have been considered only later ... are here brought up earlier. Conscious and informed decisions are made earlier."

8.4.3.3 Generality

We also asked two interview questions to measure how general the users and experts perceived the TLCM Method to be.

Q (39): "Do you think that it would be generally useful from the perspective of real estate business to use the TLCM Method?"

According to interviewees, there would be many benefits if the TLCM Method was used more generally: business practices would become more realistic, and for those who are seriously acquiring properties for the long term, using the method would clearly provide added value for the real estate business. One even stated that using the method is significant from the perspective of the national economy as well.

According to the interviews, at present the real estate sector is somewhat out of control (in Finland). Using the method would in fact have a crucial effect: as an owner you would know the condition of the properties you own. Using it would also be important because it allows us to seek facts, potential and risks. Then we have a complete framework for a specific property, and can make informed decisions and manage quality and costs. This leads to reduced costs over the life of the property and quality control. By using the method, it would also be possible to have buildings of higher technical quality.

Still, it is important to ensure that the model itself does not become too heavy, but rather remains a working tool.

Q (40): "Is this TLCM Method usable and useful in the following situations: in investment analysis, in cases were the technical potential of a building is evaluated in real estate development situations, in cases where technical life cycle strategies are developed for owned existing buildings for a chosen life cycle period?"

Finally, we wanted to know whether users and experts thought the TLCM Method would be usable and useful in those situations for what we constructed it, as outlined in the question above. They did. Some of them pointed out that it is most useful in investment analyses and

therefore should be done as a part of every investment analyses. Some of the interviewees pointed out that the extent of use should be evaluated case by case. Still, the method was considered very useful and good in these situations. One of the companies involved in the research project has already taken the TLCM Method into use.

A: (FP17): "It can be used at any phase of a property's lifecycle, when you wish to plan your operations. This serves just this purpose. Concrete, achievable and measurable benefits can be seen for example during the owner's investment analysis phase, acquisitions phase; the owner knows what he is buying, is able to find the properties which will serve his own strategies. From this it follows that mistaken investments are reduced, which is already by itself a great savings not only in terms of direct costs. Indirect costs, which can be a major expense, indeed even greater than direct investments, are also reduced. In the long term, this way of working will model the real estate owner's operations as well as the way he purchases services. A quality control system is formed in the owner's organization, but also in the organizations of the service providers. In this project (case), this was clearly seen with this owner. From the point of view of service providers, a concrete benefit of using the model is the possibility to develop his own service to be more systematic, and to get closer to the client. Then we no longer talk about a specific technical service but can create operating concepts. The overall quality of the service is maintained at a higher level, since information is retained throughout the entire process. Profitability improves for both parties. Now that we have the experiences of a few cases behind us, I really begin to see how good this model is."

8.5 Summary of testing the TLCM Method

In chapter 8 we first showed the connections of the TLCM Method to existing theories. Then we presented the cases, in which the method was tested, in short case descriptions. Finally we provided the test results of both case studies and expert interviews. The content, structure and usability of the method were tested. Also, the amount of use of the TLCM Method in cases was tested. We also asked questions related to the usefulness of the method and then, finally, related to its general usefulness, novelty and generality. This chapter sums up the results of tesing the TLCM Method in case studies.

The TLCM Method consists of a process description for interactive, cost-effective actions between technical service provider(s), a TLC manager and real estate owner organizations, checklists to aid decision-making, and task descriptions for different participants in different phases of the method (See chapter 7.5).

The results from case studies and expert interviews from testing the contents and structure of the TLCM Method are summarized in Table 8.12.

Table 8.12. Content and structure of the TLCM Method: Methods for fulfilling criteria for a well-functioning construct. A summary of case studies and expert interviews.

Methods for fulfilling the criteria for a well-functioning method	**Support according to the case studies**	**Support according to the expert interviews**	**Relevant interview questions**
The method describes an interactive cost-effective process between technical service provider and real estate owner	Very strong support	Very strong support	15, 25, 26
Modular and systematic structure	Very strong support	Very strong support	11, 12, 20, 21, 25, 26
Checklists are included	Very strong support	Very strong support	17, 18, 19
Describes the tasks of different participants	Strong support	-	13
Presents connections between phases and task descriptions Presents connections between task descriptions and checklists	Strong support	-	18 and 19
Interactive process => Facilitates communication	Very strong support	Very strong support	15
Presents decision points and iteration possibilities	Strong support	Strong support	It was used in two cases and found very useful 25, 26
Possible to optimize and set priorities => iteration is possible	Very strong support	Very strong support	12 and 25, 26, 27-31
Clearly-expressed instructions for use, theoretical summary. Training included in the taking-into-use phase	Some support	Some support	10, 14
Model is comprehensive and general in nature	Very strong support	Some support	20, 34, 35, 39, 40
Different stakeholders and their needs are taken into account in the process	Very strong support	Very strong support	17, 18, 19, 25, 26 Questionnaire
Cost, risk and needs-analysis are included in the process description	Very strong support	Very strong support	17, 18, 19, 30
Easy to use and modify	Strong/Some support	-	Questionnire Interview 8

We asked in the interviews how the users generally felt about using the method, whether it was easy/difficult to use. They said that the TLCM Method is a totally new approach to TLCM and is therefore quite demanding, but they did not actually say whether it was difficult or easy.

Participants felt the TLCM Method was a generic method for analyzing the technical potential of a building and, based on these results, for developing a technical life cycle strategy. On the whole, people did not find any useless items in the method, though some aspects of the checklists were thought useless. Nevertheless even they were said to be adequate and at the same time not too extensive.

The whole concept of “technical life cycle management” was considered wide and difficult. As a result, the TLCM Method was also said to be too wide, comprehensive and

interdisciplinary, but on the other hand, the users and experts also said that this is how it has to be. Technical life cycle management was itself considered difficult, and the TLCM Method thought very usable for facilitating technical management activities.

TLCM was considered an important management issue in the real estate business, both from the perspective of cost-effectiveness and from the perspective of the user's business and usage. Developing a TLCM strategy was considered to support strategic overall management in the real estate business. Users and experts felt that the TLCM Method was a usable tool for analyzing the cost-effectiveness of ownership, technical risks and technical possibilities as well as for developing an objective-focused TLCM strategy for buildings.

Both the interview and questionnaire data (user and expert interviews and questionnaires) showed that the modular structure of the TLCM Method was logical and systematic and therefore very usable. The first part of the analysis was considered especially good in projects in which the existing building was under investment analysis or its development potential was being considered. Also, it is suitable in situations were a TLCM strategy was to be developed for an existing owned building. Dividing the process into phases--requirements, risks, limitations, expectations and possibilities--was found to be particularly good, as this feature makes it possible to set priorities, optimize and define the objectives, and so facilitate decision-making. Also, the interactivity between the TLC manager and real estate owner (and users) was found to be excellent, since through this interactive process the analysis of technical possibilities and risks, and the cost effects of different decisions, becomes faster and more accurate according to the interviews. Both modules–analyzing the technical potential of a building and developing a technical life cycle strategy according to this data--were perceived as important, and were also thought to be logical and well-structured. Nothing essential was missing. The paper version was considered good, though some users stated that in the future a Power Point application or net tool could be developed.

The task descriptions were also thought to be good and adequate, and facilitated usage. One of the interviewees commented that it is difficult to come up with a precise description since everything depends on the consultant, the project, the clients, etc. These descriptions made it possible to provide adequate information, both to the owner to facilitate decision-making, and to the TLC manager, to analyze the building and assess its risks and potential against the primary and secondary needs of the owner. Some users said that they focused mainly on the lists that described their own tasks and found them adequate. The task descriptions made the structure of the TLCM Method logical and systematic.

We also asked how usable the checklists were and how the users perceived their structure. Both real estate owners and technical service providers thought the lists were very comprehensive and well-structured, with nothing essential missing. This comprehensiveness made using them slightly difficult, but this was also considered good: when using the lists you have to consider things from all the important perspectives. One said that it was frustrating to browse through them through from the different perspectives, but others said that the multiple perspectives facilitated usage. One user commented that the perspective of users could have been emphasized even more, and one said that issues related to HVAC techniques could have been more taken into account. Some users said that the lists included so much information that in some cases you you don't need all of it, though using the lists enables you to choose the necessary information or perspective. Some pointed out that in any case these lists would be developed in active use. There were no significant differences between the answers of persons from different organizational levels or cases. The experts also pointed out that it is always useful if checklists are used. When they browsed through the lists, they said that they seemed logical and good, though they themselves never used the lists.

The case studies included a meeting in which the material related to the TLCM Method was presented. According to the interviewees, this presentation was adequate, though they added that only by using the method in real cases can you really understand its structure and content, and the benefits of using it. All those interviewed understood the basic idea of TLCM analysis and strategy development after the presentation, or at least in the very beginning of the project. Generally, there were no clear differences in the answers of persons representing different levels of the organization, different cases or between service providers and real estate owners. In two cases, there were difficulties in defining the roles of the three service provider companies involved, and in one case was it was difficult to clarify the role of the real estate owner company, though all these problems were solved quite early in the projects. Some users would have wanted a form for presenting the TLCM strategy which was developed, but this was not provided because real estate companies all have their own systems of collecting, analyzing and processing data (maintenance books, programs, systems). Only instructions for strategy development along with recommendations for its contents were provided.

When we asked the users or experts to identify lacks or weaknesses, the most common were related to simplifying the method. Also, some said that its general nature made it clumsy, that the amount of new information was so great that it may be difficult to motivate users to take it all into account, and that training would be necessary before it could be taken into use. Still, they also said that its generality made the method usable in all the situations for which it was constructed, and that it is in any case easy to skip or consider more briefly the phases that are not essential in the current case.

The following five features of the method were considered especially good: 1) its interactivity, 2) the possibility to iterate, 3) the possibility to set priorities for objective-setting and decision-making, 4) the first four-six phases in the very beginning of the process in which the primary objectives of cost-effective ownership and usage were considered and reflected against the technical risks and potential of the building, 5) the task descriptions with the role of TLC manager and decision points. These phases or characteristics made the method usable, logical, systematic and effective.

The users actively used different modules and different phases of the TLCM Method. They also used the task descriptions and checklists, though the checklists were used more by service providers than by real estate owners. Characteristics of the method, such as interactivity, were used in all cases, iteration was used in two cases, and setting of priorities was used in all cases. Also, optimization in strategy development was used in all cases in which a strategy was developed (4/5). All the users and experts thought the method was useful and, according to the interviews, they are going to use it in the future.

Both experienced (one who participated in the executive group) and inexperienced users (those who were not acquainted with the methodolgy before the project began) used the TLCM Method systematically, according to the process description. The information needed in every meeting was mainly gathered according to the task descriptions. In some cases, some users said that some phases were not gone through as rigorously as others, though the case projects were based on using the model. Meeting practices facilitated use: during meetings the phases were gone through systematically, and at every meeting the participants noted what had been accomplished, where they were now, and what were the aims of the next phase. The model had the effect of systematizing the way matters were dealt with, forcing users to act systematically. In some cases, there were some difficulties organizing the groups since multiple participants wanted to take the role of TLC manager. Eventually, different kinds of parties took the role in different cases, which provided valuable information on the fact that this was possible for different participants. In four cases, the TLC manager was from the

technical service provider company and in one case the TLC manager was from the real estate owner company.

There were four different kinds of user groups: real estate owners who were familiar with the method beforehand and real estate owners who were not; and technical service providers who were familiar with the method and those who were not. How much the method and its phases were used was not dependent on prior knowledge of the method. In all of the cases, the persons who ultimately wrote the TLC strategy were not those who were familiar with the method beforehand. In all cases, the material was distributed to the users beforehand and training was organized at the beginning of each project.

According to all the case studies and expert interviews, the TLCM Method was very useful in practice. Users and experts stated that it clearly facilitated the making of commissions, facilitated decision-making related to technical questions, improved the quality of technical life cycle management, was thought to improve the cost-effectiveness of technical life cycle management at least in the long term, and made it possible to cost-effectively manage the technical risks of real estates. Participants thought that the method improved the competence of all stakeholders, and also thought there was a great need for such a method on the market. The technical state of the building was considered very important for real estate owners and most of the interviewees also pointed out that a building's technical condition also has a great effect on users and usage. The TLCM Method was also considered useful because it clearly facilitates analysis leading to a technical life cycle strategy serving the overall strategies and operations of the real estate business. Some of the interviewees also pointed out that this was the only way of really developing such strategies.

This method differs from previous methods of analyzing buildings in order to develop cost-effective technical life cycle strategies as follows: the process is interactive, including task descriptions and checklists; when using the method you have to make decisions in order to be able to continue the process; the method allows you to set priorities, optimize and iterate in decision-making; it allows you to make decisions according to your actual needs, taking into account risks and all the important issues related to technical performance and cost effects; it improves the competence of all stakeholders; and it is more systematic and logical than previous ways of managing technical life cycle management. It helps users consider the business as a totality.

In general, users and experts thought the method was useful in all the situations for which it was developed, though some pointed out that the extent of use should be evaluated case by case.

There were no significant differences in opinions between different interview groups or project participants in either the interviews or questionnaires.

9 Conclusions

This chapter returns to the research questions as they were initially formulated in chapter 1, providing answers to them and also considering how the actual TLCM Method incorporates the essential features identified in the second part (in chapters 4.5 and 5.3) and specified in the third part (in chapter 7.3) of the research.

The chapter also discusses the practical and theoretical evaluation of the research and TLCM Method and its applicability in other environments, first considering whether the method contains the essential features identified, and also how it performs in market analyses. Also, this chapter analyses the TLCM Method's contribution to theory as well as practice. Finally, it considers the construct's validity, internal validity and external validity, before closing with a discussion of its reliability.

9.1 Answers to the research questions

As discussed in chapter one, for the researcher the research problem originally arose in the middle of the 1990s. The general ways of purchasing and providing technical services for existing buildings seemed to be unsatisfactory. Real estate owners considered that the services provided were more or less inadequate or wrongly-focused. The services of even high quality (ranked) professionals were not considered cost-effective.

In order to understand how real estate owners perceived the importance of technical life cycle management as part of their overall business and how they perceived the actual performance of TLCM, the research questions were formulated. The first research question (RQ1) focused on the key concepts, methods and tools in the real estate sector for managing the technical life cycles of buildings, and also examined practices in the real estate business and how technical life cycle management was perceived by the stakeholders. A literature review was done in order to get a theoretical view of the subject; interview studies were done in order to get practical information. We also wanted to discover whether there was a solid foundation of appropriate theories, key concepts, methods and tools for TLCM.

In the beginning of the research we attempted to study these questions in terms of Technical Life Cycle Management (TLCM). In the first part of the research (in chapter 1) we defined the domain of TLCM as follows: "setting goals, making decisions, planning and implementing actions directed at an individual real estate from the investment analysis phase through a demolition decision, affecting the physical characteristics of the building which are important from the perspective of cost-effective ownership." The second part of the research, however, revealed that there was no such role or concept available in the real estate business as we had described it for TLCM. However, we did learn that there *was* a need to improve the managing of technical life cycle issues in real estate companies. Even though technical life cycle management was one of the strategic management issues in the real estate business, it was felt that current practices were unsatisfactory. The management of technical issues in the real estate business was partly the responsibility of strategic, tactical or operative managers in real estate owner organizations. But at the same time, there was a lack of information exchange related to business objectives, economical and lifecycle costing considerations and operative managing of real estates between the different organization levels involved.

The importance of all strategic, tactical and operative real estate management aspects were pointed out by many authors in the real estate literature. Responsibility for these different management levels is usually decentralized in real estate owner organizations and the performance of management is often not considered satisfactory. Many scientists have developed different parts of the multidisciplinary real estate business and many have also

pointed out the need to further develop and improve practices in the real estate business. Available theories and practices do not provide a sufficient frame to support overall business management, especially regarding technical issues. In other words, *there was not a solid foundation of appropriate theories, key concepts, methods and tools for TLCM.* However, we found that connecting technical issues more effectively to overall business management could provide added value for the real estate business as a whole.

Technical management of real estates was considered by one or more authors, but TLCM was not described as a solid management discipline. It was not defined as a business management concept or considered as a totality. There was no defined role for a manager responsible for strategic TLCM and strategic TLCM was not defined in general. We thus first had to define TLCM as a concept and outline its place in the real estate business (chapter 4.5). We also defined initial success factors for a TLCM Method if one would be developed. The practical studies in the first part of the research supported the theoretical findings.

The answer to the first research question is that TLCM *is* considered important from the perspective of cost-effective management of real estate and from the perspective of the satisfactory use and usage of buildings. Indeed, TLCM was even thought to have an effect on the national economy. Even though TLCM is considered important, however, stakeholders felt that it was not being performed adequately.

The second research question (RQ2), then, was to find out why such an important management area was being handled in an unsatisfactory way. Early in our research, based on the results of the initial literature review and interview studies, we realized that there was a lack of basic theories, concepts and tools for TLCM. Despite this lack, however, we also learned that there were theories available, theories related to other business areas of the real estate business than technical management that possibly could be applied to developing the theoretical foundation and tools for TLCM and thus the technical management of real estates.

In addition to theories related to the managing of the real estate business itself, there were theories related to the managing of new construction projects or the managing of maintenance. Moreover, based on this initial work, we were also able to identify the essential features of a successful TLCM Method (TLCM-M), as presented in chapters 4, 5 and 7.

The answer to the second research question, then, is that there *is* a lack of a solid foundation of appropriate theories, key concepts and methods and tools for TLCM, but it *is possible* to develop such a foundation and method for TLCM.

The third research question (RQ3) focused on the characteristics and capabilities required of such a method. We determined that the constructive research approach would be most appropriate for our task. The design work began with an additional literature review focusing on practices and methodologies used in the real estate and construction business in order to identify the necessary features of a practical, useful and usable method for cost-effectively managing the technical life cycles of buildings.

The available theories were mostly related to new construction, but we also applied theories related to investment, risk and other real estate analyses, as well as theories related to building maintenance and refurbishment projects. Moreover, in developing the TLCM Method, we also made use of the information we had gathered on the limitations of or problems with current practices in the real estate sector.

After laying this theoretical and practical foundation, we were able to begin designing and developing a new method for TLCM. Part three of this study introduces our research strategy, and presents a phase-by-phase analysis of the research process. We made a list of success

factors and analyzed what the method is required to do in order to identify the characteristics of a useful and usable construction for TLCM. This part also presents and evaluates the case studies, and also provides an analysis of the practical and theoretical contribution of this research, including its validity and reliability.

As the TLCM Method was being developed, we had recourse to many sources of data, most importantly numerous meetings and interviews with the project's executive group, which was formed for the research project and included representatives of both real estate owner organizations and different kinds of technical service provider organizations. We also made use of old customer projects, research reports related to technical life cycle management and brainstorming meetings.

This phase of the research proved, in *answer to our third research question*, that it *is* possible to construct a method based on the needs and practices of the real estate sector based on our improved understanding of how technical life cycle management should be carried out successfully. It *is* possible to define the essential characteristics of a successful, usable tool based on the literature of strategic life cycle management and on our research strategy. It is also possible to demonstrate the connections of the TLCM Method to existing theories in the business area.

The remaining research question (RQ4) focused on whether the TLCM Method really works, whether it is usable and useful, and whether it facilitates the real estate business and the provision of technical services. Does it facilitate the objective-setting and decision-making of real estate owners related to technical life cycle issues, does it facilitate implementing the decisions in practice and does if facilitate analysis of a building's technical potential and development of technical life cycle strategies? If it works, what would possibly make it easier to use and more useful?

After the TLCM Method was constructed, it was then thoroughly tested in real life cases in all the situations for which it was developed. Through interviews with both people who used the method as well as various experts, we *determined in answer to the fourth research question* that the TLCM Method *is* a good construct: it facilitates objective-setting and decision-making related to technical issues and analysis of a building's technical potential and risks, reflecting them against the objectives of an owner and users and finally it facilitates the development of an optimal cost-effective technical life cycle strategy according to the owner's business objectives. It also improves information exchange between different levels of owner organizations and between real estate owners and technical service providers as well as learning between different participants of the process. In addition, the strategy helps in implementing decisions in practice. It is both useful and usable, containing the features necessary for success, so much so that at present it is already being used in three service provider companies and in three real estate owner or investor companies who tested it.

9.2 Evaluation of the research and it`s results

In order to evaluate a research, we must consider how well it fulfills the criteria set for it. Earlier we identified two sets of criteria, one related more broadly to the constructivist research method, and the other related to the construct itself, drawn from the literature review and interview studies. We will first begin by analyzing whether the method fulfills the constructivist criteria (chapter 9.2.1), as outlined in chapter 2.2, table 2.2. Then we analyze how the construct fufills the practical criteria set for it (chapter 9.2.2) and finally we reflect the structure of the developed TLCM Method against the criteria set for it (9.2.3).

9.2.1 Theoretical criteria for the TLCM Method

The following criteria is based on the research strategy used (Kasanen, 1993; Lanning 2001) (See also: Chapter 2.1 table 2.2.):

1. Practical relevance of the construct
2. Construct's connection to existing theory
3. Theoretical novelty of a construct
4. Proved use of the construct
5. Proved practical usability and usefulness
6. Applicable in other environments

The method does have *practical relevance*, as shown first in the lack of a theoretical foundation for TLCM, and as corroborated in our case studies and expert interviews. In short, there is a solid consensus on the need for a new practical tool or method for facilitating TLCM in the real estate business.

The TLCM-M is clearly *connected to existing theories* in the real estate and construction sectors, and reflects the issues that are considered important either in the literature of real estate management or construction management. Its essential features reflect the needs and problems perceived in current practices, or suggested methods or practices in new construction projects, for developing cost-effective ownership of buildings. The TLCM-M also supports the interactivity of different participants and stakeholders in the related business areas. The TLCM Method's connections to existing theory are presented in chapters 8.1 and 8.2.

According to the literature, preliminary interview studies, case studies, and expert interviews, there is no other method or tool available on the market for facilitating strategic technical life cycle management: a method that considers the real estate business as a whole, forces real estate managers to make the necessary decisions at the right time, provides the needed information for making these decisions, makes it possible to set priorities, optimize and iterate during the process and includes checklists and task descriptions for different participants in the process. It was possible to develop the method by bringing together in a new way theories from investment analysis, maintenance, and the design and construction of new buildings. Both users and experts affirmed that the whole approach to TLCM in this process is new. Therefore, both the *practical and theoretical novelty* of the TLCM Method has been demonstrated.

The TLCM-M also fulfills the criteria of *use*, as both modules, and all phases, were used in all case studies except the fifth, where the investor did an investment analysis for an existing building. In addition, the checklists and task descriptions were used as well. There were no differences in amount of use between different organizations, different parties or different organization levels, according to the interviews. At the moment (February, 2004), three service provider companies and five real estate owner companies are using the method. One of these real estate companies is using the method in a project involving multiple real estates.

In terms of *use* and *usability*, the structure of the TLCM-M was perceived as *clear, systematic and logical*, and it was said to teach the user to think about and rationalize the work. Usability was considered good, though some pointed out that using it was a little difficult, at least at first before they got acquainted with it, as it is so comprehensive, containing so many points of views. Nevertheless, this comprehensiveness was considered a positive feature. Some users asked the researcher to simplify the structure, at least in practice, case-by case, if the method is commercialized.

According to the case studies, the TLCM-M was considered *useful in practice*. Especially its interactivity was considered a very successful feature. In addition, the checklists were

considered good and extensive. Some of the real estate owners did not pay much attention to the checklists, but others said that they help participants discuss things well. On average, the service providers considered the checklists better than the real estate owners. When users were asked to evaluate the benefits of using the TLCM-M, they all said it helped them make commissions and make decisions related to technical issues, which had a positive effect on the quality of a real estate's technical life cycle, thus improving the cost-effectiveness of TLCM and especially facilitating risk management. The experts expressed similar opinions.

Applicability in other environments proves that a construction is generic. In this thesis, the construct was shown to be a suitable, useful and practical tool in all situations for which it was constructed (cases 1-5), and users also said it was appropriately generic. In addition, one case was carried out in Russia, another environment, and there too the method was very useful. It was used in multiple situations, in several cases, and the (American) investor still uses the TLCM Method in all investment analysis situations and also when a TLCM strategy is being developed for an existing real estate. The applicability of the TLCM-M was not tested in other situations than those for which it was developed, though two companies have contacted the researcher in order to take the method into use in new construction projects. The method has also once been applied to analyze the development potential of a building intended for residential usage.

9.2.2 Practical criteria for theTLCM Method

In addition to the theoretical criteria, we also developed a list of the essential features of a practical, useful tool or method (Chapter 7.3.) According to these criteria (critical success factors), the TLCM-M also makes a significant contribution to technical life cycle management in the real estate business.

1. The method should be *logical, comprehensive and generic*
2. *Pays attention to the real estate business as a totality*. The method should make it possible to connect the defined business plans more efficiently to maintenance strategies. The method should facilitate the strategic planning of technical life cycle strategies as a part of overall business strategies and implementing of the technical strategies in practice.
3. The cost effects due to different technical life cycle strategies should be connected to long-term planning more accurately. Long-term planning should be done according to the owner's objectives. *Life cycle costing* considerations should be possible.
4. The method should help in analyzing, predicting, planning and implementing *future decision-making,* and it should also be possible to consider future developments.
5. Pays attention to the *objectives of the real estate owner* and takes into account the *changing needs of the users* of the buildings. Real estate owner organizations should be able to define their business objectives and communicate them clearly to service providers.
6. Facilitates *objective-setting* related to technical characteristics
7. Facilitates the focusing of appropriate technical services and service packages in different situations. The method should facilitate goal-setting and decision-making related to the technical objectives of the real estates and also facilitate information systems in real estate organizations.
8. Helps *strategic planning* and designing technical strategies for the attended life cycle.
9. Facilitates the *process of purchasing technical services.* Technical possibilities and the costs due to different possible technical actions should be presented clearly and

understandably. The causal relationships between different technical action solutions should be more visible.

10. Focuses on strategic, tactical and operational levels and facilitates co-operation: the method should make *communication easier* between different levels of real estate organizations and between real estate organizations and service provider organizations.
11. Paying attention to *risks and the relation between risks*, costs and the owner's objectives; facilitates risk analysis related to technical risks and the suitability and potential of a building for ownership and usage.
12. Is related to *life cycle durability as well as technical, functional and aesthetical potential* in relation to life cycle costing.
13. Makes it possible to *set priorities and optimize (=> iteration is possible).*
14. Takes into account *costs, restrictions and possibilities of maintenance.*

Interviews showed that the methodology fulfilled the criteria set for it:

According to the interviews, the method is very *logical*. This was achieved by developing an interactive process model with task descriptions and checklists. When the method is used, one proceeds from the analysis module to the strategy development module. First, the owner's and user's primary objectives (requirements) are analyzed, then the technical risks, which are reflected against the primary objectives. In addition, possible limitations are analyzed. After this, the secondary objectives of owner and user (expectations) are analyzed, concluding with an analysis of the possibilities.

Comprehensiveness was achieved by connecting technical decision-making to other important factors affecting decision-making in the real estate business. An important idea is that the method should *pay attention to the real estate business as a totality*, which was taken into account in developing the checklists which consider business from the perspectives of ownership; use; usage; life cycle costing; technical durability; technical, functional and aesthetic quality; and also maintenance. When evaluating the checklists, service providers said that the lists are very comprehensive and useful, while real estate owners added that the lists helped them take all the important factors into account. One of the expert interviewees pointed out that if such lists are used they would make the TLCM process faster and steer the whole process.

The method also fulfills the criteria of considering *life cycle costing*, as this is taken into account in several phases: first when the owner is asked to consider the relation between technical risks and costs due to realized risks and expected income (phases 5 and 6), then in the second phase where the potential of the building is analyzed (Phase 9), and finally in the strategy developing phase where the real estate owner estimates and optimizes technical actions according to cash flow analysis and technical information on the various possibilities provided by the TLCM and service providers. Interviewees felt that using the TLCM Method increases the cost-effectiveness of the TLC management of buildings.

Future decision-making was also mentioned as an essential feature of the method. The whole process aims at evaluating risks, analyzing the potential of a building to fulfill the objectives of the owner and user according to the primary objectives of ownership, making investment or other decisions according to the expected cost-effectiveness of ownership and defining the technical life cycle strategy according to the acceptable risks and a building's potential in acceptable cost frames. Users and experts pointed out that by analyzing a building and developing a TLCM strategy for it according to the method, the life cycle quality improves, TLCM will be more cost-effective and also risk management is facilitated and improved.

They also emphasized that using the method facilitates the decision-making of real estate owners related to technical objective-setting and decision-making.

According to the literature review, the method should also pay attention to the *objectives of the real estate owner* and take into account the *changing needs of users* of buildings. This was taken into account in two phases in order to make it possible to *set priorities* for the objectives related to a building's characteristics. First, the primary objectives of the owner and user are defined and reflected against the *technical risks*. Then, the secondary objectives are analyzed and reflected against the *potential of the building to achieve these objectives, technical, functional and aesthetic*. All the objectives in the TLCM-M are reflected against life cycle costing. The users pointed out that the possibility of *setting priorities* facilitated objective-setting and decision-making related to technical characteristics. As an interactive process description, the TLCM-M also facilitated the flow of information within real estate organizations and information between real estate owners and technical service providers. Interactivity also facilitated the *purchasing* of technical services. Interactivity was considered one of the most important features of the method.

Also, the possibility for *optimizing, iteration*, was used in two cases where owners were trying to identify the optimal life cycle strategy in development projects. The multiple perspectives related to *costs, restrictions and maintenance possibilities* were considered in all cases. The case interviewees considered this comprehensive approach very useful. Also, the experts pointed out that this kind of approach to TLCM was needed, but some also emphasized that usage should be based on actual need on a case-by-case basis.

Both users and experts thought that the TLCM-M was a *generic method*, suitable for all the situations for which it was developed.

Kasanen's three-phase market-based criteria are also a useful tool with which to test the TLCM Method (Kasanen et al., 1993 p. 253; Kasanen et al., 1991, p. 306).

1) *A weak market test* indicates that a manager responsible for operations has used the construct in his or her own decision-making or actions. The TLCM-M passes this test, as one executive director of a Finnish service provider company has signed a frame contract with a real estate owner responsible for strategic and operative real estate management to analyze all their building stock in Russia using this method. Investment analysis will also be done according to this system.

2) *A semi-strong market test* indicates that the construction is widely adopted by companies, and the TLCM-M passes this test as well. Three Finnish service provider companies have adopted it, and are actively using it in their business. There are also ongoing negotiations for using the method in new construction projects as a tool for multiattribute decision analysis. In addition, three Finnish and one American real estate owner companies have taken the method into use.

3) *A strong market test* is passed when some business units systematically apply the construct, and as a consequence their financial results are better than the results of units who are not using the construct. Proving this is difficult, however, since as far as we know there is no data available showing that using this method increases a unit's cost-effectiveness: there are too many variables and the TLCM-M has not been on the market for very long. We can say, however, that the companies who have adopted the method do believe that their decision-making will be more accurate and risk management will be improved, and therefore their strategic technical management will also be more cost-effective. As we saw in the interview data, both service providers and real estate owners expect that using the TLCM-M would improve the cost-effectiveness of TLC management at least in the long term. Still, there are

companies who have already taken the TLCM-M into use and keep using it, which can be seen as an indication of beneficial use and therefore also as an indirect strong market test.

9.2.3 The features of the TLCM Method

The TLCM Method itself is presented in chapter 7.5, while its essential features are presented in chapters 2.1, 4.4, 5.3 and 7.3. In the following figure, we review the connections between these criteria, essential features, and the modules, parts and characteristics of the TLCM Method (figure 9.1).

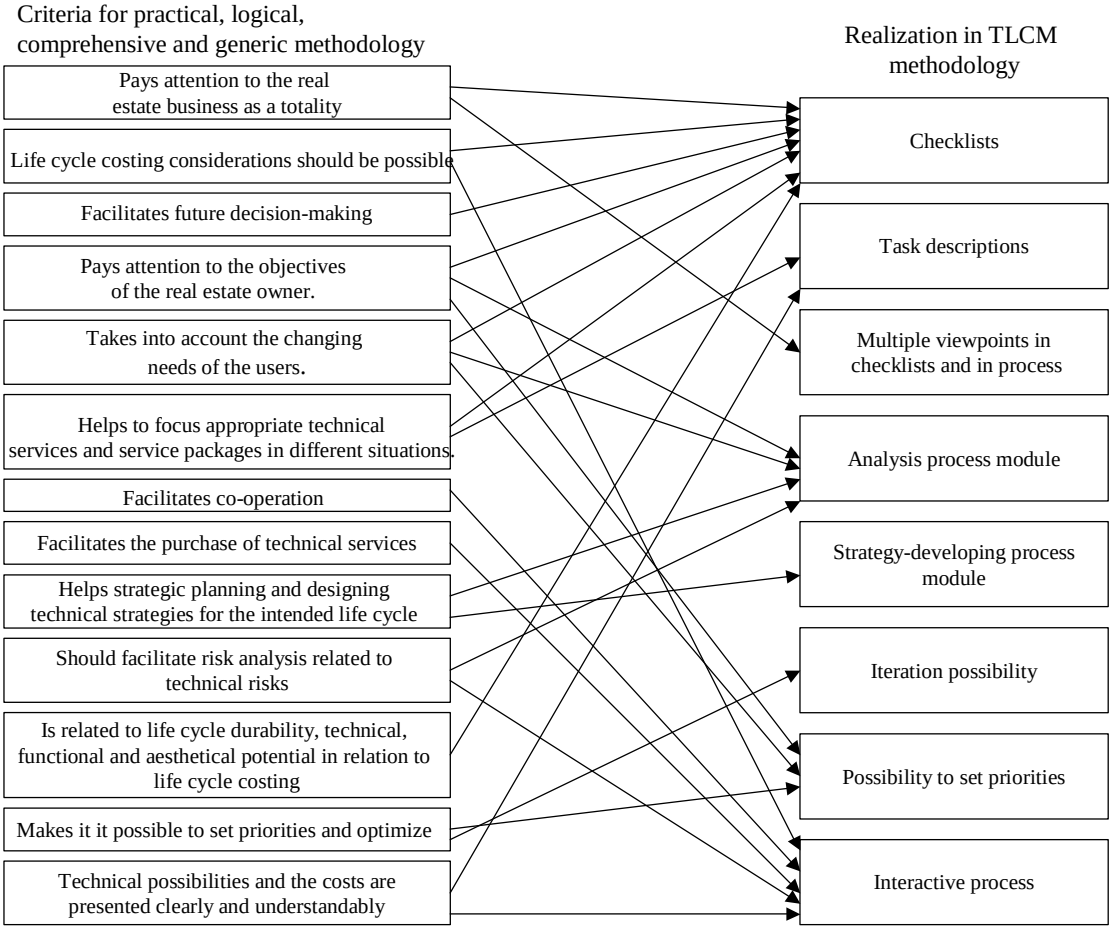

Figure 9.1. Connections between the essential features and the modules and characteristics of the TLCM Method.

We analyze here the perceptions of the users and experts interviewed in this study about how well the structure facilitated the achievement of essential features, critical success factors set for the construction according to the literature.

The interviewees pointed out that the TLCM-M is a totally new approach to the management of technical life cycles. They also said that it was a generic method for analyzing the technical potential of a building and, based on these results, for developing a technical life cycle strategy. The whole concept of TLCM was considered wide and difficult but a very important management issue in the real estate business, from the perspective of *cost-effectiveness of the owner's real estate business and from the perspective of the user's business and usage.* Users of the method (in case studies) and experts (in interview studies) felt that the TLCM-M was a usable tool for analyzing the *cost-effectiveness of ownership, technical risks and technical possibilities as well as for developing an objective-focused TLCM strategy* for buildings.

In the beginning of the research we also decided that the method should be focused on the strategic, tactic and operational levels of an owner organization and facilitate co-operation between different organization levels and between different stakeholders of TLCM. This was achieved by the modular structure of the TLCM-M and by the interactive process description. The structure of the TLCM-M was considered logical and systematic and therefore very usable. Also, the interactivity between the TLC manager and real estate owner (and users) was found to be excellent, since through this interactive process the analysis of *technical possibilities and risks, and the cost effects* of different decisions, becomes faster and more accurate according to the interviews. Both modules of the TLCM-M were perceived as important, and were also thought to be logical and well-structured.

The task descriptions were also thought to be good and adequate, and they facilitated usage. These descriptions made it possible to provide adequate information, both to the owner to facilitate *future decision-making*, and to the TLC manager, to analyze the building and assess its risks and potential against the primary and secondary needs of the owner. The task descriptions made the structure of TLCM-M logical and systematic. Also, the checklists were considered very comprehensive and well-structured, with nothing essential missing. The comprehensiveness made using them slightly difficult, but this was also considered good: when using the lists you have to consider things from all the important perspectives. The checklists were many-sided and therefore they facilitated *paying attention to the real estate business as a totality*. In the checklists the life cycle considerations were taken into account as well as future decision-making related to technical decisions. Also, both user and owner needs were considered in the checklists as well as *technical, functional and aesthetical characteristics of buildings*. By using them it was possible to analyze the technical possibilities and potential of buildings.

Especially good features of the TLCM-M were its *interactivity, the possibility to iterate and optimize, the possibility to set priorities for objective-setting and decision-making*, the first four-six phases in the very beginning of the process in which the *primary objectives of cost-effective ownership* and usage were considered and reflected against the technical risks and potential of the building and the task descriptions with the role of TLC manager and decision points. These phases or characteristics made the method usable, logical, systematic and effective.

The TLCM-M was considered very useful in practice. Using it clearly *facilitated the making of commissions and purchasing and providing technical services*. It also facilitated *decision-making related to technical questions*, improved the quality of technical life cycle management, improved the *cost-effectiveness* of technical life cycle management and made it possible to *cost-effectively manage the technical risks* of real estates. By using the TLCM-M, it is easy to evaluate the technical potential of a building as well as technical possibilities and their costs. According to the interviews, using the TLCM-M also improves the competence of all stakeholders. The interviewees pointed out that there was a clear need for such a method on the market. The technical state of the building was considered very important for real estate owners and also for the users and usage. The TLCM-M was said to clearly facilitate analysis leading to a technical life cycle strategy. *A TLCM strategy serves the overall strategies and operations of the real estate business*.

The defined concept of TLCM was considered important from the perspective of managing real estates in the long term and the constructed TLCM-M was considered a successful method for managing the technical life cycles of buildings. The need for improving TLCM in the real estate business was possible to demonstrate through the literature reviews and practical studies. Also, the critical success factors for a well-functioning construction were possibly to identify. There were available theories which could be applied in developing a TLCM Method and theTLCM-M itself was useful and practical.

9.3 Theoretical and practical contribution of the research

In order to evaluate a research's theoretical and practical contribution, we must analyze the innovation or new knowledge created in the research. What are the findings that could be added to the existing scientifically created knowledge? And also what are the benefits of the innovations? How useful is the new knowledge? In this context we also analyze the scientific evidence of the research. Can the new knowledge be generalized and is it possible to conduct instructions or normative statements from it?

An innovation itself may be beneficial although it hasn't been created in a scientific process. In addition the criteria defined in a process using scientific methods cannot guarantee that the created innovation is useful and beneficial. In this research the previous chapter presented the two sets of criteria identified at the beginning of the research and analysed whether the method fulfilled the criteria. In this chapter we present the contribution to knowledge and practical contribution of the research. The practical contribution is considered from the viewpoint of subjective experiences of the users of the construct of TLCM Method as well as by analyzing the contribution by market tests.

9.3.1 Contribution to knowledge

A constructive approach was used in this study. The use of the constructive approach demands that the relevance and research potential of a research problem is evident (Kasanen et. al., 1993). In this research the preliminary part was done in order to justify this relevance. Therefore, even the findings at the very beginning of the research can be seen as results. The relevance of the research problem was proven both by the literature review and by preliminary interview studies (preliminary interview studies 1 and 2 and literature reviews 1 and 2). The main results of this research are description of the concept of TLCM and the role of the TLC Manager. In addition, the main innovation in this research is the process of technical life cycle management, the TLCM Method. The scientific evidence of the innovations is strong in this research. The innovations are tested in case studies and the TLCM Method has been taken into use in real business life. Therefore this research provides a scientifically-tested tool for stakeholders in the real estate business.

The contribution of this study can be broken down into the following normative oriented statements for the stakeholders in the real estate business:

- Strategic technical life cycle management is an important strategic business area in the real estate business that should more efficiently be managed in all strategic, tactical and operative levels. Performing TLCM would be a priority, but there has been no theoretical foundation, means or tools for doing so. The performance of TLCM as perceived by stakeholders in the real etstae business was not adequate. A new innovative method for TLCM was needed. Even though some had pointed out the need for such a method, it had not been realized.
- Technical issues are related to most management aspects in the real estate business. They are also related to the core business of traditional corporations in terms of user satisfaction, the usability of buildings and cost-effective ownership. Therefore, they should be considered from different perspectives of the businesses. Technical Life Cycle Management should be seen as a totality itself, as an engineering discipline that contributes to overall business management and as a chain from technical objective setting to implementing the action plan. TLCM should also be seen as part of the overall business management of real estate owner companies. According to the literature, all the issues related to the domain of Technical Life Cycle Management (TLCM) are considered by one or more authors, though none has considered TLCM

as an individual management issue, despite the fact that regardless of an owner's relationship to the owned real estate, technical objective setting, decision making and implementation of decisions have a great effect on his or her business. Still, while the role of facilities manager is defined in the literature as a role in the real estate organizations of traditional corporations, there is no solid idea how TLCM should be seen in general.

The TLCM can be defined *as a new concept*. The concept of TLCM refers to the management field in which the technical objective setting, technical decision making and technical implementation of decisions are connected to managing of the overall strategic, tactical and operative real estate business. TLCM is related to the *core business* of real estate owners: it is part of their business strategies, part of strategic overall real estate strategic planning. A *TLC manager* is a person who coordinates the technical services needed by the owner's business objectives.

- Bringing together in a new way theories from investment analysis, maintenance, and the design and construction of new buildings, it was possible to develop the new innovative method, TLCM Method, as an interactive process description.

  The Method was needed because there was no theoretical foundation, means or tools for adequately performing technical life cycle management. The method includes task descriptions, references to checklists and checklists. The method was tested in cases and it was considered good, usable and useful method according to the interviewed users and it should be taken into use in all situation for which the TLCM method was created (in investment analysis, in cases were the technical potential of a building is evaluated in real estate development situations, in cases where technical life cycle strategies are developed for owned existing buildings for a chosen life cycle period). The TLCM-M innovation is novel. According to the literature, preliminary interview studies, case studies, and expert interviews, there is no other method or tool available on the market for facilitating strategic technical life cycle management: a method that considers the real estate business as a whole, forces a real estate manager to make the necessary decisions at the right time, provides the needed information for making these decisions, makes it possible to set priorities, optimize and iterate during the process and includes checklists and task descriptions for different participants in the process. Both users and experts affirmed that the whole approach to TLCM in this process is new, necessary and useful.

9.3.2 Practical contribution

In chapter 9.2.2 we analyzed users' perceptions of how well the TLCM Method reflected the criteria set for it in the beginning of the research process. In this chapter we concentrate on the practical contribution which is shown in two ways, by analyzing the subjective experiences of the users of the TLCM-M and by market tests (see also 9.2).

The TLCM-M makes a significant contribution to technical life cycle management in the real estate business. According to the interviews:

- The method is very clear, systematic and logical, and it was said to teach the user to think about and rationalize the work.
- TLCM-M was considered useful in practice also in other environments which indicates that the construction is generic.
- It is comprehensive, containing many perspectives on the real estate business. It pays attention to the real estate business as a totality. It pays attention to the objectives of the real estate owner and also takes into account the changing needs of the users of buildings.

- It makes it possible to set priorities which facilitate objective-setting and decision-making related to technical characteristics.
- The interactive process also facilitates the flow of information within real estate organizations and information between real estate owners and technical service providers. All the users learn from each other by using the TLCM method and such learning helps in developing processes in purchasing technical services.
- It makes technical life cycle management more efficient.
- It facilitates future decision-making and investment analysis.
- It facilitates risk management and makes risk management easier.
- Usage makes technical life cycle management more cost effective.
- Usage makes it possible to optimize and iterate technical solutions in the real estate business.

At the moment (February, 2004), three service provider companies and five real estate owner companies are using the method.

Kasanen's market-based criteria are also a useful tool to prove the practical contribution of the TLCM Method (Kasanen et al., 1993 p. 253; Kasanen et al., 1991, p. 306) (see also chapter 9.2).

1. The TLCM-M passes *a weak market test* as there are managers responsible for operations who have used the construct in their own decision-making process.
2. The TLCM-M passes *a semi-strong market test* as well since the TLCM-M has been widely adopted by a number of companies.
3. There are companies who have adopted the TLCM-M as part of their business model, which can be seen as an indication of beneficial use and therefore also as an indirect strong market test.

9.4 Validity and reliability of the research

According to Peura (Peura, 1996, p. 278) validity and reliability are both criteria by which to evaluate research, and are independent of the research method. Especially in qualitative research, in which the number of variables may be great and the research method is based on the interpretation of phenomenon, criteria such as validity and reliability have great importance.

Validity can be divided as follows: 1) internal validity, 2) external validity and 3) construct validity. Internal validity always focuses on causal relationships or explanatory studies. If this (explanation) is not the purpose of the study, internal validity is not that important if the quality of the research is discussed. If causal relations are to be proved, internal validity refers to the level of certainty (Yin, 1989, p. 42-43; Lanning 2001, p. 155). External validity explains how generalizable the research findings are beyond the cases used in the study. It is an important issue when talking about the quality of case study research (Yin, 1989, p. 43; Lanning, 2001, p. 155.) Construct validity means that what you want to measure is really measured, and "emphasizes the establishment of the proper operational measures of the concepts being studied" (Lanning 2001, p. 153; Peura, 1986 p 278; Yin, 1989, pp. 40-45).

According to Yin (1989) there are three principles of data collection which can help to deal with the problems of establishing the construct validity and reliability of a case study (Yin, 1989, pp. 95-103):

1) Using multiple sources of evidence. A major strength of a case study is the possibility to collect data from multiple sources, as this allows the possibility of triangulation.

2) Creating a case study database. The second principle is related to the way the data is organized and documented.

3) Maintaining a chain of evidence. By maintaining a chain of evidence the reliability of the information may be increased. In practice this means that no original evidence should be lost and clear descriptions of the process of research should be made.

9.4.1 Internal validity

Internal validity is related to causal relationships or explanatory studies (Yin, 1989, p. 42). It proves the consistency of the hypotheses, concepts and conclusions (Peura, 1996, p. 278). According to Yin, there are two important points related to internal validity. First, it is a concern only for causal or explanatory studies in which the researcher is trying to determine whether event x led to event y. Second, internal validity is related to making inferences (Yin, 1989, p. 43.) According to Peura, evaluating validity may be facilitated by asking several questions: how has the researcher viewed the invariances, how generalizable does s/he think the results of the research are, how much does s/he think that external issues (financing, organizational issues, etc) have affected the results, what are the researcher's own values, what are the relationships between the researcher and persons involved in the research (Peura, 1996, p. 279).

The main purpose of this study was not to find causal relations between events under study, but more to understand the cases and the suitability of the constructed method for real life cases. Still, while the main purpose of the TLCM Method was to facilitate cost-effectiveness in the real estate business and the case studies proved that using the method made business management more cost-effective by facilitating life cycle costing considerations, objective-setting related to technical characteristics of buildings and risk management related to technical issues, it can be said that the method is coherent and using it leads to more cost-effective business management. Also, the interviewed users and experts pointed out that the method is very general.

In analyzing cases we applied cross-case analysis, and the case descriptions included the observations about the cases.

9.4.2 External validity

According to Yin, the external validity of the study deals with the problem of knowing if the findings of the study are generalizable beyond the immediate case study (Yin, 1989, p. 43). There are two types of generalization: survey research usually relies on statistical generalization and case studies on analytical generalization. In analytical generalization, the researcher needs to generalize a particular set of results to some broader theory (Yin 1989, p. 43-44). Yin suggests some tactics applicable in case studies for testing external validity, including the use of replication and the logics of multiple case studies (Yin, 1989, p. 41). Also, according to Lanning, in case studies analytical generalization leads to replicating case studies, carrying out cross-case analysis and verifying patterns, typical characteristics (Lanning, 2001, p. 155).

We wanted to make this study as scientifically rigorous as possible, since we considered this important from the perspective of taking the method widely into use in the future. We were quite committed to the research subject since we had plenty of real life experience of purchasing and providing technical services in the real estate sector. We were especially interested in analyzing the TLCM-M in cases, and we must say that the results were very encouraging. We did our best to understand both the users and experts, in order to generate accurate information related to the technical life cycle management of real estates. We tried to achieve generalizability through various means. The method is tested in five cases, from five different starting points. The cases were chosen so that they represented situations for which

the TLCM-M was developed. In addition, in all cases (but one) we interviewed multiple participants from different levels of the organization and different parties of TLCM analysis and strategy development processes. In addition, the participating real estate organizations differed from each other in size and in the types of real estates they owned. The service provider companies had different roles in the construction industry. Generalizability was also tested in one case, which was carried out by a Finnish service provider working with American and Russian participants. Triangulation was also applied in analyses, between the cases, between the parties involved in the cases, between different organizational levels and between expert interviews and case study interviews. Data from all phases of the research are reported transparently and in a logical way.

In addition, according to Peura (Peura, 1996, p. 232-233), one way of showing general applicability is pragmatism. If a well-functioning construction is taken into use by market forces, the truth value of the construct is strengthened. As already mentioned in section 10.1.2 the TLCM-M has been taken into use by several technical service providers and several real estate owner organizations. The method has also been used by persons and companies others than those who used it in the cases. It is also in active use in the Russian market by one service provider and one American investor (real estate owner). Therefore, its generalizability and applicability in other environments has also been proved.

9.4.3 Construct validity

In terms of construct validity, Yin offers the following suggestions to the researcher (Yin, 1984, p. 41-42, in Lanning 2001, p. 153):

1) Choose cases that most evidently have something to offer regarding the research problem:

   In this study the cases were chosen from each group for which the TLCM-M was developed. We also used different kinds of service providers and different kinds of real estate owners. In addition, the participants represented all the parties involved and different levels of the organizations they represented.

2) Demonstrate that your way of measurement and measures used are clearly connected with the phenomena studied:

   We concentrated on measuring the usability and usefulness of the constructed tool. We also made sure that the users really used the method, so their judgments would be as realistic as possible. When developing the questionnaires and interview questions, we included questions examining important issues “from different perspectives.” We also attempted to eliminate possible sources of error: We did not actually want to measure how the projects themselves went, but more how the users perceived the usability and usage of the method.

3) Use multiple sources of evidence:

   “Triangulation means deploying more that one method in a study to provide enhanced validity and to increase the chance that the results are not biased” (Lanning, 2001, p. 153). Triangulation is also defined as “the combination of methodologies in the study of the same phenomenon” (Denzin, 1978, p. 291 in Jick, 1979, p. 602). There are several different methodologies for triangulation: 1) Data source triangulation, 2) investigator triangulation, 3) theory triangulation or 4) methodological triangulation (Lanning 2001, 153). According to Stake (Stake, 1995, pp. 113-114, in Lanning, 2001, 153-154), data source triangulation means using different data sources, or data from different times, to look at the same case, person etc. Investigator triangulation means using several different researchers to look at the same data. Theory triangulation means using different perspectives or theories to interpret the data. According to Stake (Stake, 1995, in Lanning

2001, p. 154), methodological triangulation increases confidence in the interpretations. In this triangulation method, different methods are used to find answers to the research questions. In this method, research may use, for example, observations, interviews or workshops in exploring some issue.

In this research, we have used both data source triangulation and methodological triangulation. In terms of data source triangulation, we have gathered data from a very wide range of sources: interviews of different parties in the case projects, interviews of parties from different organizational levels involved in the case projects, interviews of both experts and people who used the method and of course we tested the method in several different cases. We also observed and documented the case projects, and while the method was being constructed we made use of this documentation, literature, interviews, questionnaires, brainstorming meetings and discussions.

In terms of methodological triangulation, we used a variety of methods to test the usability, usefulness, novelty and generality of the TLCM-M: questionnaires, interviews, observation, documentation and discussions after the cases. Both experts and users were interviewed and they all filled out a questionnaire.

4) Establish a chain of evidence

   If a chain of evidence is established, the reader is able to follow the research and its different phases, "to follow the derivation of any evidence from initial research question to ultimate case study conclusions" (Yin, 1989, p. 102). In this study the whole process from initial research questions to conclusions is quite rigorously described. Details about the interviews (timing, questions, responses) are presented either in the thesis itself or in an appendix. Also, the case study interviews were tape-recorded, transcribed and translated by a native English speaker. The research questions have been formed so it is possible to answer them; the answers are presented in chapter 9.1.

5) Have case study reports reviewed by key informants

   The case studies have been discussed afterwards with key persons. Also, one key informant has reviewed all the case reports.

9.4.4 Reliability

Reliable data does not include incongruence (Peura, 1996, p. 280). In practice, reliability means that another investigator is later able to repeat the study in the same environment, get the same results and draw the same conclusions (Lanning, 2001, p. 157). According to Yin, the objective of the test of reliability "is to be sure that if a later investigator followed exactly the same procedures as described by an earlier investigator and conducted the same case study all over again, the later investigator should arrive the same findings and conclusions" (Yin, 1989, p. 45). According to Yin, the objective of reliability is to minimize the errors and biases in a study, and he suggests that using a case study protocol and developing a case study database will help ensure the reliability of data collection (Yin, 1989, p. 41). According to Peura, validity is not possible without reliability but reliable data is not inevitably valid (Peura, 1996, p. 280). For example, if the interviewees consistently lie, the research may be reliable but not valid (Peura, 1996).

In qualitative research, replicability is often difficult, especially when there are numerous variables. In addition, factors like human behavior, nature and mood in some situation has an effect on somebody's answers (Peura, 1996). The real world is constantly changing. Ensuring and demonstrating that the used data generation and analysis have not only been appropriate to the research questions but also thorough, careful, honest and accurate, becomes very important (Lanning, 2001, p. 157).

In this study, replicability is indeed impossible. The cases were costly real life projects. In addition, it is quite unlikely that there could be two similar case projects available, two similar real estates with similar users and user needs and the same owner. In such investment analysis cases or development potential analysis for real estates, there are too many variables. Also, decisions in the real estate business are related to the time, environment and other circumstances, and so it is not possible to replicate the cases.

Even though it is impossible to replicate the study exactly, we did attempt to achieve reliability through the various ways we collected data during the projects. We began by observing the cases, and at times also had access to the case's memo material. Then, when testing the construct's practical usability and usefulness, we collected data in different ways. The interviews focused on the same issues as the questionnaires, related to the structure, content, amount of use of different modules, phases and parts of the study as well its usability and usefulness. All users filled out the questionnaire and all were interviewed. So, we asked the same questions of all the users in different situations, several times, and from different perspectives. We also rigorously followed the same techniques and methods in all the interviews. In the case interviews, participants had used the TLCM Method, which had been introduced to them at the beginning of the project. In the expert interviews, we first presented the method and then conducted the interviews. For both sets of interviews, we used prepared questions. All the interviews were tape-recorded and we also took notes. A native English speaker translated the case interviews.

9.5 Further research issues

Many areas in real estate and construction business are in need of further research. In this multidisciplinary area there are different kinds of stakeholders in different roles. Processes should be developed taking into account the whole life cycles of buildings, usage of the buildings and the cost-effective ownership.

First, the TLCM-M should be developed to suit new construction projects as a decision-making tool. Secondly the TLCM-M could be tested and developed for residential buildings. Thirdly, the concept of the TLC manager should be expanded. We need to consider whether there is a need for a new kind of technical "program manager" for real estate owners and investors, a person able to combine the roles of TLC manager and quality manager in all new construction and refurbishment projects.

The idea and application area of technical life cycle management is quite wide since it aims to guarantee that the technical decisions and implemented actions support the owner's business idea and business goals in the real estate business as effectively as possible. Therefore, fourthly, the whole idea could be expanded to city planning and regional building planning processes in existing and new regions. It also could be tested in portfolio planning in the real estate business.

In addition the means and tools of risk management should be applied in developing risk management tools for technical real estate management. Also, more efficient, practical tools for life cycle costing should be developed.

TLCM-Method is a new way of acting in the real estate sector. Accomplishing a change in a wide and interdisciplinary sector, such as the combined construction and real estate sector, is always difficult, even if the need for change is perceived. All participants need to overcome their resistance to change. How better to do this could be studied, and methods for changing management practices in the real estate and construction sectors could be developed.

The TLCM Method is a tool for real estate owners to manage the technical life cycles of their real estates and create overall business strategies. Therefore the fifth further research issue is

as follows: All the available tools should be connected and software for overall strategic business management should be developed.

9.6 Summary

The main focus in the research was to study the role and performance of technical life cycle management as a strategic, tactical and operative part of overall real estate business.

The real estate business is a very multidisciplinary area in which the real estate owner needs to decide how to create strategies for business development, set goals, identify the different options which best serve his business needs, implement these solutions in practice and at the same time run a profitable business in the rather exceptional business environment of real estate. This dissertation concentrates on technical issues in the real estate business and strives to answer these questions in terms of Technical Life Cycle Management (TLCM). The domain of the research interest is first characterized as the domain that incorporates the life cycle of a building from investment analyzing to the demolition decision, taking into account both technical and economic perspectives. We study how a real estate owner sets goals, makes decisions and plans and implements actions directed at an individual real estate which affect the physical characteristics of a building. In this study we especially focus on those characters that are important from the perspective of cost-effective ownership.

The research problem was that strategic planning did not seem to be a common practice related to the technical life cycles of buildings: there seemed to be many unsatisfactory issues related to the purchase or provision of technical services, and buildings were not performing well over their technical life cycles. Too often, technical management seemed not to be goal-oriented, and there were plenty of technical problems. Accordingly, the first research question was: What is the status of technical life cycle management (TLCM) processes? What are the underlying theories, key concepts, methods and tools in the real estate sector? What are the practices of TLCM; how do they reflect the body of knowledge, if any; how is the performance of TLCM perceived by the stakeholders? Is there a solid foundation of appropriate theories, key concepts, methods and tools for TLCM?

We attempted to answer this question in preliminary studies. These preliminary studies included two interview studies and a literature review. According to the first research question, there could have been four possible outcomes relating to the preliminary studies: first, there are no impediments to the performance of TLCM in the real estate business; second, there is a theoretical foundation, means or tools for performing TLCM, but doing so is not a priority; third, performing TLCM is a priority, but there is no theoretical foundation, means or tools for doing so; last, performing TLCM is a priority and there is a theoretical foundation and means to do so, but for some reason it is not done. In effect, these four possible outcomes acted as hypotheses and were duly tested. The overall objective of the preliminary studies was to find out which of the outcomes was relevant and then, according to the results, formulate the remaining research questions and define an appropriate research strategy.

We ended up defining the TLCM concept and developing the TLCM Method because it became clear that strategic objective-setting, decision-making and the implementation of decisions in practice, especially related to technical questions (TLCM), was not being performed in a satisfactory way despite the perceived importance of the subject. According to the preliminary studies:

> "Strategic technical life cycle management is an important strategic business area in real estate business that should more efficiently be managed in all strategic, tactical and operative levels. Performing TLCM would be a priority, but there has been no

theoretical foundation, means or tools for doing so. The performance of the TLCM perceived by the stakeholders in real estate business was not adequate. A new innovative method for TLCM was needed."

In defining the concepts of technical life cycle management (TLCM) and technical life cycle manager (TLC manager), we studied how the roles of different parties involved and concepts within the real estate sector were defined and performed and how the performance was perceived in general. We also studied what were the strategic focus areas in the real estate business and who, in real estate organizations, was responsible for different strategies. We used theories and knowledge related to the real estate and construction businesses. The concepts studied were based on theories related to management practices, roles and the responsibilities of different practioners in the real estate and construction business. We summarized this, as well as discussed lacks in strategic business planning, in chapters 4.3 and 4.4. There was a disconnection between strategic planning and the implementation of strategies, a disconnection between the strategic planning of different strategic business areas and also a lack of appraisal, analysis, prediction, planning and improving of future decision-making. In addition, information systems were inadequate. Strategic planning was inadequate from the perspective of a cost-effective real estate business, the objectives of a real estate owner's business ideas and taking into account the changing needs of the users of buildings.

First, we defined the *position of TLCM* in the real estate business as a part of strategic, tactical and operative business areas of real estate owner organizations (figure 4.21). Then, we *defined the new role of TLC manager* with his/her responsibilities, tasks and actions for facilitating technical life cycle management. This role description is a part of the interactive TLCM Method. The aim was to describe the responsibilities of a person whose goal is to build a cost-effective TLCM strategy according to the priorized objectives of the owner and the user, taking into account the technical risks and technical potential of a real estate as well as life cycle costing considerations and real estate economics. This role is new, and the owner of the real estate decides whether to in- or out-source this management task.

According to our theoretical and practical studies, there was not any solid foundation of appropriate theories, methods and tools for TLCM and therefore we first tried to find theories related to the real estate and construction businesses appropriate for developing a general, useful and practical method. According to these we defined the essential features of a successful method, and then *developed a method* (with task descriptions of different participants and check lists linked to the descriptions). This method was then tested in five cases and we proved its usability and usefulness in practice. We also demonstrated that a TLC manager, as defined, was required, and included a description of the TLC manager's role in the process descriptions of TLCM analysis and strategy development.

The main contribution to knowledge of this research is that it 1) demonstrates the need for advanced technical life cycle management; 2) demonstrates the need for a TLC manager; 3) defines the role of TLC manager as a concept and describes it as part of the TLCM process. The practical contribution of this research is its description of the interactive technical life cycle management process with task descriptions, references to checklists and the checklists themselves. This process description is a new method for managing the technical life cycle of buildings. The process includes two parts: technical life cycle analysis and the technical life cycle strategy development. In the analysis the technical potential of a building is analyzed from the perspective of the primary business objectives of the owner and reflected against the technical risks, costs of risk management and income expectations of the owner.

The cases showed that using the TLCM-M improved the cost-effectiveness and quality of technical life cycle management of buildings. It also facilitated technical objective setting of real estate owners. In the TLCM Method, the technical alternatives and technical potential and

risk analysis of a building is reflected against the primary objectives of the owner company, taking into account the objectives of users and real estate economic aspects, including life cycle costing considerations. This part of the TLCM-M was especially considered new and very useful. Using the TLCM-M also made risk management easier. Both service providers and real estate owners considered that using the TLCM-M facilitated the purchasing and provisioning of technical services and also information exchange between different participants during the process. Using the method also improved learning experiences between different participants in the process. They also pointed out that the method is very useful in strategic planning of the technical life cycle as a part of overall business strategies in the real estate business. The method is also suitable for all kinds of investment or other decision-making situations in the real estate business, in investment analysis and in cases where the technical potential of a building is evaluated in real estate development situations, in cases where technical life cycle strategies are developed for owned existing buildings for a chosen life cycle period. It provides a fast and systematic method for investment situations, life cycle costing considerations and long-term technical planning of real estates. The method can be used as part of the strategic planning of AM/CREM and/or PM/FM. The TLCM Method also provides a systematic way to create a technical life cycle strategy for a building.

The TLCM-M is in use in several real estate owner and technical service provider companies and the role of the TLC manager has been adapted in those companies.

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Appendices

Appendix 1: Preliminary interview studies. 3 pages.
Appendix 2: Discussions at two service provider companies. 1 page.
Appendix 3: Presentation of version 2 of the TLCM methodology. 8 pages.
Appendix 4: Case studies and expert interviews. 4 pages.
Appendix 5 Questionnaire form 1 (a+b) used in testing the TLCM methodology in case studies. 4 pages
Appendix 6: Questionnaire form 2 (a and b) used in case studies and in expert interviews. 2 pages.
Appendix 7: Questions in case study interviews. 2 pages.
Appendix 8: Questions in Expert interviews. 2 pages.

Appendix 1: Preliminary interview studies 3p.

Table A1.1. The interviewed persons and dates of interviews in preliminary interview study 1.

NR	NAME	COMPANY	DATE OF AN INTERVIEW	HOW THE INTERVIEW WAS DONE	NOTES	CHECKING OF INTER-PRETATIONS
A1	Marjatta Erwe	Senaatti	11.8.2000	Open-ended interview	Notes	By mail Participant in project
A2	Aulis Kohvakka	Senaatti	27.1.2000	Open-ended interview	Notes	By mail Participant in project
A3	Timo Kankaanranta	Aleksia	2.2.2000	Open-ended interview	Notes	By mail
A4	Veikko Majava	Sponda	2.2.2000 3.7.2000	Open-ended interview	Notes	By mail
A5	Jukka Hakkila	Castrum	Many, e.g. 25.1.2000	Open-ended interview	Notes	By mail
A6	Timo Kankuri	Ilmarinen	16.3.2000	Open-ended interview	Notes	By mail
A7	Niina Nurminen	Ilmarinen	22.5.2000	Open-ended interview	Notes	-
A8	Juha Olkinuora	Nordea-kiinteistöt	15.3.2000	Open-ended interview	Notes	By mail Participant in project
A9	Pekka Lunden	Kiinteistö-Varma	29.6.2000	Open-ended interview	Notes	-
A10	Arto Ahonen	Elisa	22.3.2000	Open-ended interview	Notes	By mail
A11	Erkki Oksanen	Sonera	3.4.2000	Open-ended interview	Notes	-
A12	Pentti Vierikko	Forum	6.4.2000	Open-ended interview	Notes	By mail
A13	Rabbe Kihlman	Fortum	15.3.2001	Open-ended interview	Notes	-
A14	Matti Aarnisalo	Tapiola	8.3.2000	Open-ended interview	Notes	By mail
A15	Seppo Lehto	Kapiteeli	21.1.2000	Open-ended interview	Notes	By mail
A16	Pertti Rantanen, Heikki Räisänen, Juhani Katko	Nokia	5.4.2000	Open-ended interview	Notes	By mail
A17	Markku Vesa	Euro Devo	1.2.2000	Open-ended interview	Notes	-
A18	Keijo Kaivanto	Kiinteistöalan koulutus-keskus	24.1.2000	Open-ended interview	Notes	Participant in project
A19	Asko Sarja	VTT	28.11.2001	Discussion	Notes	-
A20	Teppo Lehtinen	TKK	Many 1999-2000 e.g. 21.1.2000	Open-ended interview/ discussions	Co-operative project	Project is reported
A21	Jussi Palmu	Catella	10.5.2000	Open-ended interview	Notes	-
A22	Kauko Viitanen	TKK	6.6.2000	Open-ended interview	-	-

A23	Ari Ahonen	Tekes	27.12.1999	Open-ended interview	Notes	-
A24	Juhani Reen	Rakli	25.1.2000	Open-ended interview	Notes	-
A25	Kaj Hedvall	Rakli	12/1999	Open-ended interview	-	-
A 26	Olli Olkkonen	KTI	29.11.2000	Open-ended interview	-	-
In all	28 persons	26 interviews				

Table A1.2. The interviewees and dates of interviews in preliminary interview study 2.

NR	INTERVIEWEE	ORGANISATION	DATE	HOW THE INTERVIEW WAS DONE	GATHERING OF INFORMATION
B1	Marja Kallio	Skanska	A few e.g. 29.5.2000	Interview Discussions	Notes The person is involved in project
B2	Risto Vahanen	Vahanen Oy	Many, e.g. 16.2.2000, 9.3.2000, 8.10 2000, 29.11. 2000, 17.1.2001	Interview Discussions	Notes The person is involved in project
B3	Heimo Levamo	Kiinteistön Tuottoanalyysit Oy	Many e.g. 16.2.2000, 24.8.2000 15.6.2000	Interview Discussions	Notes The person is involved in project
B4	Executive group	1 service provider	Many, e.g. 6/2000	Discussion	Notes
B5	Jarmo Halonen	Kiinteistön Tuottoanalyysit Oy	Many, e.g.:20.8.1999, 19.3.2000	Interview Discussions Case project	Notes Project memo Tape recorder
B6	Atte Stambej	Insinööritoimisto Mikko Vahanen Oy	Many, e.g.: 20.8.1999, 19.3.2002	Interview Discussions Case project	Notes Project memo
B7	Petri Saarinen	Insinööritoimisto Mikko Vahanen Oy	Many, e.g.: 18.2.2001	Interview Discussions	Notes Tape recorder
B8	Pekka Laamanen	Insinööritoimisto Mikko Vahanen Oy	Many, e.g.:20.3.2000, 15.6.2000, 3/2002	Interview Discussions Case projects	Notes Tape recorder
B9	Tommi Pilli	Insinööritoimisto Mikko Vahanen Oy	24.4.2002.	Interview	Notes Tape recorder
B10	Pekka Korhonen	Insinööritoimisto Mikko Vahanen Oy	Many, e.g.: 17.3.2000, 15.6.2000, 3/2002	Interview Discussions	Notes Tape recorder
B11	Ville Pekkala	Insinööritoimisto Mikko Vahanen Oy	Many, e.g.: 17.3.2000, 15.6.2000, 3/2002	Interview Discussions	Notes Tape recorder
B12	Jyrki Jalli	Insinööritoimisto Mikko Vahanen Oy	Many, e.g.: 9.4.2000, 15.6.2000, 4/2002	Interview	Notes Tape recorder
B13	Ilkka Jerkku	Insinööritoimisto Mikko Vahanen Oy	Many, e.g.: 9.4.2000 3/2002	Interview Discussions Case projects	Notes Tape recorder
(B14)	Teppo Lehtinen	HUT	Many, e.g.: 7.6.1999, 17.1.2000, 28.3.2000	Case project Discussions	Notes
In all.	13				Report

Appendix 2: Discussions at two service provider companies

Table A2 Interviews at service provider companies in 2002

NR	INTERVIEWEE	DATE OF INTERVIEW	HOW THE INTERVIEW WAS DONE	DATA COLLECTING METHODS
C1	Managing director	Many, e.g. 6/2002	Open ended interviews Discussions	Notes Tape recorder
C2	Managing director	Many, e.g. 4/2002, 6/2002	Open ended interviews Discussions	Notes Tape recorder
C3	Group manager	4/2002	Open ended interviews	Notes and tape recorder
C4	Manager	Many e.g. 6/2002, 12/2002	Discussions	Notes
C5	Managing Director	Many e.g. 6/2002/ 12/2002	Discussions	Notes
Total	5			

In these discussions, the various parts of and ideas related to this model for technical life cycle management were discussed, bringing forth valuable information about needs and practices and making it possible to improve and further develop the ideas.

Appendix 3: Presentation of version 2 of TLCM methodology

Presentation of the TLCM –methodology " version 2" - Interviews and questionnaire

The aim of presenting "version 2" of the model was to ensure that it was ready to be tested in real cases**.** Real case-projects are long-lasting, costly and require the participation of many persons, so it was important to be sure that the model was ready for testing.

This presentation included informal open-ended interviews/discussions and a questionnaire given to interviewees after the meeting, with questions related to the expected usability and usefulness of the methodology. In co-operative executive group meetings, these ideas had already been discussed and therefore there was preliminary information available about the construct's functionality and usefulness all the time. Table A3.1 shows interviewees and dates of the interviews.

Table A3.1 Interviews in executive group. Presenting "version2" of the TLCM methodology.

NR	INTERVIEWEE	COMPANY	DATE OF INTERVIEW	HOW THE INTERVIEW WAS DONE	DATA COLLEC-TION METHOD	CHECKING OF INTERPRETATION
JR1	Marjatta Erwe	Senaatti	12.2.2002	Open ended interview Questionnaire	Notes Questionnaire	By e-mail
JR2	Marja Kallio	Skanska	14.2.2002	Open ended interview Questionnaire	Notes Questionnaire	By e-mail
JR3	Juha Olkinuora	Nordea	13.2.2002	Open ended interview Questionnaire	Notes Questionnaire	By e-mail
JR4	Risto Vahanen	Vahanen	13.2.2002	Open ended interview Questionnaire	Notes Questionnaire	By e-mail
JR5	Heimo Levamo	KTA	13.2.2002	Open ended interview Questionnaire	Notes Questionnaire	By e-mail
JR6	Keijo Kaivanto	Kiinteistö-alan koulutus-keskus	13.2.2002	Open ended interview Questionnaire	Notes Questionnaire	By e-mail

During these interviews, I presented the TLCM methodology and its modules, analysis and strategy developing, as well as the checklists. We discussed the logic of the checklists, and looked them over. Group members commented on the methodology. I took notes and interpreted these comments, then sent the interpretations by e-mail to those interviewed. Executive group members were asked to fill out a questionnaire if they wanted to clarify some of their comments.

I then collected these comments and prepared the final version of the TLCM methodology (version 3).

Feedback on version 2 of the TLCM methodology

The presentations included:

1. Presentation of version 2 of the model
2. Open-ended interviews

3. E-mailing notes on the interviews to interviewees
4. Questionnaire sent by e-mail

Interview questions:

- How can the constructed TLCM methodology itself, along with its usability in real estate owner organizations, be developed? (Presentations, training etc.)
- If the methodology proves useful (in the testing phase), then who do you expect to be its main users in the real estate organization? To become a strategic tool for real estate organisations, who should use it? What is the greatest obstacle for using it?
- Does the methodology take into account all the relevant factors related to developing technical life cycle strategy and making investment decisions (analysis and strategy development processes)? What issues would still be important from the viewpoint of the methodology's usability? What is your opinion of the methodology?
- What form would be best from the viewpoint of taking the methodology into use? What would a better-working tool look like?
- What kinds of qualifications would technical service providers or other TLC managers need in order to use the TLCM methodology?
- What kinds of added value would using the TLCM methodology offer owners?
- Could you imagine using this methodology yourself?
- Comments on the 2nd version of the methodology.

How can the TLCM -methodology itself, along with its usability in real estate owner organizations, be developed? (Training, instructions etc.)

According to the interviews, most real estate managers have an economic or juridical background, and even those with technical backgrounds only rarely have even basic understanding of questions related to technical life cycle management. Therefore, in every real estate organization, the following actions are needed:

1) Basic training related to the following subjects:
   - What is the technical life cycle of a real estate and what factors are related to it?
   - What are the means of affecting the technical life cycle of a building in different phases of its life cycle (in theory and in practice)?
   - What is technical life cycle management in practice: action model and process description. What does it cost to use the model? What are the benefits of using the model?

2) In using the TLCM -methodology, it is extremely important to analyze in an interactive way the following subjects related to common practices in real estate organizations, together with a technical consultant (expert):
   - the real estate strategy of the company
   - the ways of managing properties and their technical life cycles
   - the risks of the owned real estates

After performing these analyses, the organization will have the necessary basic data and hence the ability to make decisions related to the technical life cycles of their properties.

If the TLCM -methodology provides useful, then who do you expect to be its main users in the real estate organization? To become a strategic tool for real estate organizations, who *should* use it? What is the greatest obstacle for using it?

According to the interviews, the TLCM -methodology should be used by all decision-makers involved with life cycle decisions and real estate business strategies:

People working in strategic business planning in real estate companies or real estate departments in non-property companies, as well as those responsible for investment decisions, will get the greatest benefits from using the TLC management model.

"Especially this model should be used in traditional real estate companies."

Persons responsible for calculating investment for new construction projects

Project planning managers

Preliminary planning and planning managers

Construction work managers

Maintenance managers

Real estate managers

Technical advisors

The obstacle – problem - in taking the TLCM -methodology into use might be the unwillingness of real estate or corporate managers to discuss their strategies and strategic planning with service providers, partly because they don't have long-term strategic plans, and partly because discussing these strategies has not been a common practice. In addition, as always, all change will be resisted, at least in the beginning. (JR3)

"Using the model requires a strong and confidential relationship between service providers and real estate owners." (JR3)

Does the TLCM -methodology take into account all the relevant factors related to developing technical life cycle strategy and making investment decisions (analysis and strategy development processes)? What issues would still be important from the viewpoint of the model's usability? What is your opinion of the methodology?

According to the interviews and discussions between service providers and real estate owners, there are some major benefits of using the TLCM -methodology (strengths):

- Cash flow management related to technical investments and risk management is made possible by using the TLCM -methodology. It is possible to anticipate future costs: financing arrangements and budgeting become easier.
- The methodology makes it possible to minimize technical risks and anticipate future actions. Owners have a realistic understanding of their properties and their technical value.
- Potential usage alternatives are easier to evaluate. Using the methodology facilitates future planning.
- It is possible to avoid misinvestments in purchasing real estate, or in making technical life cycle investments in an existing property. Technical risks and technical potential can be analyzed.
- It is possible to set priorities for technical life cycle investments and maintenance actions and analyze the effects of different technical decisions on the characteristics of the building and on future costs.
- Using the methodology facilitates the making of assignments in investment analysis and technical condition analysis.
- Monetary savings can be achieved when the analysis and strategy development processes become faster and more real estate specific.

- Using the methodology helps service providers specify the quality and extent of analysis, thus developing technical life cycle strategies for real estate according to the owner's objectives. Services can be designed and implemented according to actual requirements and needs.
- Technical risks, possibilities and costs due to a building's technical characteristics can be identified. It is possible to evaluate a building's technical potential, and connect this with real estate business planning.
- The importance of technical life cycle management increases as buildings get older, and as the need for flexibility increases. Predicting the future is difficult, and working life is changing fast. It should be possible to modify buildings to keep pace with the changing needs of users, and the model facilitates this.
- This interactive process facilitates the owner's decision-making. The process reveals a building's technical value, so managing the cognitive risks is easier and more cost-effective than in a situation where the risks are not known.
- The checklists contain many points facilitating the setting of objectives specifically for a given property, and hence decision-making about that property in the analysis phase.

In addition the following comments about the TLCM -methodology were made:

"My opinion is that in the model all the important points of view and all the important aspects are taken into account – the model seems to be useful and the issues related to the technical life cycle of buildings are investigated from many useful points of views. The analysis is useful and important, because it is very true that even if the business ideas and the role of a real estate for the owner company were clear, the owner's objectives for individual real estates vary, and therefore specifying the critical needs in the analysis phase is very important. In this way, the critical characteristics can be achieved and maintained, and the relationship between the characteristics and the life cycle costs can be analyzed." (JR1)

The structure of the process (analysis and strategy development) seemed to be logical and sensible. The analysis is needed in developing a technical life cycle strategy as well as in a situation when investments are considered. By analyzing the technical potential of a real estate, the objectives and requirements for cost-effective ownership can be defined and specified. The specified objectives makes it easier both to purchase and provide services. Also the interactivity of the TLCM -methodology was considered a very sensible and useful feature.

The general opinion was that the TLCM -methodology includes all the important aspects and points of view. It was considered a logical and useful tool for creating and connecting technical life cycle strategies to other business strategies in real estate owner organizations. The best thing about the methodology was said to be its comprehensive approach, instead of considering single factors related only to technical things. This feature makes it possible to make cost-effective decisions related to the whole real estate business. Technical aspects cannot be cut out of business strategies… Doing financial analysis without technical analysis is not possible, because technical decisions are eventually also financial ones and the effects due to technical decisions are extensive.

"Using this model creates a new culture for the real estate business in which it is possible to develop technical strategies according to the facts based on the objectives of the business." (JR6)

There are also some weaknesses related to the structure or usability of the TLCM -methodology:

- The model forces service providers to understand the real estate business better.
- TLC service providers must increase their technical know-how.

- Service providers must become more proficient at life cycle costing.
- Service provider companies can increase their technical know-how by effectively co-operating with researchers in the areas of building physics and material technology. Implementing research knowledge in practice should be more effective.
- All parties should change their attitudes and ways of action.

The following comments and suggestions for improvement were given:

"Testing the model in cases will show which features should be developed or specified." (JR2)

"In addition, the model should include a list of tasks for service providers and real estate managers for each phase, so it would be easier to analyze when adequate information has already been collected or when further information is needed." (JR2)

"Also, needed background information on an old building under a consideration could be listed somewhere." (JR2)

"The central questions which must be answered in the different phases of analysis and strategy definition could be clearly shown some place. Otherwise, the process is clear and good." (JR2)

"Sometimes it is important that users are closely involved in the maintenance strategy definition phase, particularly in cases where responsibility for the technical life cycle management between user and owner is specified and divided in contracts." (JR2)

Using the TLCM -methodology requires very wide and interdisciplinary knowledge. Both real estate owner and service providers must according to the discussions develop their know-how and understanding. Neither real estate owners nor service providers are able to use the model without training. (JR4), (JR5)

Some general suggestions were given:

- "The connections between using checklists and process descriptions should be shown somewhere." (JR2)

- "A description of how results should be reported would facilitate taking the methodology into use." (JR2)

- "The user of the building is interested in the potential added value that can be achieved." (JR2)

- "… It could still be a little more simplified… and the concepts should be translated into understandable language." (JR3)

What form would be the best from the viewpoint of taking the methodology into use? What would a better-working tool look like?

According to the discussions the TLCM -methodology (analysis and strategy development processes) is a clear and logical description of interaction between a real estate owner and technical service provider – it is not just a separate (single) tool. It is a method. (JR4)

After testing the model in pilot cases, training in using the model should be arranged in owner and consultant organizations. Without this kind of training it is difficult to implement using the model in practice. (JR4), (JR5), (JR2). The final form of the tool could also be a cd-rom or a net-tool. Also, a paper handbook of the model and checklists is needed, as this is practical. In addition, both theoretical and practical training is needed. (JR4), (JR6) The dscription should be "as simple as possible so that it could be a useful tool." (JR1)

The TLCM -methodology is and should just be a description of the interactive process. After this project, users can develop it for their own organizations. It would be good if the technical life cycle manger could do the following:

Simulations between the effects of different decisions: effects on life cycles, life cycle cost etc.

The current information should be available to all participants: real estate owners, facilities manager, maintenance staff etc. (JR4), (JR5)

A final printed version could be a handbook (paper version) with instructions, process description and checklists; also a cd-rom version could be useful. (JR6)

What kinds of qualifications would technical service providers or other TLC managers need in order to use the TLCM -methodology?

"Real estate owners and technical life cycle managers should work co-operatively, because the TLC-manager is one of those who creates and implements the owner's strategies in practice. In practice, the technical life cycle manager should be an encouraging advisor who participates in strategic planning and decision-making processes together with the real estate owner." (JR4)

"Qualifications of TLC-service providers… they must understand the strategic core business needs of real estate owners, the technical factors affecting the technical life cycle and quality characteristics of a building, and the cost effects due to different technical life cycle decisions." (JR4)

What kind of added value would using of the TLCM -methodology offer owners?

The general expectation regarding the added value of using the TLCM -methodology in the real estate business was related to improving efficiency and cost-effectiveness. The interviewees also expected that using the model would be very beneficial for service providers. The following comments were given:

- By using this tool, it will be possible to make important decisions related to technical life cycle management and to manage the life cycle of an individual real estate or the whole building stock. (JR1), (JR4), (JR6)

- The methodology offers a wide and interdisciplinary description of a way of action in the strategic planning of the technical life cycles of buildings. As an added value, by planning and implementing technical life cycles of the buildings according to the model, the quality of technical characteristics and technical life cycle management will improve and the life cycle costs will decrease. (JR3), (JR6)

- The TLCM methodology helps service providers develop services and service packages according to the objectives of real estate owners, and focus and optimize their services and actions. It makes it possible to provide services according to the actual needs. (JR4), (JR5)

- "By using this methodology the owner is able to anticipate, program and budget necessary future actions better in the chosen life cycle period." (JR1)

- "By using this TLCM -methodology (process: analysis and strategy development), technical risks can be minimized and risk management can be developed." (JR6)

- "The first and second phases of the model are particularly important. In these phases, the risks and possibilities, as well as the building's potential from the viewpoint of expected usage and ownership, can be addressed. When the relationship between objectives and risks is identified, decisions related to risk management can be made. The owner's objectives and cost-effective ownership are always above other things." (JR1)

- "This makes it possible to logically define strategies." (JR3)

- “I think the benefits of using this model will be cost savings, time savings, as well as the ability to define projects more precisely. Using the model would also help direct actions according to objectives and actual need.” (JR1)

-According to the interviews the constructed TLCM methodology makes it possible to develop strategies according to the principles of life cycle theories, which is important. The managing of ecological, cost-effective, and durable buildings is possible.

Could you imagine using this TLCM -methodology yourself?

“Yes, I can. Both parties, real estate owners and service providers, would benefit from using it.” (JR1)

“As a real estate owner, I will use the construct.” (JR6)

“As a service provider, I will use the methodology and develop partnership relations with customers based on the TLCM -methodology. If I were a real estate owner, I am sure I would use this.” (JR4)

“I believe I would use the methodology. Testing it in real life cases will give valuable information about its usability, thus helping to develop and improve it.” (JR2)

Everybody who was interviewed wanted to test the TLCM -methodology.

Summary of testing version 2 of the TLCM methodology

The following comments and ideas for improvement were given:

- The TLCM -methodology could include a list of tasks for service providers and real estate managers for each phase, so it would be easier to analyze when adequate information has already been collected and when further information is needed.
- The necessary background information for each case could be listed somewhere.
- The central questions that must be answered in different phases of an analysis, including the strategy definition phase, could be clearly shown someplace.
- Users should be more closely involved in the maintenance strategy definition phase.
- Training before each case should be arranged.
- The connections between the checklists and process descriptions should be shown somewhere.
- The description of how results are reported should be improved.
- The user of the building is interested in the potential added value that could be achieved.
- The model should be simplified and the concepts translated into understandable language.

A summary of the strengths and weaknesses of the TLCM -methodology, areas requiring improvement, and possible benefits of use are listed in table A3.2.

Table A3.2 Strengths, weaknesses and necessary improvements of the construct. Benefits from using it.

Strengths	**Weaknesses**
- The structure of the process (analysis and strategy development) seems to be logical and sensible. - By analyzing the technical potential of a real estate, the objectives and requirements for cost-effective ownership can be defined and specified. - The specified objectives makes it easier to both purchase and provide services - The interactive process facilitates decision-making - The checklists contain lots of items facilitating the decision-making of real estate owners and service providers - Using the methodology creates a new culture for the real estate business in which it is possible to develop technical strategies according to the facts, based on the objectives of the business - By using the methodology the technical risks can be minimized; risk management can be developed. - The first and second phases of the methodology are particularly important, as they facilitate assessment of a building's risks and possibilities, as well as its potential for expected usage and ownership. - This methodology is a tool with which it will be possible to make important decisions related to TLCM. - The life cycle of an individual real estate or the whole building stock can be managed with this. - The methodology offers a wide and interdisciplinary description of a way of action in technical life cycle strategic planning - Using the methodology, it is possible to manage ecological, cost-effective, and durable buildings.	The TLCM -methodology requires service providers to better understand the real estate business. – Difficult TLC service providers must increase their technical know-how. The usage of the methodology requires know how on life cycle costing. Service provider companies can increase their technical know-how by effectively co-operating with researchers in the areas of building physics and material technology. Implementing research knowledge in practice should be more effective. All parties should change their attitudes and ways of action. TLC service providers must understand the strategic core business of the real estate owners, the technical factors affecting the technical life cycle and quality characteristics of a building, and the cost effects due to different technical life cycle decisions.
Benefits	**Necessary improvements**
- Facilitates cash flow management related to technical investments and risk management - Makes it possible to minimize technical risks and anticipate future actions. - Facilitates future planning. - Makes it possible to avoid misinvestments - Makes it possible to set priorities for technical life cycle investments and maintenance actions, and analyze the effects of different technical decisions on the characteristics of the building and on future costs. - Makes it easier to make assignments in investment analysis and technical condition analysis. - Saves money, since the analyzing and strategy processes become faster and more real estate specific. - Helps service providers specify the quality and extent of analysis, thus developing technical life cycle strategies for real estate according to the owner's objectives. Services can be designed and implemented according to actual requirements and needs. - Helps in identifying technical risks, possibilities and costs due to a building's technical properties,	The methodology should include a list of tasks for service providers and real estate managers for each phase, so it would be easier to analyze when adequate information has already been gathered or when further information is needed. The necessary background information on old buildings in the current case could be listed somewhere. The central questions that must be answered in different phases of an analysis, including the strategy definition phase, could be clearly shown someplace. Sometimes it is important that users are closely involved in the maintenance strategy definition phase. The use of the methodology requires very wide and interdisciplinary knowledge. Both real estate owners and service providers must develop their know-how and understanding. Neither real estate owners nor service providers are able to use the methodology without training. The connections between the checklists and process descriptions should be shown somewhere. The description of how results are reported should be improved. The methodology could still be a little more simplified… and the concepts should be translated

thus making it possible to evaluate a building's technical potential. - The importance of technical life cycle management will be increased in the future - Decreases life cycle costs.	into understandable language.

Appendix 4: Case studies and expert interviews 4 p.

In table A4.1 and table A4.2 the cases and interviewees in cases are presented. Also the methods for data collecting in cases are presented.

In tables A4.1 and A4.2:

Cases: A, B, C, D, and (F+), F+= multiple similar cases
R1, R2, R3...= Real estate owner organizations, /1, /2 –number refers to participant
P1, P2, P3...= different service provider organizations, /1, /2 –number refers to participant
I = interviews done
Q = questionnaires used
N = notes written during the interviews
R = interviews tape recorded
O = observations used and notes written during the case
D = documentation used in case

In table A4.3 the expert interviews are presented

In the table A4.3:

E = Expert interview
1, 2, 3, = code number on interviewee
C = Consultant
R = Real estate owner
P = Other professional within real estate sector

Table A4.1 The first case group**.**

Nr	Interviewee and case	The role of the interviewee in company	Phases of person being involved	Date of interview / other used data collection methods during the case/ interview dates	Collection of information:
1. Case turn: Real estate owners are involved in project					
	CASE A		April-October 2002	Documents and observations	
1	AR11	Real estate manager	1-24	I and Q / 9.10.2002	N, R and Q
2	AR12	HVAC –manager	1-24	I and Q / 9.10.2002	N, R and Q
3	AR13	Real estate manager	1-24	I and Q/ 9.10.2002	N, R and Q
4	AR14	Project Manager	1-24	I and Q/ 8.10.2002	N, R and Q
5	AP11	Director	1-24	I and Q / 10.10.2002	N, R and Q
6	AP12	Specialist (TLC manager)	1-24	I and Q/ 10.10.2002	N, R and Q
7	AP21 *) E6C3	Consultant	1-5	-	-
8	AP13	Consultant	1-24	I and Q/ 10.10.2002	N, R and Q
9	AP14 *) E4C1	Consultant	12-24	I and Q / 14.4.2003	N, R
10	AP41**)	Manager	7-13	Discussion/ 10.9.2002	Notes
11	AP42**)	Architect	7-13	Discussion / 10.9.2002	Notes
12	AP51**)	HVAC-specialist	7-13	Telephone discussion / 22.8.2002	-
	Interviewed 7/12				
	Case B		January – April 2003	Documents and partial observations	
13	BR31	Manager (TLC)	1-24	I and Q / 16.6.2003	N, R and Q
14	BR32	Real estate manager	1-24	I and Q / 16.6.2003	N, R and Q
15	BP61 *) E5C2	Project manager Consultant (FM)	1-13	Expert interview and Q / 5.5.2003	N, R and Q
16	BP15	Specialist	1-24	I and Q /16.6.2003	N, R and Q
17	BP23**)	HVAC-specialist	1-24	Discussion	-
	Interviewed 3/5				
17	2 cases 10 interviews 3 Expert interviews 4 Discussions				

*) Interviewed in expert interviews
**) Discussion, no interview

Table A4.2. Second case group

Nr	Interviewee and case	The role of the interviewee in company	Phases of person being involved	Date of interview / other used data collection methods during the case/ interview dates	Collection of information:
2. Case turn: Real estate owners are not involved in project					
	Case C		May-August 2002	Documentation and Observation	
1	CDR21	Real estate Manager	1-23	I and Q / 7.11.2002	N, R and Q
2	CDR22	Real estate Director	1	-	
3	CDP18	Director	1-5	Discussion	
4	CDP16	Specialist in construction technology/ consultant	4-12	I and Q / 8.10.2002	N, R and Q
5	CDP22	Specialist in HVAC-technology/ consultant	4-12	I and Q / 10.10.2002	N, R and Q
6	CDP31	Director	1-23	I and Q / 6.11.2002	N, R and Q
7	CDP32	Manager (TLC manager)	4-23	I and Q / 28.11.2002	N, R and Q
8	CDP33 **)	Worker	5-23	Discussion	-
	Interviewed 5/8				
	Case D		May - October 2002	Documentation and Observation	
9	CDR21	Real estate manager	1-23	I and Q /7.11.2002	N, R and Q
10	CDR22	Manager	1	-	-
11	CDP18	Manager	1-5	Discussion	-
12	CDP16	Specialist in construction technology/ consultant	1-12	I and Q / 8.10.2002	N, R and Q
13	CDP22	Specialist in HVAC-technology/ consultant	1-12	I and Q / 10.10.2002	N, R and Q
14	CDP31	Director	1-23	I and Q / 6.11.2002	N, R and Q
15	CDP32	Manager (TLC manager)	1-23	I and Q / 28.11.2002	N, R and Q
16	CDP33**)	Worker	5-23	Discussion	-
	Interviewed 5/8				
	Case F (-F+) Multiple cases		10/2002-4/2003		
17	FP17	Director (TLC manager)		I and Q /16.4.2003	N, R and Q
	3+ cases 6 (11) interviews				

**) Discussion, not interviewed

Table A4.3. Experts commenting the construct

INFORMANT CODE	FIELD OF REAL ESTATE BUSINESS	ROLE IN COMPANY	INTERVIEW DATE
E1C1	Consultant Construction industry	Director of planning	5.5.2003
E2C1	Consultant Construction industry	Director	16.6.2003
E3C1	Consultant Construction industry	Expert	14.4.2003
E4C1	Consultant Construction industry	Expert	5.5.2003
E5C2	Consultanat Designer (interior), (FM)	Expert	14.4.2003
E6C3	Consultant HVAC	Expert	14.4.2003
E7R1	Real estate owner	Area Director	7.5.2003
E8R2	Real estate owner	Director, R&D	8.5.2003
E9R3	Real estate owner	Real estate asset manager	15.4.2003
E10R4	Real estate owner	Real estate asset manager	15.4.2003
E11R5	Real estate owner	Managing director	9.5.2003
E12R6	Real estate owner	Director, Real Estate Investments	8.5.2003
E13R7	Real estate owner	Real Estate Director	6.5. 2003
E14E1	Expert/ public sector	R&D manager	7.5.2003
E15E2	Expert/ public sector	Managing director	8.5.2003
Altogether 14 interviews and 1 discussion			

Appendix 5: Questionnaire 1 in case study interviews

Background information on interviewed person

1. Name:

2. Company:

3. Education:

4. Role in company:

5. Experience in real estate sector and experience related to technical life cycle management of real estates (years):

Amount of use of the phases of the TLCM methodology

What phases were used and how intensively they were used in the case project?
Choose the alternative that best describes your experience of using the TLCM methodology.
Alternative 1 represent: The phase of the construct is not used at all
Alternative 6 represent: The phase was used intensively.

Questionnaire 1a

The phase of the construct and amount of use of it	**1**	**2**	**3**	**4**	**5**	**6**
1. Business idea: Vision, mission and goals of the company						
2. Real estate specific goals of the owner + gathering of background information						
3. Users requirements for technical characteristics of the real estate due to business needs of user						
4. Technical risk analysis						
5. Technical risks, acceptable risk level and costs due to risks and risk management						
6. Selection of acceptable risk level and relationship between risk and income /benefits						
7. Technical life cycle and quality expectations						
8. User's expectations for quality of the building						
9. Technical potential of a real estate for achieving quality and life cycle expectations						
10. Limitations for maintenance due to usage or user						
11 The alternative maintenance possibilities and their cost effects						
12 Evaluation of the results of the technical analysis.						
14. Input for strategy developing						
15. Needed technical life cycle actions.						
16. Choosing of the general principals for strategy development						
17. Technical solutions and alternative measures and actions						
18. Definition of the optimization criteria by the owner if still needed						
19. Optimization and specification of the alternatives presented in phase 17						
20. Acceptance of the proposed program or new iteration						

Usefulness of the usage of the phases of the TLCM methodology

How useful did you perceived the usage of the different phases of the methodology? Benefits of using the individual phases of the methodology, in analyses of a real estate and strategy development modules.
If you perceived the amount of use low, then how useful the phase would have been if it was used? If the phase was used, there is no need to answer the last question.

Choose the alternative that best describes your experience of using the TLCM methodology.
Alternative 1 represent: The phase of the construct was not useful at all: "no benefits at all".
Alternative 6 represent: The phase was extremely useful: "significant benefits".

Questionnaire 1b

The usefulness of the different phases of the TLCM methodology	**1**	**2**	**3**	**4**	**5**	**6**
1. Business idea: Vision, mission and goals of the company						
- If the phase was not used, then how useful it would have been if it was used?						
2. Real estate specific goals of the owner + gathering of background information						
- If the phase was not used, then how useful it would have been if it was used?						
3. Users requirements for technical characteristics of the real estate due to business needs of user						
- If the phase was not used, then how useful it would have been if it was used?						
4. Technical risk analysis						
- If the phase was not used, then how useful it would have been if it was used?						
5. Technical risks, acceptable risk level and costs due to risks and risk management						
- If the phase was not used, then how useful it would have been if it was used?						
6. Selection of acceptable risk level and relationship between risk and income /benefits						
- If the phase was not used, then how useful it would have been if it was used?						
7. Technical life cycle and quality expectations						
- If the phase was not used, then how useful it would have been if it was used?						
8. User's expectations for quality of the building						
- If the phase was not used, then how useful it would have been if it was used?						
9. Technical potential of a real estate for achieving quality and life cycle expectations						
- If the phase was not used, then how useful it would have been if it was used?						
10. Limitations for maintenance due to usage or user						
- If the phase was not used, then how useful it would have been if it was used?						

11. The alternative maintenance possibilities and their cost effects						
- If the phase was not used, then how useful it would have been if it was used?						
12. Evaluation of the results of the technical analysis.						
- If the phase was not used, then how useful it would have been if it was used?						
14. Input for strategy developing						
- If the phase was not used, then how useful it would have been if it was used?						
15. Needed technical life cycle actions.						
- If the phase was not used, then how useful it would have been if it was used?						
16. Choosing of the general principals for strategy development						
- If the phase was not used, then how useful it would have been if it was used?						
17. Technical solutions and alternative measures and actions						
- If the phase was not used, then how useful it would have been if it was used?						
18. Definition of the optimization criteria by the owner if still needed						
- If the phase was not used, then how useful it would have been if it was used?						
19. Optimization and specification of the alternatives presented in phase 17						
- If the phase was not used, then how useful it would have been if it was used?						
20. Acceptance of the proposed program or new iteration						
- If the phase was not used, then how useful it would have been if it was used?						

Appendix 6: Questionnaire 2a in case studies and in expert interviews

Background information on interviewed person

1. Name:

2. Company:

3. Education:

4. Role in company:

5. Experience in real estate sector and experience related to technical life cycle management of real estates (years):

The usability and usefulness of the TLCM methodology

1 = Not at all: no benefits of not useful
2 = Only a little benefits, a little useful
3 = Some benefits and somewhat useful
4 = Quite a lot benefits and quite useful
5 = Significant benefits and very useful

Usefulness and usability of the construct in the projects in which the user used the construct	**1**	**2**	**3**	**4**	**5**
How useful the TLCM methodology was in making decisions related to technical life cycle of a building?					
Benefits for the owner					
Benefits for the user					
Benefits for the service provider					
Dos the construct facilitate the purchasing of technical life cycle services					
Do you think it is possible to improve the cost effectiveness of decision making related to technical decisions by using the analyzing phase?					
Do you think that the developing of technical life cycle strategy according to this model does facilitate the cost effective management of real estates?					
Does the use of the construct facilitate the risk management?					
Could you image of using the methodology in the future?					
Was it easy to use the methodology? *)					
Were the check lists useful? *)					

Was there something essential missing from the TLCM methodology?

Were there some unuseful issues within the TLCM methodology?

*) Not included in questionnaires of Experts.

Questionnaire 2b: Novelty, generality and general usefulness of the TLCM methodology

Have you seen or used any other similar methodology before? Is there another methodology for TLCM available in the market? Yes/no

If there is, which methodology it is and where is it available?

If you have used a similar or other kind of methodology for TLCM before, then how was its content and usability compared to TLCM methodology?

Statements:

1 = I totally disagree
2 = I somewhat disagree
3 = No opinion
4 = I agree
5 = I fully agree

Statement / Grade	1	2	3	4	5
That kind of methodology is needed.					
The idea of the TLCM methodology and its content differs from previous methods for doing the same thing.					
The use of the methodology would provide new knowledge in developing TLC strategy and analyzing a real estate from the technical point of view as a part of overall real estate strategies.					
It would be useful for real estate owner to use the methodology.					
Using of the methodology facilitates the purchasing of technical services.					
Using of the methodology facilitates the objective setting of real estate owners.					

Appendix 7: Questions in case study interviews

The interviews are available from the author.

Interviewee
Question
1) Was the TLCM methodology used in case project?
2) Was the methodology used systematically according to process description?
3) Were the check-lists used during the project?
4) Did the participants of the case project follow the logic of the TLCM methodology (phases, task descriptions and related parts of the checklists)?
5) Were both the analysis and strategy development module included in the case project?
6) Was there anything preventing the usage of the methodology during the project?
7) If there was something that prevented usage of the TLCM methodology during the project, how would usage be facilitated?
8) How did you genarally feel about using the TLCM methodology?
9) Are you going to use the TLCM methodology in the future?
10) Was the presentation of the TLCM methodology and training at the beginning of the project adequate?
11) Is the idea of the constructed model logical and understandable (systematic process in which the requirements, risks, limitations, expectations and possibilities are considered)?
12) Was the structure of the TLCM methodology usable?
13) Were the task descriptions and the descriptions of needed input from different participants in different phases described in adequate level?
14) Was the idea and objective of analyzing technical potential in order to develop the technical life cycle strategy clear to you after the presentation?
15) How does the interactivity of the TLCM methodology affect decision-making and information?”
16) How useful was the analyses module in the TLCM methodology related to the planning of purchasing, making contracts and focusing the purchasing of technical services? Was it useful?
17) How useful the check lists were during the project? Were they useful?
18) Ihow do you perceive the logic of the check lists, were they good?
19) Did they include adequately information?
20) What is your opinion about the content of the TLCM methodology?
21) How could the methodology be improved? What changes would you make? What would a better working methodology be like?
22) Have you developed a technical life cycle strategy before in which the technical objectives and actions are determined according to real estate business goals?
23) Does the methodology and resulting technical life cycle strategy facilitate the development of total real estate strategies, and also vice versa?
24) Is a construction like the TLCM methodology needed on the market? Opinion?
25) What are the strengths of the constructed model?
26) What are the weaknesses of the constructed model?
27-31) Does and if it does, then how the using of constructed model effect the following issues: Making commissions with technical service providers? Decision making related to technical issues? The quality of technical life cycle management? Cost effectiveness of technical life cycle management? Managing of technical risks?
32-33) Do you perceive the analyzing of technical characteristics and technical condition of a real

estate as an important thing to real estate owner? Or user?
34) Do you think that using this methodology facilitates development of a technical life cycle strategy for a real estate?
35) Is the methodology practicable and usable?
36) How does the model differ from previous ways of managing the technical life cycles of buildings?
37) Have you used a similar methodology or any other model for creating technical life cycle strategy before?
38) Did using the TLCM methodology shape the project (cases) somehow?
39) Do you think that it would be generally useful from the viewpoint of real estate business to use the constructed methodology?
40) Is this TLCM methodology usable and useful in the following situations: in investment analysis, in cases were the technical potential of a building is evaluated in real estate development situations, in cases where technical life cycle strategies are developed for owned existing buildings for a chosen life cycle period?

Appendix 8: Questions in Expert interviews

The questions in expert interviews were as follows:

Q (10): Was the presentation of the TLCM methodology in the beginning of this meeting adequate?

Q (11): Is the idea of the TLCM methodology logical and understandable (systematic process in which the requirements, risks, limitations, expectations and possibilities are considered)?

Q (12): Is the structure of the TLCM methodology usable?

Q (13): Are the task descriptions and descriptions of the needed input from different participants in different phases described adequately?

Q (14): Was the idea and objective of analyzing technical potential in order to develop the technical life cycle strategy clear to you after the presentation?

Q (15): How does the interactivity of the TLCM methodology affect decision-making and information?

Q (16): How useful is the analysis module in the TLCM methodology related to the planning of purchasing, making contracts and focusing the purchasing of technical services?

Q (17): How useful are the checklists?

Q (18-19): How do you perceive the logic of the checklists, are they good? Do they include adequate information?

Q (20): What is your opinion of the contents of the constructed methodology?

Q (21): How could the methodology be improved? What changes would you make? What would a better working methodology be like?

Q (22): Have you developed a technical life cycle strategy before in which the objectives and actions are determined by the business goals?

Q (23): Does the methodology and resulting technical life cycle strategy facilitate the development of total real estate strategies, and also vice versa?

Q (24): Is a construction like the TLCM methodology needed on the market?

Q (25): What are the strengths of the constructed model?

Q (26): What are the weaknesses of the constructed model?

Q (27-31): Does using the TLCM methodology affect the following issues? If so, how?

- Making commissions with technical service providers?
- Decision making related to technical issues?
- The quality of technical life cycle management?
- Cost effectiveness of technical life cycle management?
- Managing of technical risks?

Q (32-33): Do you think that analyzing the technical characteristics and technical condition of a real estate is important for owners and users?

Q (34): Do you think that using this methodology facilitates development of a technical life cycle strategy for a real estate?

Q (35): Is this methodology usable?

Q (36): How does the model differ from previous ways of managing the technical life cycles of buildings?

Q (37): Have you used a similar methodology or any other methodology for creating a technical life cycle strategy before?

Q (38): Did using the TLCM methodology shape the project (cases) somehow?

Q (39): Do you think that it would be generally useful from the viewpoint of real estate business to use the TLCM methodology?

Q (40): Is this TLCM methodology usable and useful in the following situations: in investment analysis, in cases were the technical potential of a building is evaluated in real estate development situations, in cases where technical life cycle strategies are developed for owned existing buildings for a chosen life cycle period?