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Preface

This workbook is the outcome of a research project entitled MittaMerkki ("towards risk-conscious investment decision-making and value creation, 2015–2016). The project aimed to advance companies' abilities to create value, providing decision models and tools by which to evaluate investments and assess uncertainty and risk. The overall objective was to enhance researchers' and practitioners' understanding of how activities related to investment and investment risk assessment converge, and how the wider value perspective could be successfully incorporated into investment decision-making.

The MittaMerkki project was conducted through an inter-disciplinary research consortium consisting of the VTT Technical Research Centre of Finland Ltd (VTT) and the University of Vaasa (UVA). VTT is a state-owned and controlled non-profit limited liability company, which carries out research and innovation activities to meet the needs of industry and knowledge-based society, with specific emphasis in this project on risk management, strategic decision-making processes, and evaluation techniques that support investment decisions. The University of Vaasa is a business-oriented and multi-disciplinary university, providing a wide range of courses spanning from business administration, technology studies, management sciences and communication studies. The Industrial Management unit is a multi-disciplinary research group that studies strategies, processes and practices within industrial value systems, networks and firms. This research group utilizes theories of strategic and operations management and focuses on three particular themes: inter-organizational networks and relationships, strategies and strategy processes, as well as industrial service business. This workbook is based on the contributions of researchers from both VTT and UVA.

The MittaMerkki project and this workbook would not have been possible without the financial support of several parties. The project has been funded by Tekes – The Finnish Funding Agency for Innovation, VTT, UVA and the MittaMerkki project's case companies – TVT Asunnot Ltd, Jyväskylän Energia Ltd, TEAK Ltd and Humming World Ltd. The authors wish to express their gratitude to all of the above.

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Authors

Contents

Terminology

AHP	Analytic hierarchy process. An approach to decision-making that involves structuring multiple-choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion, and determining an overall ranking of the alternatives. The AHP concept was developed by Saaty.
CFI	Critical factor index.
Competitive advantages	Defined by Porter and is based on generic strategies. Generic strategies are those that been created to improve companies and allow them to gain competitive advantages over their competitors. These generic strategies are: 1. overall cost readership, 2. differentiation and 3. segmentation.
Cost breakdown structure	A hierarchical structure which includes all cost items relevant to the current case, dividing larger cost items into smaller and more concrete cost parameters that are easier to assign a monetary value.
Decision-making process	The process of examining possibilities and options, comparing them, and choosing the best course of action.
Direct cost	A direct cost is a cost that can be clearly associated with specific activities or products.
Economic evaluation	The comparative analysis of alternative courses of action in terms of both their costs and consequences (monetary values) in order to assist decision-making.
Economic evaluation method	A monetary evaluation method. In MittaMerkki a method for evaluating the costs and profits of different investments over a given time span.

Economic impact	The additional value created by an investment project, measureable in economic terms.
Ecological impact	The impacts of investment project on the environment, nature and local surroundings.
GRI	The Global Reporting Initiative.
Indirect cost	Indirect costs are costs that are not directly associated with a single activity, event, or other cost object.
Intangible cost	Intangible costs are typically those for which no market value exists and for which there is no available systematic or agreed method for measurement. These costs comprise both direct and indirect intangible costs.
Investment	The creation of physical and intangible (human and intellectual capital) assets that are capable of producing products, services, processes, business models etc. This includes money and other resources committed or property acquired for future income and benefits.
Investment decision	A decision made by management, investors or other decision-makers with respect to the amount of resources and funds to be deployed in pursuit of an investment opportunity.
K/T Rankings	Knowledge and technology rankings are a required section of the sense and respond method, in which a company's share of technology is evaluated in terms of basic, core and spearhead technology.
Method	Methods are systematic and elected procedures by which to achieve previously defined targets.
RBV	The resource based view of the firm, introduced by Wernerfelt, supposes that the critical factors for success exist within the firm itself in terms of its resources and capabilities.
Risk	Defined as the combination of the probability (frequency) and consequences of a particular scenario.
Risk analysis	The process of risk identification and risk estimation. Risk analysis provides a basis for evaluating the tolerability of risks and determining necessary risk reduction/control measures.

Risk assessment	The process of risk identification, risk estimation and risk evaluation. Refers to the evaluation of the assessed risk by reference to the criteria and thresholds set by the decision-maker(s) in order to determine priority of treatment.
Risk-conscious decision-making	Managerial decision-making under conditions of risk and uncertainty, whereby companies systematically incorporate a risk perspective and risk evaluation into their decision-making process. Management are aware of the main risks of the decision in question.
Risk estimation	Refers to an assessment of the likelihood of occurrence and possible consequences of the risk events.
Risk management	Aims to protect the property, income and various activities of a company while aiming to keep overall costs as low as possible. Risk management is not only about identifying and assessing risks and selecting risk reduction measures, but also being able to respond quickly and effectively to realized threats as they arise.
Roadmap	A tool for mid- to long-term business planning, integrating various themes (e.g., technologies, products and markets). Typically a structured, visualized presentation of the present and target states of the company, and the steps through which the target state is to be reached.
Sand cone model	The sand cone model illustrates the studied object by illustrating its hierarchies as well as the relative importance of and relationships between its sub-objects. In the study presented by this workbook, the sand cone model is also used to illustrate levels of uncertainty.
Sense and respond (S&R)	The sense and respond concept assists decision makers by offering a picture of what may happen in the future. This strategy helps firms to collect data regarding their expectations and experience, and assists them in recognizing how they see themselves compared to their competitors. It also helps managers to react and make decision quickly.
Social impact	The effect of an investment project on the well-being of the community and society.

Social impact assessment (SIA)	A social impact assessment is the process of analysing (predicting, evaluating and reflecting) and managing the consequences, both intended and unintended, for the human environment of planned interventions (policies, programmes, plans, projects) and any social change processes invoked by those interventions so as to bring about a more sustainable and equitable biophysical and human environment.
Tangible cost	Refers to items that can have market value. Can be either direct or indirect.
T&K -uncertainty	The total amount of risk affected by technology and knowledge (T&K) in the department/sand cone. Describes how much, in general, the department "falls" under its competitive range when the T&K risk estimate is realized. (See equation 14).
Tool	Tools are utilities supporting the execution of methods at a detailed level
Uncertainty	A lack of certainty. A state of having limited knowledge, under which it is impossible to precisely describe the existing state or future outcomes. A state of which more than one possible outcome is foreseeable.
Value	The monetary, material or assessed worth of an investment in assets, products, services or business and operating models.
Variability coefficient (VarC)	In this research, a measure of knowledge- and technology-based uncertainty calculated on the basis of weights assigned to basic, core and spearhead technologies.

1. Introduction

1.1 What is it all about?

Increasing competition and changing business environment force companies, organizations and authorities to look for new products, services and collaboration possibilities. Companies' and their value networks' abilities to make long-term decisions on both tangible and intangible investments, as well as to take and manage risk, are key to ensuring systematic progress and solid foundations for profitable business ventures. To guarantee long-term success, it is essential to select the best available investment plan. Well-planned investment process and implementation of investment decisions can ensure a company's ability to deliver sustainable value for its stakeholders.

In an uncertain economic environment companies aim to secure their financial position and investments are kept to a minimum. In addition, all investments are evaluated more critically than they are during periods of intense economic activity. Companies should, however, continue their strategic development during low-demand periods. This includes investments in potential growth areas, measures for improving competitiveness, research and development activities, development of products and services, and business model revisions (Eloranta 2012). New investment opportunities external to traditional operating models and their interfaces should be explored.

As investment decisions are among the most important decisions made by companies, decision-makers need to understand the factors that affect their decision-making process and may prevent sound investment decisions. The transition in value creation, furthermore, is forcing companies to seek new models and means of operating and supporting their business and investments. Additionally, the need to integrate wider value perspectives into decision-making is increasing. Investments should be evaluated, selected and prioritized not only in terms of their monetary value, but also with regard to sustainability, safety, quality, social acceptability and other typically intangible criteria (Räikkönen et al. 2015).

The wider value perspective has rarely been included in such assessments up to the present day. This is mainly because these value elements are typically difficult to measure solely in economic terms, and there is thus a lack of models and approaches by which to address the importance of such indirect and intangible effects. In addition, there is often pressure to demonstrate short-term effects rather than to emphasize the investment's entire life cycle.

1.2 How does this workbook support investment decision-making?

This workbook is based on the results of MittaMerkki, a research project partly funded by Tekes – the Finnish Funding Agency for Innovation under the "New Value Creation" call. The project was carried out in close cooperation between two research organizations – the VTT Technical Research Centre of Finland Ltd (VTT) and the University of Vaasa (UVA) – and four private companies from various sectors of industry and service business in Finland – TVT Asunnot Ltd, Jyväskylän Energia Ltd, TEAK Ltd and Humming World Ltd.

The purpose of this workbook is to support companies in their aim to make successful and risk-conscious investment decisions and to incorporate the wider value perspective into their investment decision-making. From this perspective it will enhance companies' abilities to plan investment process, to assess investments and to support the related decision-making in a systematic manner. The procedures described are not tied to any specific branch of industry. However, the subject matter concerns, in the first place, companies that aim to generate social and environmental impact alongside financial return to investments. The workbook is aimed at all managers and staff involved in investment planning and decision-making, strategy and business development. Figure 1 below and the following paragraph are offered to guide the reader through the workbook and explain its structure.

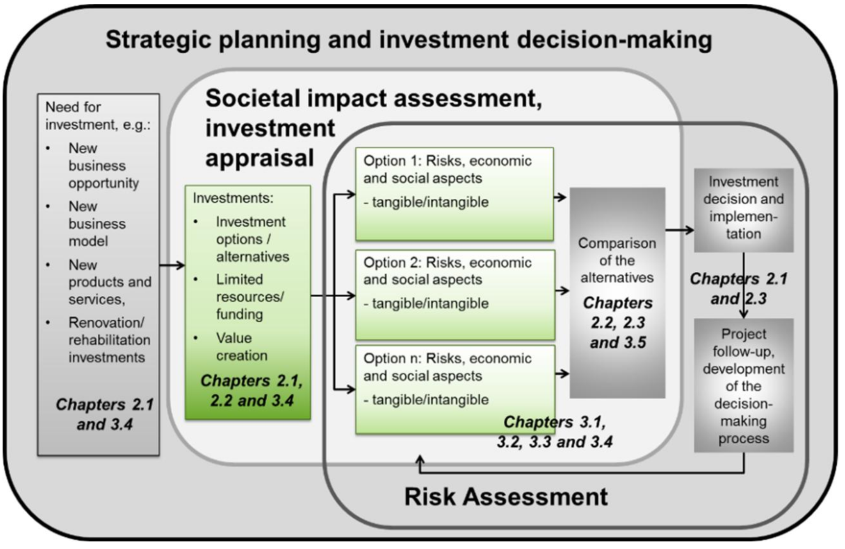

Figure 1. The structure of the workbook.

The workbook is divided into four main chapters, of which Chapter 3 is the most substantial. Chapter 1 offers an introduction, while Chapter 2 lays the groundwork for the phenomenon under scrutiny – investment and risk assessment in the context of new value creation – outlining the topic and the focal concepts. Chapter 3 covers the process of investment impact assessment, from identification to evaluation of investments. It surveys in viewpoints related to strategic decision-making, risk assessment, multi-criteria decision making and risk-conscious assessment of economic, social and environmental impacts of investments. Moreover, Chapter 3 discusses research and analysis conducted in the case companies as part of the project. The studies published in this workbook are based on case studies from broad perspectives within knowledge intensive services. As such, it is possible to undercover a preliminary and working model for the combined investment appraisal, social impact assessment (SIA) and risk analysis as well as for technology and operations strategies preferred for the target markets. It is intended that answers to questions regarding acceptable risk levels in contexts of various turbulent challenges will be uncovered in the course of this analysis. Chapters 3.5 and 4 conclude the workbook, summarizing its findings and discussing its more general contributions and implications

2. Towards risk-conscious investment decision-making and value creation

2.1 Strategic decision-making under uncertainty

In a highly volatile economic environment involving systemic uncertainties companies need prompt responses and strategic flexibility. The task of evaluating the most beneficial course of action challenges high-level management and requires coherency between the main decision priorities and the finite resources of the company. Though faced with an increasing number of risk factors decision makers must nevertheless make choices between different long-term investment options. Such processes require strategic foresight, good understanding of risk assessment techniques and change management.

This workbook supports the management necessity of conducting a strategic priorities analysis based on analytic hierarchy process (AHP), risk factor analyses and several other evidence-based decision support tools. A robust and comprehensive method combining risk assessment, investment impact and tactical planning is a very effective instrument for understanding the quantitative implications of decision-making in contexts of uncertainty.

At the same time, many risk factors are subject to international and governmental policies that are not directly influenced by companies' decision-makers. Firms are focused on quarterly and annual indicators, and are thus far outside the scope of politics. Nevertheless, still synchronizing company strategy and political goals is vital for ensuring the longevity of the organization and return on investments. Later on in this workbook, a description and implementation guidance regarding suitable managerial tools by which to enhance the construction of companies' strategies is provided.

2.2 The new value creation perspective in investment decision-making

2.2.1 The concept of new value creation

At a fundamental level, creating value is the basis of all business and is critical to all firms. Each company has several processes and activities (Grönroos & Voima 2012, Voima et al. 2010, Bowman & Ambrosini 2007, Wynstra et al. 2006) through which they create value for shareholders, customers and other stakeholders in many different ways (Khalifa 2004). The complex nature of value creation becomes clear when one asks where, when, how and by whom this value is created (Voima et al. 2010). In Figure 2, the value concept adopted in the MittaMerkki -project is presented. It considers investment decision-making from the perspective of various stakeholders, and links together the diverging value provided to the company itself, wider society, other organizations and citizens.

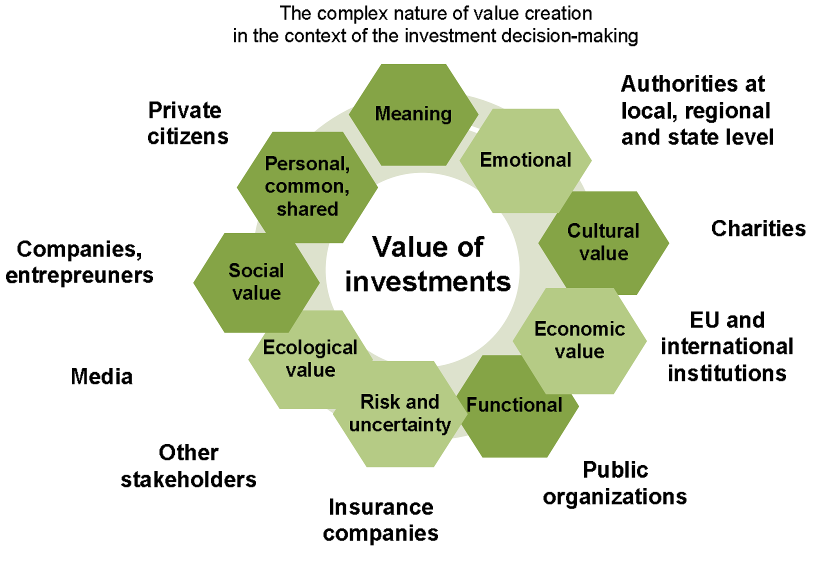

Figure 2. The wider value creation perspective in the context of investment decision-making, as applied in this research.

This complexity emphasizes that the concept of value creation is different from different perspectives and for different stakeholders. (Heinonen et al. 2010, Voima et al. 2010). While the traditional perspective emphasizes only the company's role in value creation and in investment decision-making, the new perspective considers customers and other stakeholders to also be important players (Meyer & Schwager 2007).

2.2.2 Economic profitability

Economic value is one of many possible ways in which to define and measure value. The term "profitability" is often used in this context and indicates the achievement of positive (or high) economic returns on investments. Profitability can be defined in two ways (Götze et al. 2008):

- *Absolute profitability* is achieved if the total cost of making an investment is lower than the total cost of rejecting it.
- *Relative profitability* is achieved if making an investment results in a total cost that is lower than that of alternative investment project(s) under consideration.

The definition of costs and profits lays the groundwork for the assessment/prediction of the economic profitability of an investment. In order to estimate the total costs and profits of an investment, or those for a defined portion of its life cycle, it is necessary to first divide the costs and profits into applicable cost and profit categories. All direct and indirect profits and costs, irrespective of whether or not they can be quantified and valued, should be identified. Broadly, there are two major cost and profit categories by which investments are to be evaluated: investment costs along with other initial costs, and future costs and profits. Initial costs and profits are all costs and profits incurred prior to implementation of the investment under consideration. Future costs and profits are those incurred after implementation of the investment. Typically, 80% of costs arise from 20% of cost categories and 80% of benefits arise from 20% of benefit categories. (Räikkönen et al. 2012.) Table 1 presents a high-level summary that illustrates the main cost and profit categories of investments.

Table 1. Example of the main cost and profit categories.

COSTS		
Acquisition costs / investment costs / capital costs • Concept and definition phase • Design and development phase • Non-recurring investment costs • Recurring investment costs	Direct sustaining costs • Operations costs • Maintenance costs • Disposal costs	Indirect sustaining costs • Indirect operations, maintenance and disposal costs • Social costs • Legal and regulatory costs • Political costs
PROFITS		
Direct economic profits	Social profits	Ecological profits

Each cost and profit item will have some value in the final evaluation of an investment. Such values should reflect the state of knowledge regarding rational possibilities in assigning monetary values. For example, if engineering estimates for costs and related benefits are available (via market prices) they can be used. Examples of different ways by which to estimate and valuate costs and profits include the following (Layer et al. 2002):

- *Analogous estimating, or top-down estimating,* means using the actual costs and profits of previous, similar investments as the basis for estimating the costs and profits of a current proposal, and can be seen as a form of expert judgement.
- *Bottom-up estimating* involves estimating the costs and profits of individual cost and profit items, before summarising or rolling-up the individual estimates to get a total.
- *Parametric modelling* can be described as the use of sets of formulae, generated via statistical methods, for top-down estimating. Such evaluation may be executed using regression analysis methods, optimization techniques or neural networks, for example.

In addition, there are a number of alternative methods for valuating such impacts (e.g., shadow prices, replacement cost method, production method, substitute or proxy method, change in earnings, hedonic pricing, travel cost method and willingness to pay) that are suitable for various specific purposes, and vary in terms of the accuracy with which they present the value of investment impacts. The chosen method should always reflect the decision situation at hand, the possibility of assigning monetary values for different costs and profits and data availability (Räikkönen et al. 2014). Moreover, semi-quantitative and qualitative approaches can be used for the estimation of intangible impacts. Typically, these methods can indicate whether a given alternative is better or worse than another, but they cannot specify a monetary value. These methods and estimation approaches are discussed in more detail in Chapters 3.2 and 3.4.

2.2.3 Social value

Porter and Kramer (2011) argue that companies continue to view value creation narrowly, concentrating on optimizing short-term financial returns and ignoring the most important customer needs and the broader factors that are key to long-term success. Most companies engage in activities related to social responsibility, but social issues are not at the core of their agenda as they should be. The solution to this state of affairs could be in the principle of shared value. The total value of investments should be created in such way that, in addition to economic value, investments are aimed also at creating value for society by addressing its needs and challenges. The authors define shared value as “policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates" (Porter & Kramer 2011).

Lately, there has been increasing interest and activity related to impact investments, which are "investments made into companies, organizations and funds with the intention of generating social and environmental impact alongside a financial return" (GIIN 2016). It is increasingly important to be able to measure and demonstrate the impact of these investments (Social Impact Investment Taskforce 2014). Consequently, decision-makers are under pressure to find new ways to increase awareness of the overall impact of investments. Currently, there are no comprehensive frameworks that effectively enable measuring and linking social progress to business success (Porter et al. 2012).

Social impacts can be conceptualized as changes to one or more of the following aspects of society (Vanclay 2003):

- people's way of life
- culture
- community
- political systems
- the environment
- people's health and wellbeing
- personal and property rights
- people's fears and aspirations.

The European Venture Philanthropy Association (EVPA) has developed a practical guide to measuring such investment impacts (EVPA 2013). The guide focuses on two levels: how to measure and manage the impact of specific investments and how to measure the extent to which the investing organization itself contributes to that impact. The guide presents a five-step process for social impact assessment. The steps are as follows:

1. Setting objectives: setting the scope of the impact assessment and identifying the desired social change.

2. Analysing stakeholders: ranking the potential stakeholders in order of priority, weighing their contributions to the completeness of the analysis, and analysing their inputs, activities and potential outputs.

3. Measuring results: measuring the output, outcome and impact that derive from the activities for the key stakeholders, and understanding how different types of indicators can be used to map the social results.

4. Verifying and valuating impact: verifying that the impact reports are not too subjective and whether it was valued by the key stakeholders. Considering quantitative and qualitative methods and comparing results against relevant benchmarks.

5. Monitoring and reporting: collecting data and devising a system for storing and managing data. Reporting the data to relevant stakeholders.

The Global Reporting Initiative (GRI) develops international standards on sustainability reporting. These standards represent global best practice on reporting economic, environmental and social impacts. In the latest version of the GRI standard series the following social impacts are covered: employment; labour/management relations; occupational health and safety; training and education; diversity and equal opportunities; non-discrimination; freedom of association and collective bargaining; child labour; forced or compulsory labour; security practices; rights of indigenous peoples; human rights assessment; local communities; supplier social assessment; public policy; customer health and safety; marketing and labelling; customer privacy; and socioeconomic compliance (GRI 2016).

2.2.4 Investment uncertainty and risk

Investment decisions reflect a company's visions, values and business objectives, as defined by the company itself and its stakeholders. However, the decision to invest requires careful consideration, as investment decisions are exposed to high level of internal and external uncertainty and risk. Treatments of risk and uncertainty in the literature (Funston & Ruprecht 2007, Fiegenbaum & Thomas 2004, Beasley et al. 2007, Emblemsvåg & Kjølstad 2002, Miller 1992, Collins & Ruefli 1992, Winfrey & Budd 1997) vary in their use of these terms. In everyday life, risk and uncertainty are often used interchangeable, but there are some basic differences.

In common use, the main distinction between the terms “risk” and “uncertainty” is that risk denotes a positive probability of something bad happening, while uncertainty does not necessarily imply a value judgment or ranking of the possible outcomes.

- **Risk.** Fundamentally, the word “risk” is very strongly associated with negative outcomes (i.e., threats and potential problems) and is defined as “exposure to the chance of injury or loss; a hazard or dangerous change”. The concept of risk as performance variance, by contrast, is widely used in finance, economics and strategic management. Under either the variance or negative variation understanding, "risk" refers to variation in corporate outcomes or performance that cannot be forecast ex ante (Miller 1992). However, Hillson (2002) defines risk as a concept of two varieties: “opportunity”, which is a risk of positive effects, and “threat”, which is risk of negative effects.
- **Uncertainty.** The term "uncertainty" as used in strategic management and organization theory refers to the unpredictability of environmental or organizational variables that impact corporate performance, or the inadequacy of information about these variables (Miller 1992). According to Emblemsvåg and Kjølstad (2002), uncertainty as a general noun is defined as “the state of being uncertain; doubt; hesitancy”. Thus, neither loss nor gain is necessarily associated with uncertainty; it is simply that which is not known with certainty. According to Klir and Yuan (1995), there are two main types of

uncertainty: fuzziness and ambiguity. Fuzziness occurs whenever definite, sharp, clear or crisp distinctions are lacking. Ambiguity results from unclear definitions of the various alternatives (or possible outcomes). These alternatives can either conflict with one another or be unspecified (Emblemsvåg & Kjølstad 2002, Klir & Yuan 1995).

Investment uncertainties and risks can result from factors both external and internal to the company. They can be further categorized into specific types of risks, such as business and strategic, or financial and operational (Taneja et al. 2008, Coso 2004, FERMA 2003). The returns on an investment can be uncertain due to technical and production-related factors, as well as to multiple market-related factors, such as the cost of raw materials, variable demand levels, or existing competing products (Kärri 2007). If uncertainties are not included in the evaluation process, a company may fail to make the right strategic choice, which may result in loss of market share and profits (Shil & Allada 2007).

When companies set out to incorporate risk and uncertainty considerations into their investment decision-making, a range of time horizons must also be accounted for. The degree of uncertainty grows dramatically the further one looks into the future. Moreover, as time horizons broaden, different perspective and actions are demanded from decision-makers (Funston & Ruprecht 2007). The importance of managing uncertainty and risk is especially clear in the case of new investments where time horizons for planning and decision-making can stretch to 10 or 20 years. (Beasley et al. 2007, Funston & Ruprecht 2007, Fiegenbaum & Thomas 2004.)

Over recent decades, many intuitive and analytical methods have been developed to evaluate investment risk. Different evaluation techniques incorporate uncertainty in different ways, and each focuses on different factors and offers its own advantages and limitations. Some of these methods are briefly discussed in Chapter 3.1 of this workbook.

2.3 The investment decision-making process

Investment decisions are of vital importance to all companies, since they determine both the potential for success and the ultimate cost structure (Götze et al. 2008). Figure 3 presents a conceptual investment decision-making process, indicating the main inputs, outputs and linkages between different steps, which has been developed and followed in the MittaMerkki -project. The starting point is a perceived need for investments. As described in the figure, assessing the value of investments can be considered a continuous process. Additionally, investment decision-making can be considered a multidimensional problem, for which any individual dimension of assessment – economic, strategic, or risk-related – is inadequate for addressing all relevant elements.

The conceptual decision-making process indicates that the assessment should be integrated, including financial assessment, risk assessment and analysis of social impacts. The framework itself includes many steps that comprise setting the boundaries and framing conditions for the assessment, generating investment alternatives, and ultimately making the decision. The essential aspect of the framework is the assessment of risks, costs and benefits, culminating in the synthesis of these factors to reach an overall ranking of different investment options. More importantly, the framework provides a loose coupling between different methods and modules. (Räikkönen et al. 2015.)

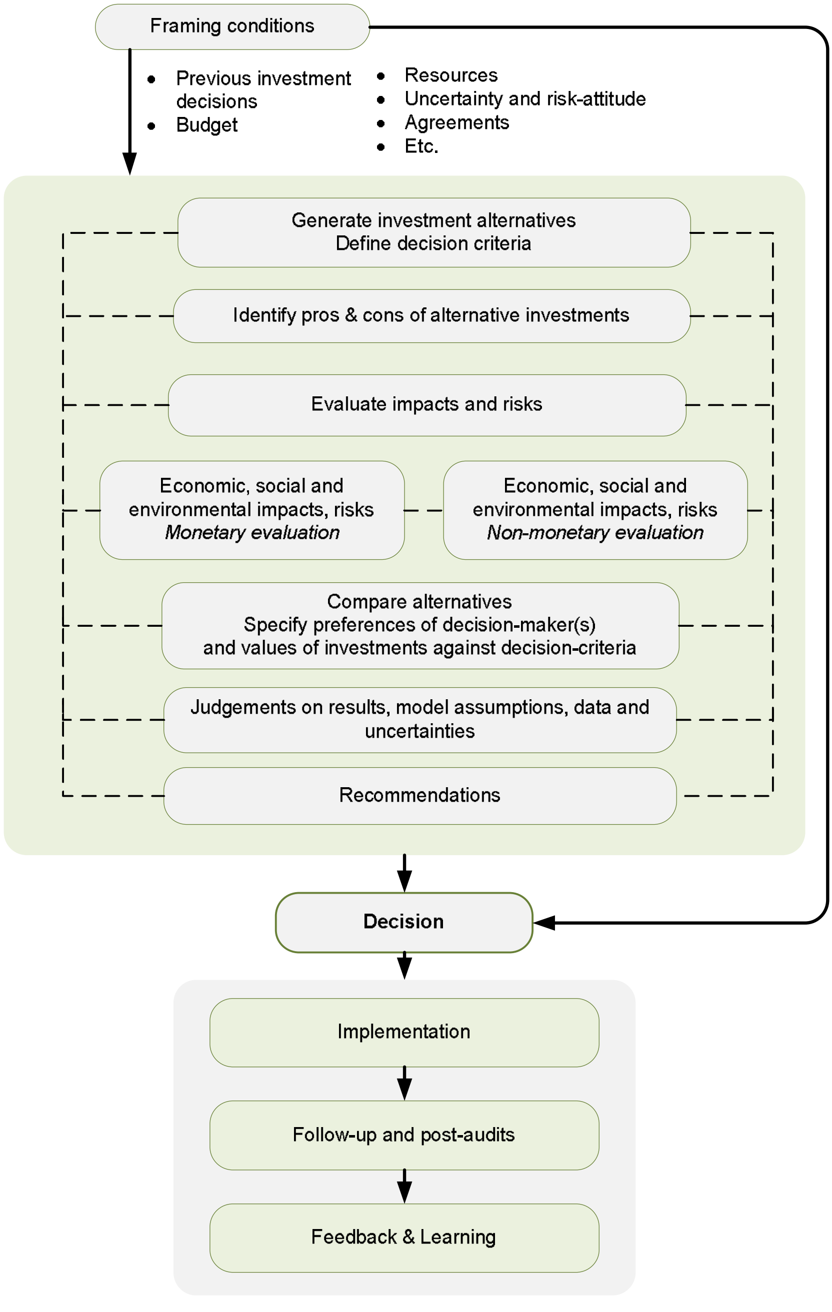

Figure 3. The investment decision-making process, developed and applied in this research.

The investment decision-making process illustrated in Figure 3 is flexible in the sense that it encompasses the most rigorous quantitative assessments, but also allows for purely qualitative or combined qualitative and quantitative assessments. It is also flexible in the sense of allowing for entry to or exit from the process at various steps, not just the first and final steps, respectively. At all steps, the formal process is accompanied by framing conditions that steer the process from outside of the process itself, e.g., through linkages to other processes competing for a shared budget.

3. New value creation perspective – methods and case examples of investment impact assessment

3.1 Economic evaluation

3.1.1 Economic analysis of investments

Evaluation is an essential phase of the decision-making process as it provides a link between the generation of proposals and the actual decision. To support reliable, sustainable, cost-effective, efficient and transparent decision-making regarding investments, different investment appraisal methods can be applied. Typically, economic analyses involve identification, measurement and evaluation, followed by comparison of the costs and profits of two or more alternatives. In economic evaluations, the costs and consequences of alternative investments are compared so as to examine the best use of scarce resources. A considerable amount of research has been performed in this area and the general features of these methods are well known (Meyer et al. 2013, Stermole & Stermole 2009, Götze et al. 2008, Pike & Neale 2003, Keeney & Raiffa 1993).

Traditional investment appraisal methods include discounted cash flow (DCF), (including net present value [NPV] and the internal rate of return [IRR]), return on investment (ROI) and payback analysis. Life cycle cost (LCC) evaluation also takes into account the costs of usage, maintenance and disposal, and the profits the investment generates over its lifetime. Thus, it is a practical solution for comparing alternatives that have tangible value. A solution with high LCCs might generate a high profit. If costs alone are used as the basis for decision-making, alternatives offering intangible and indirect profits might be ignored and opportunities might be lost. Earned value analysis, the productivity index and expected commercial value are more recent examples of analysis methods that can also be applied. The application of real options methodology (or options pricing theory), which presents projects as a series of investment decisions, helps to reduce risk through investing at discrete stages as uncertainty decreases and more information becomes available. Finally, numerical probability-based assessment methods, such as Monte Carlo simulations and stochastic programming, facilitate probabilistic modelling (Farr 2011, Götze et al. 2008).

Different economic analysis techniques incorporate uncertainty in different ways; each focuses on different factors and has its own advantages and limitations (Ye et al. 2000). Sensitivity analysis can be used to uncover which factors are the most relevant in terms of risk regarding the profitability of the investment (Piyatrapoomi et al. 2004). The traditional DCF method supposes that the present value of the project is assured and the investment process is static. It ignores the impacts of uncertainty on the evaluation, as well as the values of flexible management (Jiang & Zhang 2003, De-Yi et al. 2008). To relax all assumptions correctively, numerical probability-based assessment methods, such as Monte Carlo simulations and stochastic programming approaches, can be applied. Real options offer managerial flexibility, whose value can be sufficiently significant to warrant explicit inclusion in the investment evaluation (Kettunen 2009, Shil & Allada 2007). When evaluating a portfolio of investments, it should be considered that the risk of the whole portfolio is not, in general, the sum of the risks of the individual investments, as investments can be correlated such that risks are balanced, thereby reducing the risk of the portfolio taken as a whole (Kettunen 2009).

Empirical findings show that, although economic analysis methods are typically the most popular, companies using them as their primary decision-making criteria can experience lower outcome levels in terms of performance (Cooper et al. 2001). This means that, in practice, quantitative economic measures should be used as a guide rather than as the sole basis for the approval or rejection of specific investment alternatives. Decision makers should also understand the key assumptions underlying economic evaluation, how analyses and calculations are executed, and what the final results really mean.

3.1.2 The case of TVT Asunnot Ltd: an economic analysis of affordable housing investments

The aim of social or affordable housing is to ensure “a decent home for every household at a price they [can] afford” (Scanlon et al. 2014). Access to decent and affordable housing is a critical condition for economic growth and a stable society (King 2006). Thus, governments and communal municipalities in different countries allocate tax revenues to support the housing of people with low incomes. The mechanisms by which affordable housing is offered vary across countries, as does the proportion of social housing relative to the overall housing stock (Scanlon et al. 2014). In Finland, the Housing Finance and Development Centre implements housing policy by providing subsidies for new construction, renovation and purchase of housing (Ministry of the Environment 2015). These subsidies can be applied for by individual citizens, local authorities, public organization or corporations that fulfil certain preconditions.

The MittaMerkki project case company TVT Asunnot Ltd is a real estate company owned by the city of Turku in Finland. The company is a public non-profit corporation that offers affordable rental housing to people in various life situations, aiming to maintain and promote the well-being of individual citizens and society at large. TVT Asunnot Ltd owns a wide variety of residential options in blocks of flats, terraced houses and small private homes throughout Turku. The company owns almost 11,000 homes, with a total market asset value of over 1 billion €. The company has a yearly turnover of 75 M€, its administration, maintenance and repair costs amount to 48 M€ and its finance costs are 23 M€. It is subject to a government-imposed maximum limit on profit, and excess profit is used to lower rent level prices and for new investments. (TVT Asunnot Ltd 2016, Forss 2013.)

The aim of the economic analysis in this case study was to support investment decision-making by providing information on the economic profitability of different investment options. The case company faces two main economic restrictions related to renovations and new buildings. First, although the case company is a non-profit corporation, it needs to cover expenses. Public funding is used in investment financing and the terms of such loans are more favourable than terms on the open financial market, but housing expenses are not directly compensated by tax money. Second, government restrictions limit rents to a level that is approximately 10% lower than those for similar tenements on the free market. Through economic evaluation, a real estate company can assess whether the intended rent level can be achieved via the planned investment and which of the planned investments would lead to the most cost-effective outcome. The economic evaluation method applied in this case comprises the following five steps (Kunttu et al. 2016b):

1. Basics of evaluation

The first phase is to define the investment options to be compared and basic information related to investments. The intended location of building investment and type of investment – renovation or new construction – are examples of the basic information in this case. The basic economic parameters used in these calculations were the discount rate, inflation of expenses, inflation of rent and the expected lifetime of the investment. (Figure 4.)

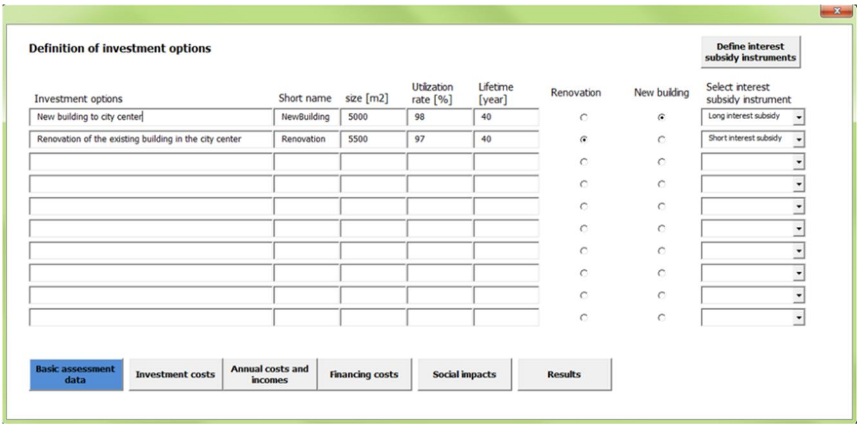

Figure 4. Example of the interface for the definition of investment options.

2. Investment cost

The second phase includes the definition of the investment cost structure, the evaluation of cost elements and the calculation of the total investment cost for each of the investment options. Investment costs include various cost elements and a structured approach is thus needed to ensure that all relevant cost items are incorporated into the calculation. The numerical values for all cost items related to investment cost can typically be obtained via offers and other documents. The total investment cost is typically calculated simply by summing the various cost values.

3. Annual costs and income

To balance investment and lifetime cost with expected incomes, the next phase of the process focuses on the definition of the structure for annual costs and incomes related to each investment option. Compared to investment costs, lifetime costs and incomes are more challenging to evaluate because the values will be realized only in the future and are thus inherently more uncertain than investment cost. Expected annual costs in the real estate business can be estimated quite accurately by utilizing data and experiences from other kinds of tenement buildings. Incomes related to tenement buildings consist of rent payments, water costs and other living costs (e.g., parking, use of laundry, etc.) paid by tenants. In this kind of situation, when income needs to cover expenses, required income and rent per square metre can be calculated based on investment and annual costs.

4. Results

The results of the economic evaluation provide guidance on which investment options are acceptable in terms of required rent per square metre. In addition, investment options can be compared in terms of rent payments and payback times. By combining economic evaluations together with intangible impacts, it can be determined whether desirable intangible consequences are achieved via reduced rent.

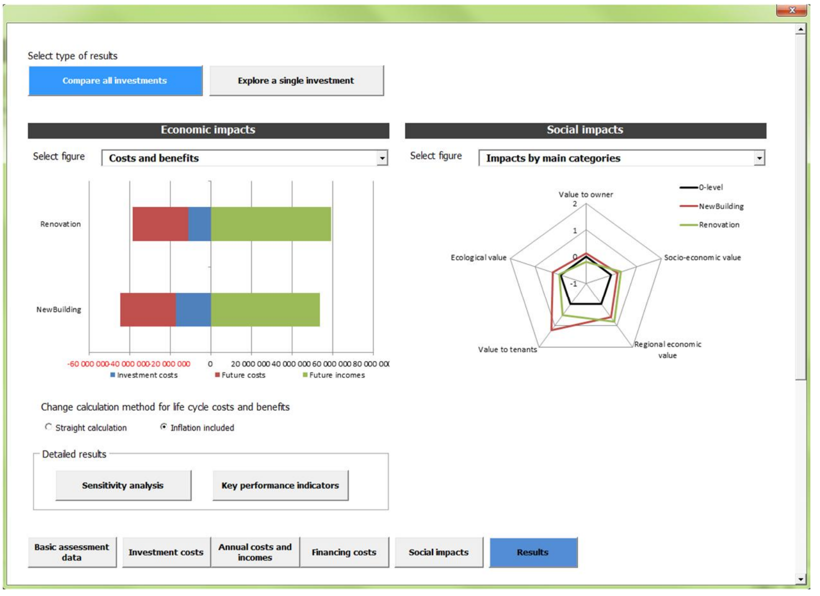

Figure 5. Example of the comparison of investment options.

5. Sensitivity analysis

Uncertainty is inherently related to all decision-making situations. However, this case features fewer uncertain elements than many other cases. The simplest form of sensitivity analysis is the what-if analysis, which provides new results based on modifications to calculation values. The main source of uncertainty is the utilization rate of houses. Low utilization rates decrease incomes while costs remain fixed, which leads to pressure to raise rental rates. The sensitivity analysis calculates the lowest utilization rate that would still provide an acceptable rent level and cover costs.

The approach and related tools described at the general level in this chapter can be considered as a decision-support approach to be applied in the investment planning phase. This approach supports TVT Asunnot Ltd and its stakeholders in their aim of making transparent, systematic and reliable decisions, as it creates a common understanding of the investment alternatives and their possible consequences before the decision is taken.

3.2 Social impact assessment (SIA)

3.2.1 Measuring social impacts of investments

In order to demonstrate the economic, environmental and social results of investments, impact measurements must be carefully planned and applied. Several frameworks have been developed to assist in planning impact measurements for

impact investment projects. These include, for example, IRIS, Outcomes Matrix, Harmonized Indicators for Private Sector Operations (HIPSO) and EVPA.
The concept of SIA has been developed over recent years. SIA has been defined as follows by Vanclay (2002):

- A social impact assessment is the process of analysing (predicting, evaluating and reflecting) and managing the consequences, both intended and unintended, for the human environment of planned interventions (policies, programmes, plans, projects) and any social change processes invoked by those interventions so as to bring about a more sustainable and equitable biophysical and human environment.

The key factors for successful impact measurement are as follows (Social Impact Investment Taskforce 2014):

1. Set goals. Define the desired impact of the investments.
2. Develop frameworks and select metrics. Determine the metrics to be used for assessing the performance of the investments.
3. Collect and store data. Capture and store data in a timely and organized fashion.
4. Validate data. Ensure the data are of a sufficient quality.
5. Analyse data. Review and analyse the data for insights.
6. Report data. Share progress with key stakeholders.
7. Make data-driven investment management decisions. Assess stakeholder feedback, address recommendations and make the necessary changes.

Impact can also be evaluated using the logic model approach (W.K. Kellogg Foundation 2004). This method involves dividing the factors to be assessed into inputs, activities, outputs, outcomes and impacts.

- Inputs are the resources needed for the project.
- Activities are the processes, tools, events, technologies and actions related to the project implementation.
- Outputs are the direct results of the project.
- Outcomes are the benefits or changes for participants that result from the project outputs.
- Impacts are the long-term changes and consequences of the project.

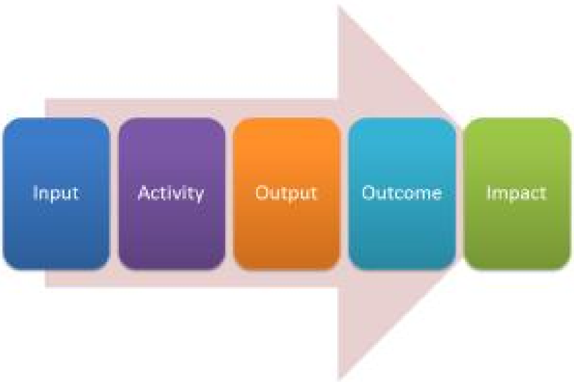

Figure 6. Logic model.

Using the logic model, the Social Impact Investment Taskforce (2014) developed an impact value chain model. Impact measures can be categorized as qualitative, quantitative or financial. The following table provides some examples of these different types of measures.

Table 2. Impact value chain and qualitative, quantitative and financial indicators to measure impact (Social Impact Investment Taskforce 2014).

	Input	Activity	Output	Outcome	Impact
Qualitative	Description of inputs	Description of activity	Description of outputs	Case studies describing outcomes	Qualitative evaluation of impact
Quantitative	Volume of non-financial inputs	Volume of activity delivered	Numbers of outputs delivered	Outcomes measured using quantitative indicators	Impact measured using robust measurement framework
Financial	Financial value of incoming resources	Cost of activity	Cost per output	Cost per outcome; social financial value of outcome	Social financial value of impact

3.2.2 The case of Humming World Ltd: the social impact of high impact projects

Humming World (HW) is a Finnish start-up company that aims to deliver high-impact projects in developing countries through partnerships and cooperative actions. The core objective of HW is to initiate projects in less developed parts of the world, creating value by generating employment opportunities, providing sustainable economic growth, developing educational resources, improving the environment and upgrading the local infrastructure (roads, building and power supplies) to raise overall living standards. The philosophy of HW is to utilize local resources in the best possible manner and to create a platform for the locals by providing the expertise and resources required to achieve the desired objectives. Any project of this nature requires a significant amount of financial investment and technical know-how to ensure that all stakeholders are on board and the targets can be achieved in an efficient and effective manner.

HW seeks to address key challenges – such as project financing, project development and global linkages – by providing crowdfunding solutions, connecting people and mobilizing required resources that may otherwise hinder long-term sustainable development goals. HW's initial project, Thompukandam Village Destination (TVD), is located in an eastern province of the Ampara region in Sri Lanka. The region is known for its naturally beautiful surroundings and is primed to become an attractive and rewarding sustainable tourism destination. However, at present, improper planning and tourism management contribute to a weak tourism industry. Furthermore, the area's infrastructure, educational establishments and surroundings are also poorly maintained. The region offers very few economic opportunities to its residents, causing them to migrate to bigger cities for work.

HW seeks to raise the living standard of the people of Thompukandam by developing its natural surroundings and establishing it as an attractive tourism destination for both local and international tourists. The developmental programme is introduced and established through three development areas: sustainable tourism development, livelihood projects to foster and facilitate small-scale industrial livelihood opportunities, and solid waste management development. Moreover, the project also aims to improve the preschool facilities in the town so as to boost the overall educational standard of the region. The success of the project will change the fortunes of the people living in the community, as well as those in neighbouring areas. Furthermore, the model developed for this project can later be replicated by HW in other developing regions that are facing similar challenges.

Project Results

In order to develop an impact measurement tool in the case of HW, the impact value chain concept (matrix) was applied. In this matrix, different steps in the evaluation of the project's impact are considered. The process of the impact value chain traditionally starts with input-level data and progresses to activity-, output-, outcome- and impact-level data (Measuring impact 2014, W.K. Kellogg Foundation 2014, Clark et al. 2004). An illustration of the impact chain evaluation and its steps is presented in Figure 7:

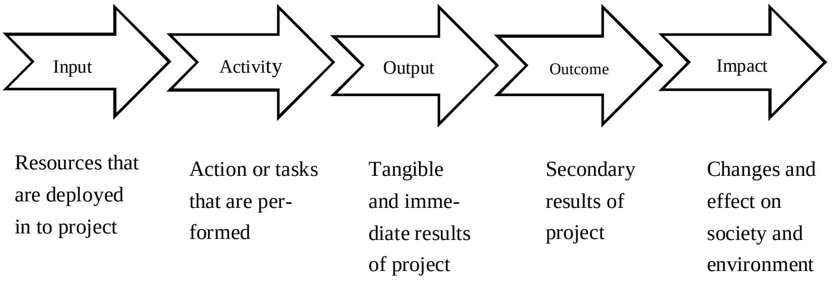

Figure 7. Impact value chain (EVPA, 2013).

Considering the qualitative, quantitative and financial aspects of each step, the impact value chain matrix will be as follows.

Table 3. The impact value chain matrix.

	Input	Activity	Output	Impact
Qualitative				
Quantitative				
Financial				

HW's TVD programme was introduced and establish through three development areas: sustainable tourism development, livelihood projects to foster and facilitate small-scale industrial livelihood opportunities, and solid waste management. The assessment was intended to cover the widest possible range of impacts that may arise from the TVD programme. An important step in the research was to gain an in-depth understanding of the economic, environmental and social impacts of the TVD programme. Until now, the developed structure has included three major impact areas: employment, training and education; citizenship and community; and conservation of the natural environment. Therefore, applying the master plan of the HW project and negotiation with its project manager, the impact value chain of HW would be as follows:

Input:

The inputs are the different tasks, investments, activities, etc. that should be executed in order to establish the project. According to the HW master plan, the inputs for this project are as follows:

Quantitative input:

- Building the Thompukandam Rest Café with various facilities for tourists and visitors.

- Building facilities, including kitchen facilities, facilities for the various trainee programmes, waste management facilities, a garden of "exotic" plants with name tags, etc.
- Preparing proper guidelines for maintenance, plants and fishing, and books for local fish and bird identification. Building birdwatching cabins, etc.
- Training qualified staff, such as teachers, in order to establish various training programmes.
- Training local people in various skills, such as removing garbage from the housing areas, maintaining fences and yards, etc.
- Training local people for various professions that are in demand in the local job market, including ceramics, basketry, traditional jewellery making, etc.
- Establishing various supply chain management programmes to deliver goods and souvenirs from producers to end customers.
- Investing in potential local industries, such as ceramics production.

Activity:
The primary activities related to the HW project's inputs are as follows:

- Establishment/installation of various facilities.
- Training local people and enlisting some experts to facilitate project implementation.
- Securing financing from investors and various partners to implement projects.

Output:
Outputs are the immediate results of establishing the project that can be observed after all the inputs and activities are executed. The HW project's outputs would be as follows:

Qualitative output:

- Clean, attractive and safe streets.
- Clear visibility and access throughout Thompukandam.
- Footpaths along the river and canals lined with "exotic" plants.
- Improved local industries/businesses, such as the fishing, textile, fashion and clothing, and handloom weaving industries.
- Increase in the number of skilled workers.
- Establishment of the visitor centre – the Thompukandam Rest Café – with various facilities for tourists and visitors.

Quantitative output:

- Increased net profits in various improved industries
- Increased number of tourists and visitors to Thompukandam
- Increased number of trained teachers and skilled workers
- Increased number of children in school.

Outcome:

Outcomes are the indirect results of inputs. In fact, they are the secondary results of the project, considered in terms of a longer time frame (at least five years).

Qualitative outcomes:

As the HW project improves the economic situation of Thompukandam Village (TV), it is estimated that, after some years, the living standard of the local people will improve in a number of dimensions, including the following:

- Reduction in the rate of malnutrition among children up to six years of age.
- Improvement in infrastructure, and the health and hygiene status of children.
- Improvement in women's empowerment and economic self-sufficiency. Increased involvement of women in decision-making processes.
- Improved educational performance of children.
- Increased interest in education and the education system on the part of children, parents/caregivers, school teachers and members of the villages.
- Increased probability of villagers having a high level of education.
- More qualified teachers.

Quantitative outcomes:

The improvement of living standards in TV will result in increasing numbers of the following:

- Mothers sensitized to child health issues.
- Children moving from malnourished to healthy status.
- Children accessing clean water and sanitation facilities.
- Mothers practising healthier feeding of their children.
- Women empowered regarding their rights and improved livelihood opportunities.
- Poor families having supplemental income and the ability to meet their children's educational needs.
- Girls in school.

Impact:
The impacts of the project are its results from a very long-term perspective. In fact, the impacts are the ultimate results of establishing the project, which are not visible in the initial stages of project accomplishment and only appear many years after the successful implementation of the project.

Qualitative impacts:

- Decrease in social class distinctions in TV.
- Decrease in poverty.
- Increases in the national literacy rate.
- Increased educational achievements.
- Increased prosperity.
- Increase in the number of social and economic developments in TV.
- Decrease in the number of early marriages among children.
- Increased number of sustainable livelihoods.
- Improvements in material well-being.

Quantitative impacts:

- Increased number of self-reliant families living with dignity.
- Increased number of children with an appropriate curriculum in their formative years.
- Increased number of educated people.

3.2.3 The case of TVT Asunnot Ltd: the social impact of affordable housing investments

The MittaMerkki -project social impact assessment of the TVT Asunnot Ltd case study was made by applying multi-criteria decision-making techniques. The method used to assess non-monetary forms of the impact of affordable housing is derived from the multi-attribute utility theory (MAUT) devised by Keeney and Raiffa (1993). Weights required for the calculations were defined using an AHP developed by Saaty (1980, see also Chapter 3.4.1). These methods were chosen as they provide a flexible and easily comprehensible means of analysing complicated problems while allowing for consideration of both subjective and objective factors in the decision-making process and taking conflicting factors into account (Räikkönen et al. 2016.)

As the first step of our AHP application development, a hierarchy for categorizing the forms of social impact of new construction and renovation investments was developed (Figure 8). The decision hierarchy was created by analysing and combining the knowledge and opinions of experts in affordable housing within TVT Asunnot Ltd with the results of a literature review conducted by the researchers. The top level of the hierarchy is “new construction and renovation investments in affordable housing” and the value categories includes five main value elements: value to owner, socio-economic value, regional economic value, value to tenants and ecological value, which are each further subdivided into specific forms of impact. In our application, the criteria and sub-criteria are fixed, but the weights and scores are assigned during the group evaluation.

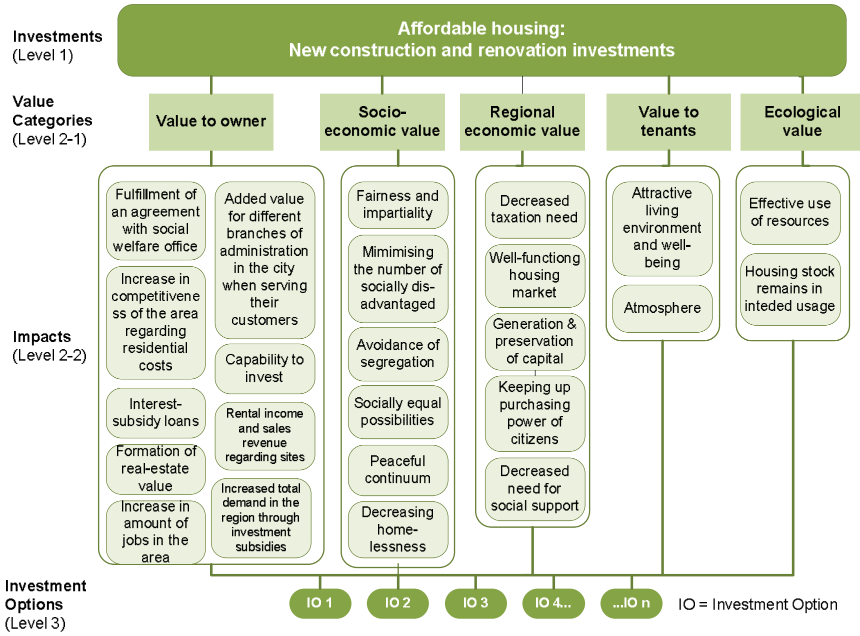

Figure 8. The proposed impact structure for new construction and renovation investments in affordable housing (adapted from Räikkönen et al. 2016).

The structure described in Figure 8 was tested and applied by assessing TVT Asunnot Ltd's current investment proposals. The weighting of value categories and evaluation of various forms of impact were performed during the assessment process by applying expert judgment. The AHP approach was used to determine the weights of the independent value categories of the decision hierarchy. The group began the evaluation by comparing, pairwise, the mutual importance of the value categories in the context of current investment proposals. Each value category was compared in relation to the others and the priorities were compiled in a pairwise comparison matrix. The relative weights of the overall value categories summed to 1.

The next step was to evaluate the impacts in accordance with expert judgment (see example in Figure 9). In order to increase the objectivity of the evaluation, the factor scoring is based on a fixed system. The scales (i.e., the scores for different forms of impact) were primarily modelled on a "very high (5)", "high (4)", "medium (3)", "low (2)" and "very low (1)" scale. For some forms of impact, other scales were introduced to ensure better results transparency. In addition, some forms of impact were not evaluated in this way, and were instead appraised on the basis of more qualitative information.

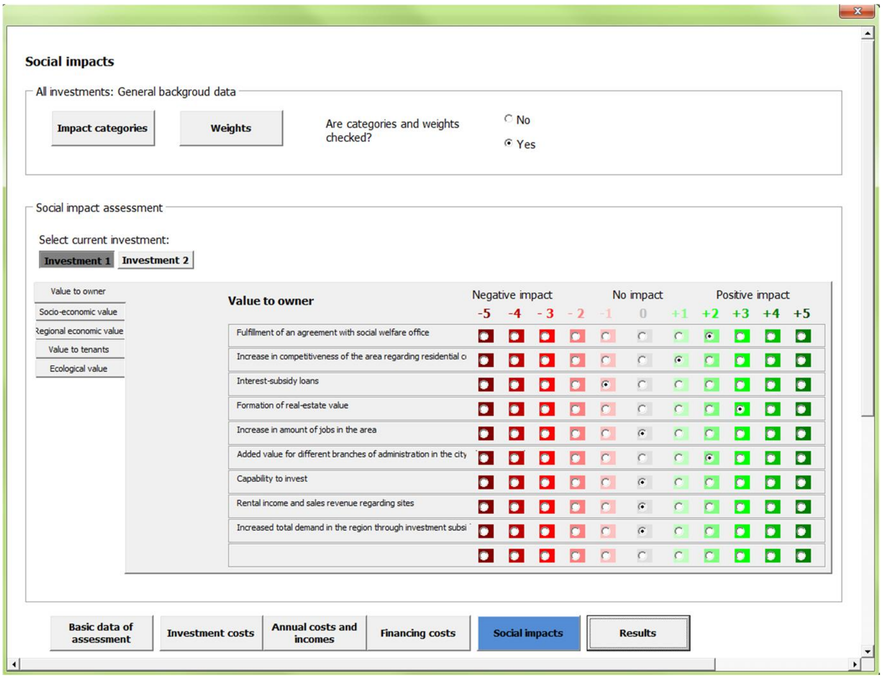

Figure 9. Example of the evaluation of social impacts of the value category “value to owner”.

By multiplying the weights and the impact scores, the profiles of the different investment options were illustrated. The weighted score for individual investments was calculated and the different options were ranked. Following the ranking of evaluated investments, the decision makers preliminarily determined the order of superiority of the investment options. Such results can be presented, for example, in the form of tables and graphs.

3.3 Risk assessment

According to IEC/ISO 31000 and IEC/ISO 31010 standards, risk assessment is a process that provides understanding of risks, their causes and their probabilities, such that an organization’s decision makers and other related parties can treat the risk. Risk assessment comprises risk identification, risk analysis and risk evaluation (Figure 10). Risks can be assessed on a number of levels: at the level of the organization or the department, for individual projects or activities, or at the level of a specific risk.

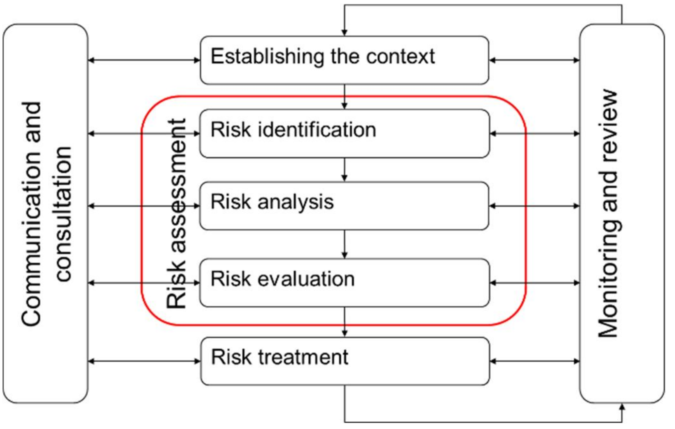

Figure 10. Risk assessment as an aspect of the risk management process (IEC/ISO 31000 2009).

3.3.1 Risk identification

Risk assessment begins with risk identification, which is a process of finding, recognizing and recording risks (IEC/ISO 31000 2009). The main objective in the risk identification phase is to identify possible risk scenarios, including sources of risks, their causes and their potential consequences. Additionally, positive risks (i.e., opportunities) should be identified.

There are various methods that can be used for risk identification. These can include evidence-based methods (e.g., checklists), systematic teamwork approaches (e.g., brainstorming) and inductive reasoning techniques (e.g., hazard and operability studies, or HazOps). According to the IEC/ISO 31010 standard, for example, the following methods are strongly applicable for risk identification:

- Brainstorming
- Structured or semi-structured interviews
- Delphi method
- Checklists
- Primary hazard analysis
- HazOps
- Hazard analysis and critical control points (HACCP)
- What-if analysis
- Scenario analysis
- Failure mode and effect analysis (FMEA)
- Cause-and-effect analysis
- Human reliability analysis
- Reliability centred maintenance (RCM)
- Consequence/probability matrix.

3.3.2 Risk analysis

Risk analysis provides input for risk evaluation. It includes considerations of the causes and sources of risk, their consequences and likelihoods. A single event can have several different consequences and can influence several objectives.

Risk analysis methods can be qualitative, semi-quantitative or quantitative. The level of detail depends on the application analysed and the availability of required data. It is possible that more than one analysis method is needed to reveal all possible risks if the target is complicated. According to IEC/ISO 31010, the following methods are strongly applicable for analysing consequences and probabilities, i.e., levels of risk:

- Environmental risk assessment
- What-if analysis
- Root cause analysis
- FMEA
- Human reliability analysis
- RCM
- Consequence/probability matrix

In qualitative risk assessment, the consequences, probability and risk levels are expressed verbally, e.g., as high, medium or low. These levels usually combine consequence and probability classes, which should be clearly explained. In semi-quantitative assessment, numerical scales are applied to consequences and probabilities that can be used for calculating a risk index. In quantitative assessment, practical values for consequences and probabilities are used. In many cases, in practice, the data required for a fully quantitative assessment are not available. Even when the data are available, however, it must be emphasized that the generated risk levels are always merely estimates.

3.3.3 Risk evaluation

Risk evaluation means determining the significance of the level and type of risk so as to make decisions regarding actions responding to the risk, if required (IEC/ISO 31010 2009). This is performed by comparing estimated risk levels with defined risk criteria. Such decisions may include, for instance, decisions regarding required treatment actions and prioritization of risk treatment actions. These decisions are usually highly dependent on the available budget for risk treatment.

The IEC/ISO 31010 standard provides three bands for risk evaluation:

- *Upper band*: risk is regarded as intolerable, risk treatment is essential regardless of the costs.
- *Middle band*: costs and benefits are taken into account, opportunities should be balanced against possible consequences.

- *Lower band*: the level of risk is negligible/small, no risk treatment actions are needed.

For many safety-critical applications, the “as low as reasonably practicable” (ALARP) principle is applied. According to the ALARP principle, a high-risk potential for an unwanted event must be reduced until the cost of further reduction is not reasonable by comparison to the benefit gained.

3.3.4 The case of Jyväskylän Energia Ltd: an investment decision-making method based on risk assessment

Jyväskylän Energia Ltd is a Finnish energy company that owns and runs electrical power, water and district heating networks in the city of Jyväskylä in central Finland. Their main challenge in this case study was to compare investment projects across different networks, as their limited investment budget was common to all their controlled networks (Figure 11). The aim of the case study was to develop an investment comparison method by which the decision-makers could define an investment portfolio to reduce overall risk in the most cost-effective manner.

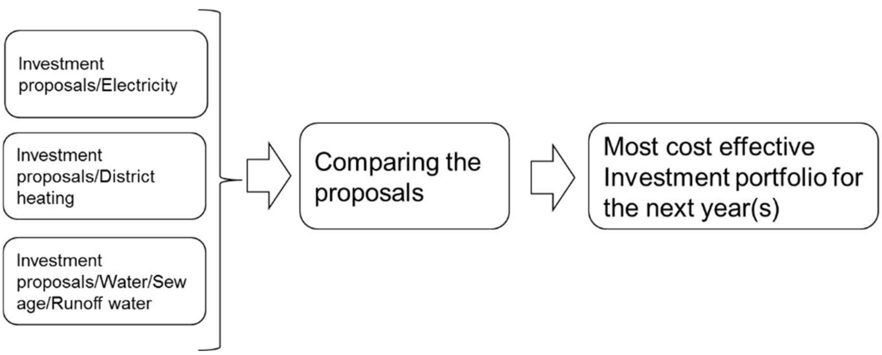

Figure 11. The challenge of the Jyväskylän Energia case.

Investments allocated to existing network infrastructure are practically always related to the reduction of infrastructure breakdown risks, e.g., leakages in water networks or failures in electricity distribution networks. Mitigating these risks and maintaining the required service levels are not directly profitable actions, and the benefits of such investments are difficult to measure using traditional investment appraisal methods. Regarding critical infrastructure, such as electricity, water and district heating networks, there are also intangible values that must be accounted for in investment decision-making. (Kunttu et al. 2016a)

The selection of a rehabilitation investment portfolio is a multi-criteria decision taken annually within Jyväskylän Energia Ltd. It is beneficial to define an investment portfolio containing the most important investments in the current situation.

All investment proposals are important, but the main question is which investments should be implemented within the coming year.

Method development

In this case, the appraisal of investment proposals was conducted by comparing their various risk mitigation effects. Thus, it was essential to identify the specific risks that each investment would avert or mitigate. A demonstration tool, which supports the risk analysis and investment portfolio calculation, was constructed during the method development process, illustrated in Figure 12.

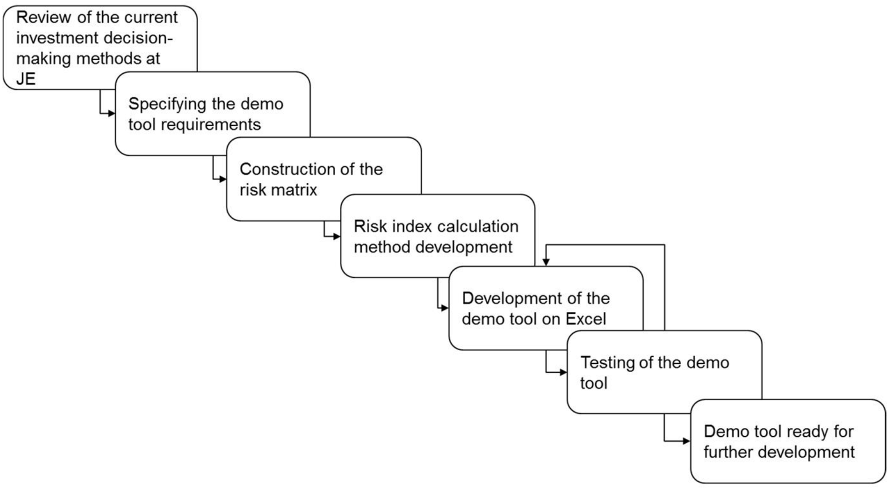

Figure 12. Investment comparison method development process.

Construction of the risk matrix

The risk analysis was carried out based on a risk matrix approach, according to which the risk has two dimensions – the probability of risk realization and the severity of the consequences if the risk is realized. The probability was categorized into five different levels. With regard to the consequences of risk realization, the consequence descriptions had to be detailed – otherwise it would be very difficult to ensure, for instance, that moderate effects on the water network are comparable to moderate effects on the electricity or district heating networks. In discussions regarding relevant variables describing possible consequences, experts have identified four aspects:

- Consequences for human and environmental safety.
- Consequences for customers, describing inconvenience caused to customers.
- Economic consequences, including all costs the company would need to pay if the risks were realized.

- Asset functionality consequences, covering issues related to a network's ability to perform its function into the future (e.g., the availability of spare parts and capacity).

Each of these four consequence aspects were defined on five levels: economic consequences were defined in monetary terms, while the other aspects were defined by means of qualitative descriptions. Descriptions of consequences for customers, for instance, were defined on the basis of the number of people suffering consequences and the length of time of disruption. After defining the descriptions for the aspects relating to consequences, a risk matrix was formulated. The developed risk matrix was implemented in the demonstration tool (Figure 13).

Figure 13. Example of the interface for risk analysis.

Risk index

In order to assign a qualitative value to the qualitative risk definition, a risk index was adopted. The risk index is a numerical value representing the criticality of the risk, which can be used when comparing risks and selecting those in most urgent need of attention. Typically, the risk index is calculated by multiplying the values of probability and consequence. In this case study, the risk index combined four aspects, i.e., the risk index is an average of the risk values of the four different aspects. If the importance of an aspect varies, a weighted average can be used to calculate the risk index. Weights were defined via an AHP study. (See also Chapter 3.4.1.)

In many cases an investment reduces multiple risks. If the risks reduced by a single investment are independent, risk indexes can be summed for the investment risk index. In practice, however, risks are dependent and summing will cause excessively high-risk indexes for investments that affect more than one risk. In the case of dependent risks, then, the risk index takes the highest risk value as such, while other risk values are reduced by a percentage value that reflects the strength of dependence.

To quantify the risk reduction, the value of the current risk index and estimation for the residual risk index were calculated. The risk reduction value was calculated by a simple subtraction: taking the risk index of an investment proposal before investment and subtracting the risk index after investment.

As the investment budget is always limited, its effective allocation is one important objective. The measure of the cost-effectiveness of an investment proposal is calculated from the amount of risk index reduction and the cost of the investment.

Selection of the investment portfolio

The selection of investments to be implemented from a long list of investment proposals is known as the traditional knapsack problem, for which the objective is to select a set of choices that optimize the selected parameters and meet the defined constraints. In this case, the aim was to minimize the residual risk, that is, to minimize the risk remaining after all selected investments are realized. The constraint is the investment budget, such that the total sum of investments cannot exceed the given budget.

Key performance indicators (KPIs)

There are three key performance indicators (KPIs) that could be calculated along with the risk index:

1. The risk reduction indicator favours large investments, which typically affect several risks.
2. Cost per risk reduction point favours smaller investment proposals.
3. Proportional cost and risk reduction – if an investment can reduce risk by a greater proportion than it is a proportion of the total investment cost, it can be considered cost-effective.

The aim of these KPIs generated by the above calculations was to provide information to the decision makers regarding the different investment proposals. Based on these KPIs, the decision makers can come to understand how each investment proposal might affect risk and which proposals are most cost-effective.

The calculation of KPIs for each investment proposal and the creation of the investment portfolio were implemented in the demonstration tool. The results are presented in tables and figures so as to support the decision makers whose task was to make the final choice of funded investments (Figure 14). Although the method provides an investment portfolio created in accordance with the given objectives and constraints, it is not intended to be adopted without further consideration. This method uses only risk-related criteria, but naturally other types of criteria can also direct investment decisions.

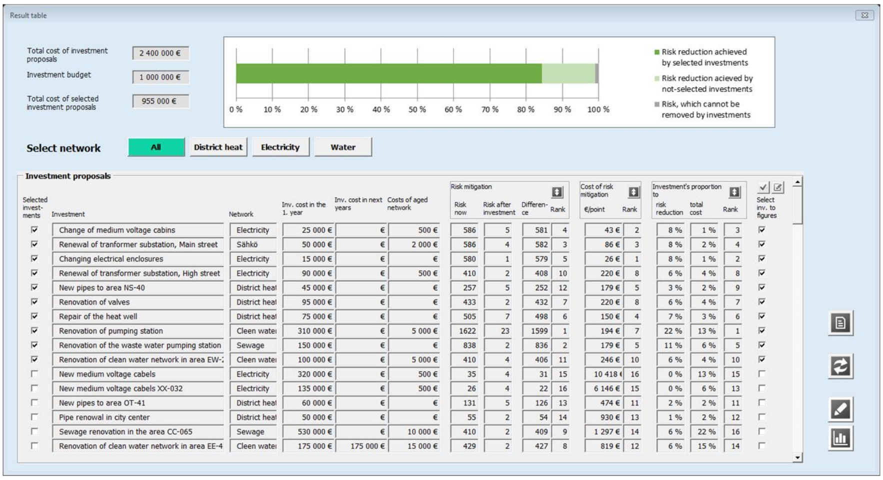

Figure 14. Example of results shown in the demonstration tool.

The demo tool that was developed during the case is designed only for demonstrative purposes. In a large company like Jyväskylän Energia Ltd the tool could not be a single Excel-file e.g., due to dozens of users. Therefore, it is recommended that a production-ready tool will be developed in the future according to the experiences gathered from the demo tool.

3.4 Multi-criteria and strategic analysis methods

3.4.1 Analytical hierarchy process (AHP)

Saaty introduced AHP in the early 1970s, inspired by a practical need to organize and analyse tortuous decisions. According to Saaty, the AHP method is efficient means by which to handle the complexities of reality by using hierarchical structures. The AHP approach is conceptually simple and easy to use, while nevertheless being effective in terms of decision-making. With AHP, every element of a problem is presentable (Niskanen 1986). By using AHP, decision makers can identify significant factors, thereby basing their decisions on knowledge. AHP is used all over the world in fields such as government, business, industry, healthcare and education. (Saaty 1980.)

The AHP method begins with stating the problem, or selecting a goal. It is important to recognize the criteria that affect the behaviour of the problem. The problem is then structured into a hierarchy. In a hierarchy, there are small groups – criteria that are easily comprehensible and understandable elements. Every level of these criteria are divided into even smaller criteria, or sub-criteria. The main criteria are cost, quality, time and flexibility. (Saaty 1980.)

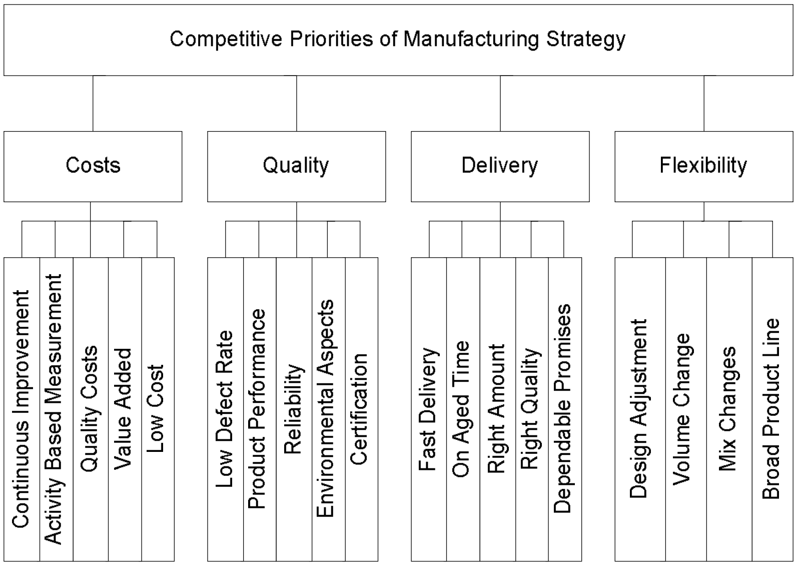

Figure 15. Structure of hierarchy of criteria and sub-criteria (Saaty 1980).

Different kinds of criteria are then compared to one another in a pairwise fashion. All selected factors are divided into pairs and each pair is addressed and compared, from which the interviewee selects the most important criterion. The interviewee gives weight to their answers on a scale from 1 to 9 to illustrate which factors are more important and by how much. The aim is to analyse the importance level of all the relevant factors and attributes.

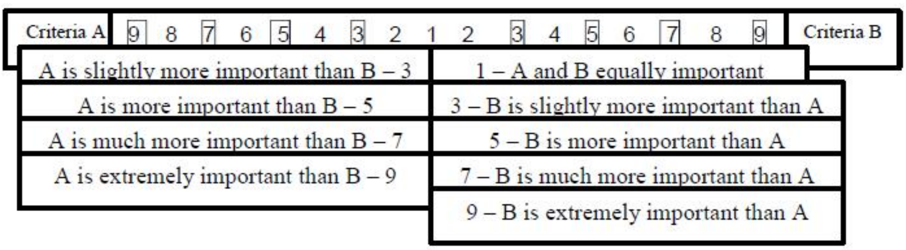

Figure 16. Format of numerical judgments in pairwise comparison (Shylina 2013).

This pairwise comparison enables decision makers to consider both quantitative and qualitative measures simultaneously. AHP is suitable for large companies applying multi-focused strategies (Saaty 1980). Saaty proposed nine AHP phases (Niskanen 1986):

1. Defining the problem
2. Constructing the hierarchy

3. Comparative evaluations
4. Assigning numerical values to the comparisons
5. Calculating the priority vectors
6. Estimating inconsistency
7. Analysing local priorities
8. Synthesizing results
9. Establishing the consistency of the whole hierarchy.

The logical inconsistency of the answers is measured as an inconsistency ratio (ICR). Knowing the level of consistency of the answers is vital to decision-making, as the ICR indicates the validity of the answers. The ideal ICR is zero, as this indicates complete consistency. When the ICR is greater than zero, some inconsistency exists among the provided answers. It is recommended that the ICR be less than 0.1 (Saaty 1980). For example, if respondents value criteria A much more than criteria B, and criteria B equally to criteria C, they must logically value criteria A much than criteria C. Deviation from this answer would be inconsistent and thus undesirable.

How to determine an analytical hierarchy process (AHP)

AHP can be used to measure and examine financial and non-financial quantitative and qualitative attributes. AHP aims to integrate different kinds of measures into individual scores so that decision alternatives can be ranked. Complex information is thus handled using hierarchical structures (Saaty 1980).

Firstly, the hierarchical structure is realized based on the decision problem. It contains the overall objective, criteria, sub-criteria and decision alternatives (Figure 15). When the hierarchical structure has been determined, the relative priorities of each criteria and sub-criteria must be defined. This is done by pairwise comparison, whereby the significance of distinct criteria is expressed in relation to higher-level elements. On the basis of these decisions, a questionnaire is drawn up. (Rangone 1996.)

The questionnaire can be distributed in paper or electronic form, and the larger the number of respondents, the better the analysis will be. The respondents make pairwise comparisons between the presented factors, selecting those they consider to be the most important using the provided scale (Figure 16). When all the answers are gathered, they are processed using software, such as Expert Choice, wherein the pairwise comparison data are organized and summarized. All the answers and data are converted into numerical ratings, such that the priorities of all alternatives and the weights of each criterion are calculated (Figure 17).

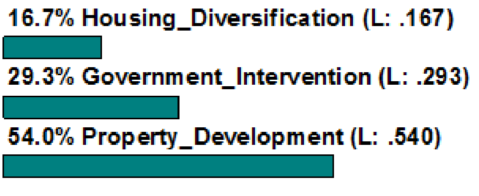

Figure 17. Example: main priorities weights.

3.4.2 The case of TVT Asunnot Ltd: a strategy analysis using AHP Process

We have undertaken this part of the research with the goal of exposing the cumulative effects of different priorities in affordable housing policies. The analysis of the collected data attempts to address broad questions of housing policy and practice, with a primary emphasis on how best to approach affordable housing and the way in which such housing is built, operated and maintained.

This process compares three main criteria that must be considered when establishing strategic objectives in this particular case:

- Government intervention
- Property development
- Housing diversification.

The Finnish housing finance and subsidy system is a "dual model" based on supporting supply and demand, which functions in cooperation with public actors (represented by the state, the Housing Finance and Development Centre and municipalities) and actors on the market (such as developers, owners, banks and construction companies).

Information about the company was collected from 23 online. The participants had to assign varying levels of importance to major critical factors through pairwise comparison. The decision-making hierarchy was constructed to represent the Finnish affordable housing model and its business process. The information from the questionnaires was analysed and from the comparison of the alternatives we calculate the priorities of the alternatives with respect to each criterion and the weights of each criterion with respect to the goal. The values for the main priorities for the whole sample are presented in Figure 18.

Figure 18. Main priorities importance weights (a).

Sub-priorities were then multiplied by the weights of the respective criteria. The results were summed to get the overall priority of each alternative, as shown in Figure 19.

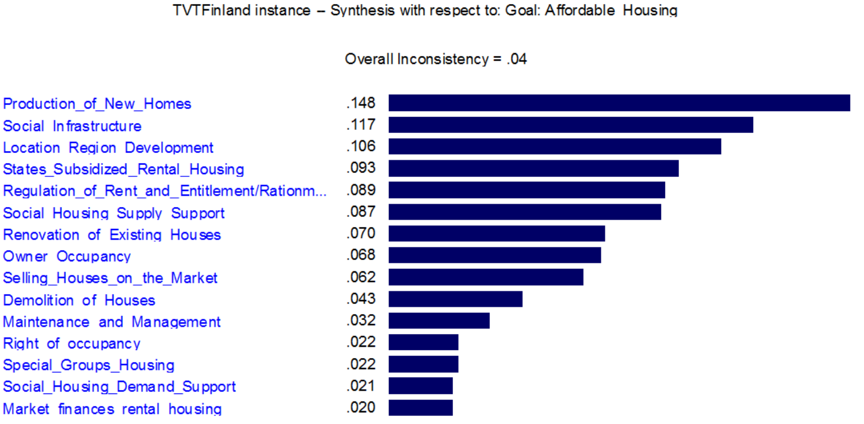

Figure 19. Main priorities importance weights (b).

Such an approach helps by requiring policymakers and housing practitioners to more explicitly and self-consciously weigh conflicting priorities. The presented analysis attempts to maintain a balance between oversimplifying the problem and unnecessarily increasing its complexity. It is vital to ensure that we can apply and tailor the analysis to specific issues and environments, once sufficient information and good knowledge about the modelling approach is available to determine affordable housing strategy.

3.4.3 Sand cone model

The sand cone model illustrates the studied object by demonstrating its hierarchies as well as the relative importance of and relationships between its sub-objects. Structure is the key to understanding the sand cone model. The factors placed at the bottom of the structure can be understood as internally crucial to the organization, functioning as a base for value creation for external stakeholders, such as customers. The other factors are then arranged upon this base. The top of the model shows the customer-oriented factors that result from the internal factors. (Takala et al. 2006: 338.)

To clarify the model, the original version by Ferdows and De Meyer (1990) is presented below (Figure 20). This model was created to enhance organizations' manufacturing strategies by analysing four different and important capabilities: quality, dependability, speed and cost-efficiency. As can be seen from the figure, quality was placed at the bottom, serving as a foundation to support dependability, with speed then "resting" on dependability, and finally cost-efficiency "resting" on speed. Based on this model, cost-efficiency can be understood to be the ultimate goal, which means it is the most visible and external factor, and does not have much influence on the stability of the structure. In practice, this would mean that "saving money everywhere" is not the central internal method of achieving cost-efficiency. On the contrary, cost-efficiency can instead be seen as the results of quality, dependability and speed factors. (Takala et al. 2006: 338–339.)

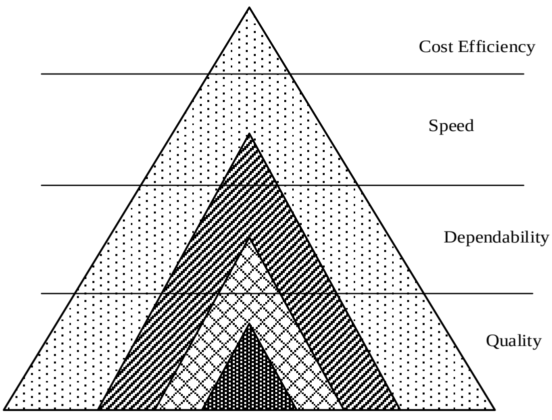

Figure 20. The original sand cone by Ferdows and De Meyer (Takala et al. 2006: 338).

The sand cone model emphasizes how development should always start from the bottom of the model. Only in this way can best total performance be achieved. In the Ferdows and De Meyer case, it would mean that development must begin with quality, proceeding through dependability to speed and finally to cost-efficiency in order to achieve a better performance. Ultimately, development based on the sand cone model must have a positive effect towards the top of the model (e.g., in cost-efficiency) – otherwise, the model is not working properly according to its principles. (Niemistö & Takala 2003: 102.)

To explain how the process would work in practice, Ferdows and De Meyer (1990) offer the following example. In order to improve cost-efficiency by 10%, a greater percentage improved in speed is required. If this value for speed is, for example, 15%, an even larger share of the improvement effort is required for dependability (e.g., 25%) and again for quality (e.g., 40%). Ferdows and De Meyer also underline that their model is, of course, not the only way by which to improve cost-efficiency, but that with the sand cone model cost-efficiency improvements can be achieved without expense to the other factors. In fact, on the contrary, greater cost-efficiency is accomplished precisely by enhancing these other capabilities. Improvements in this manner would also lead to more stable and long-lasting improvements. What these improvements might constitute in practice is a question left to the firm itself. Since the concepts of quality, dependability, speed and cost-efficiency are all very broad, there is a wide range of possible improvements open to these companies. This also means that differentiation from competitors is possible for individual companies. (Ferdows & De Meyer 1990: 174–175.)

Since the original sand cone model was developed, it has been used successfully by many organizations, including, for example, the Finnish Air Force (FAF). In this model developed by Takala (2002), the AHP method was used to derive the relative importance percentages for the FAF, determining the levels of the sand cone model. Through this developed model, two distinct importance levels could be drawn. The first level is constituted by basic pillars with high levels of importance, accounting for two thirds of the whole strategy. The second level is described as operating philosophies, with lower levels of relative importance and accounting for the remaining third of the strategy. The complete sand cone model for the FAF is illustrated in Figure 21. From this figure it can be seen how, in addition to the basic pillars and operating philosophies, the original conical layers of the Ferdows and De Meyer model have been transformed into "flat" layers. This illustration was found to be more appropriate in this case, as it reveals the bottom layer (which includes factors such as flight safety and technology) that are a very visible aspect of the FAF's strategy with regard to its stakeholders. (Takala et al. 2006: 339–341.)

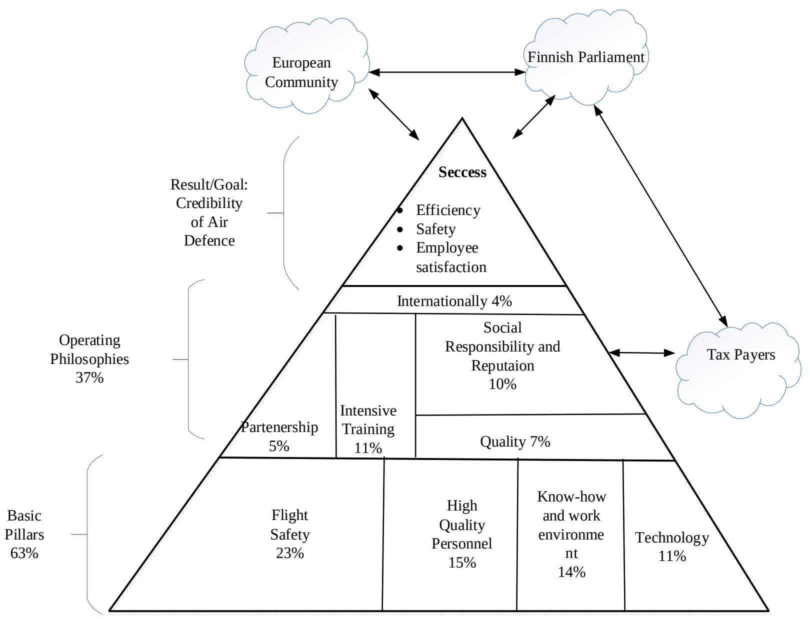

Figure 21. The sand cone model for the FAF's strategies (Takala et al. 2006: 341).

Ultimately, this modified sand cone model takes the relevant factors and organizes them into three layers – the bottom layer of basic factors, the middle layer of facilitating factors and the top layer of resulting factors – based on AHP values. It describes the structure of sub-strategies and their strategic role in a visual, systematic and simple way. However, military organizations usually have strong cultures, long traditions and a unanimous system of decision-making. This means that more research is needed in other types of organizations with multi-focused strategies, high uncertainty and the potential for disagreement. Additionally, the question of the extra parameters required in order to apply this model more generally remains to be answered. (Takala et al. 2006: 342.)

One further example of the sand cone model is illustrated in Figure 22. This model shows the prioritization of the factors concerning professional Finnish ice hockey clubs and their business environment. Based on the study, management was placed at the bottom of the cone, serving as a basic foundation for the other factors and being externally visible only to the sponsors. People and resources were assigned to the middle layer since both depend on management and support processes. People are seen as an internal element by the clubs, but are also externally visible to a certain extent in terms of media affairs. Lastly, the clubs' processes (including matches) were located at the top of the cone, as these are truly the most visible aspects of such clubs, both to partners and, especially, to customers. However, this layer does not play any supportive role in the cone. (Leskinen & Takala 2005: 43.)

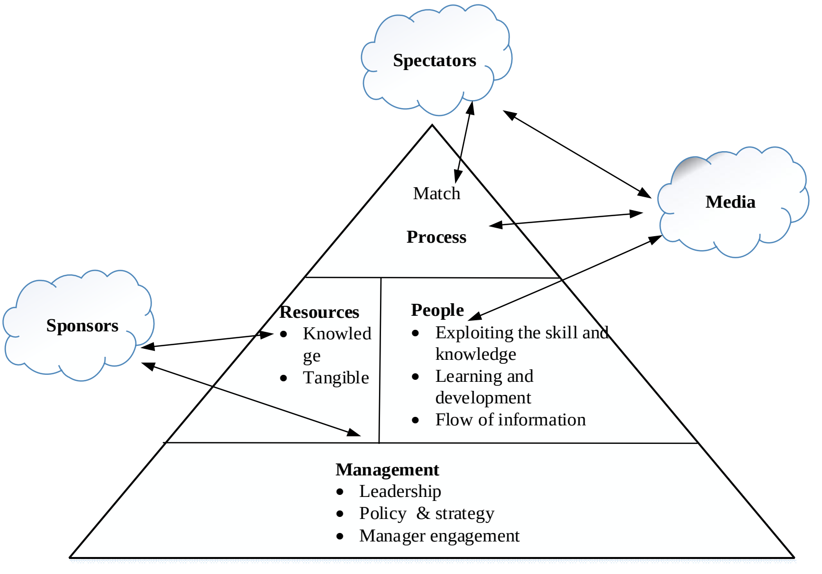

Figure 22. The sand cone model for the ice hockey clubs (Leskinen and Takala 2005: 43).

The MittaMerkki -project has provided a great opportunity to further develop the sand cone model and to answer the aforementioned questions (see Chapter 3.4.7). Combining risk assessment and investment decision-making in an energy sector case, for which the AHP method is already used to weigh the investment criteria, offers an excellent new environment in which to test the sand cone model, with a different organization type and different challenges from the FAF and ice hockey clubs examples. As new parameters, knowledge and technology (K/T) rankings were added to the sand cone model so as to evaluate how technology and knowledge affect decision-making and, hence, the factors collected in the sand cone. These parameters are introduced in the model as a form of uncertainty that causes so-called “collapses” in the sand cone layers. These collapses stem from the different K/T requirements in different departments of the case company.

3.4.4 Sustainable competitive advantage (SCA)

Competitive advantages refer to those advantages a business has over its competitors. One of the main frameworks for evaluating competitive advantages is strengths, weaknesses, opportunities and threats (SWOT) analysis, introduced by Ansoff in the 1960s (see Ansoff 1965). The idea behind the SWOT framework is to identify and implement strategies that decrease risk and internal weakness while increase external opportunities and strengths. However, this model focuses exclusively on impacts on the firm’s environment and does not consider companies’ unique structures and characteristics. Therefore, in 1990, Michael Porter introduced positioning theory to competitive advantages based on generic strategies (Porter 1996). Generic strategies are those that any company can use to improve and gain competitive advantages over their competitors. These generic strategies are:

1. Overall cost leadership: the ability to produce products and services at lower costs than competitors. Under this strategy, firms try to produce their products at the same quality but at cheaper prices than their competitors. This provides price value to the customer. Lower prices result in higher profits, as long as companies are able to sell a reasonable quantity of their product. If companies are not able to sell significant amounts of their products, they can instead cut production costs by using cheaper labour or raw material.
2. Differentiation: a situation in which the product or service of one business is different from those of its competitors. Under this strategy, companies invest heavily in research to produce innovative and high-quality products, such that customers are willing to pay extra for the benefits of the product innovations.
3. Segmentation: a strategy by which companies focus on a few specific target markets rather than the entire available market. Firms that use this strategy type focus on the needs of their specific customers and investigate ways by which to improve their daily lives. Under this strategy type, companies allow customers to have input into their products and services.

For over a decade, finding a way to achieve and maintain sustainable competitive advantage (SCA) was the primary topic of investigation for researchers and scholars. One perspective on SCA is the resource-based view (RBV) theory, which supposes that the critical factors for business success exist within the firm itself, in terms of its resources and capabilities. This model tries to strike a balance within firms' existing resources, utilizing them to creating competitive advantages. RBV was introduced by Wernerfelt in 1984. According to this theory, resources and products are two sides of the same coin and should be taken into the account simultaneously so as to identify optimal product markets and specify the firm's resource profile. Wernerfelt defines resources as anything that might be thought of as a strength or weakness of a given firm, such as personnel, creative talents, brand name, unique production process and distribution location. According to Wernerfelt, three categories of resources can be defined:

1. Resources of fixed capacity, such as physical assets. This type of resource rarely plays a role in expanding a firm's scope.
2. Resource of unlimited capacity, such as the firm's reputation and brand.
3. Resources of fixed short-term but unlimited long-term capacity, such as the corporate culture and a firm's learning curve.

Under RBV, firms are considered to be unique, even within a single industry. The differences between firms arise from the differences between their resources, and RBV grounds a firm's strategy in its resources. This means that, if a firm has an advantage in something, it should use it (Wernerfelt 1984).

3.4.5 Sense and respond (S&R) method and critical factor indexes (CFIs)

Nowadays, the traditional approach of planning production based on manufacture is being replaced by sensing customer needs and respond to them in real time. In fact, companies are moving from the traditional strategy of "make and sell" to a faster and more immediate strategy of "sense and respond" so as to compete in today's turbulent business environment. The sense and respond (S&R) concept assists decision makers in attaining a picture of what will happen in the future. This strategy helps firms to collect data about their expectations and experience, and also assists them in developing a picture of how they see themselves as compared to their competitors (Bradley & Nolan 1998). Ranta and Takala (2007) designed a questionnaire for applying the S&R method with the purpose of developing an operative management system to detect critical factor index (CFI). The following table presents a sample S&R questionnaire:

Table 4. Format of the questionnaire (adapted from Ranta & Takala 2007).

	Scale: 1=low, 10=high		Compared with competitors			Direction of development		
Performance attribute	expectation (1-10)	experience (1-10)	worse	same	better	worse	same	better
Performance1								
Performance2								

The S&R questionnaire is used to detect CFI, which is a supporting tool for strategic decision-making and helps managers to make decision and react quickly. It also helps companies to detect the areas and scope of required improvement. CFI is developed through three further stages so as to offer a better picture of companies' CFIs, as well as to reduce the effect of small sample size. These three stages are: balanced critical factor index (BCFI), scaled critical factor index (SCFI) and new scaled critical factor index (NSCFI). Once the S&R questionnaire is completed by the managers of the studied case companies, the following formulae are used to calculate CFIs (Tasmin et al. 2016):

$$\text{CFI}=\frac{\text{Std(experience)}*\text{Std(expectation)}}{\text{Gap Inde}*\text{Direction of development Index}*\text{Importance Index}} \quad (1)$$

$$\text{BCFI}=\frac{\text{Std(experience)}*\text{Std(expectation)}*\text{Performance Index}}{\text{Importance Index}*\text{Gap Index}*\text{Direction of developmen Index}} \quad (2)$$

$$\text{SCFI}=\frac{\sqrt{\frac{1}{n}*\sum_1^n(\text{experience(i)}-1)^2}*\sqrt{\frac{1}{n}*\sum_1^n(\text{expectation(i)}-10)^2}*\text{Performance Index}}{\text{Importance Index}*\text{Gap Index}*\text{Development Index}} \quad (3)$$

The parameters are:

$$\text{Gap index}=\left|\frac{\text{Avg(experiecne)}-\text{Avg(expectation)}}{10}-1\right| \quad (4)$$

$$\text{Direction of development index}=\left|\frac{\text{Better\%}-\text{Worse\%}}{100}-1\right| \quad (5)$$

$$\text{Importance index}=\frac{\text{Avg(expectation)}}{10} \quad (6)$$

$$\text{Performance index}=\frac{\text{Avg(experience)}}{10} \quad (7)$$

$$\text{SD expectation index}=\frac{\text{Std(expectation)}}{10}+1 \quad (8)$$

SD experience index=$\frac{\text{Std(experience)}}{10} + 1$ (9)

NSCFI=$\frac{\sqrt{\frac{1}{n}*\sum_1^n(\text{experience(i)})^2}*\sqrt{\frac{1}{n}*\sum_1^n(\text{expectation(i)}-11)^2}*\text{Performance Index}}{\text{Importance Index}*\text{Gap Index}*\text{Development Index}}$ (10)

Where:

Gap index=$2^{\left(\frac{\text{avg(expection)}-\text{avg(experience)}}{10}\right)}$ (11)

Development index = $2^{(\text{worse }\%-\text{better }\%)}$ (12)

Once the calculation is ready, the results are presented in bar charts, like the following (Figure 23):

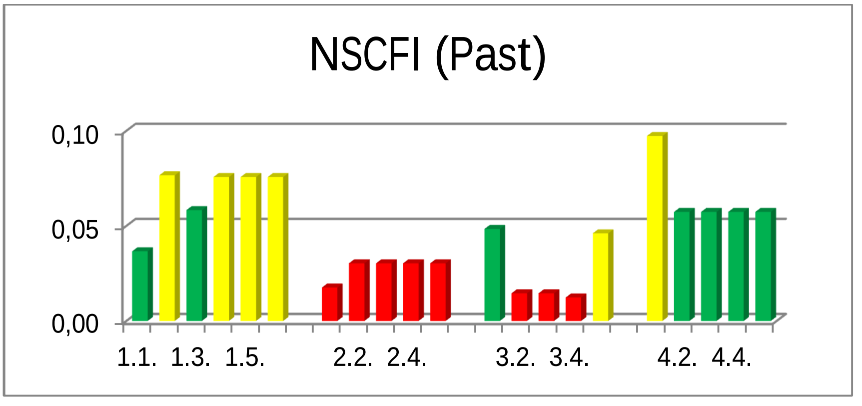

Figure 23. Example of the final bar chart to represent the calculation of CFI.

In above bar chart, the green bars represent the criteria that are balanced, the red bars stand for under-resourced criteria and the yellow bars stand for over-resourced criteria. The red and yellow bars in the CFI bar chart are critical factors and therefore could present opportunities for an improvement plan (Liu et al. 2011).

How to determine critical factor index (CFIs)

In order to determine the CFI of a firm, S&R questionnaire (Table 4) are distributed to respondents. At least three respondents from a firm should complete the S&R questionnaire before analysis is performed. Greater numbers of respondents result in better analysis. Once the answers are gathered, Formulae 1–12 in Chapter 3.4.5 are used to calculate CFIs.

When all the CFIs are calculated, the next step is to illustrate them in bar charts, as in Figure 23. To do so, all CFIs should first be normalized. CFIs are normalized by dividing the number of CFIs for each criterion by the sum of all CFIs for all criteria. After normalization, the sum of CFIs for all criteria is equal to 1.

Using Excel, the bar charts of normalized criteria are drawn. The resource allocation of the attributes is considered ideal if it is equally distributed. To determine the colour of each bar, the average resource level is defined by dividing 1 by the total number of criteria. An attribute is considered to be balanced and assigned the green colour if its CFI value is between one third and two thirds of the average resource level. If the CFI value of one attribute exceeds two thirds of the average resource level, then this attribute is considered to be over-resourced and is assigned the yellow colour. Attributes that have a CFI value of less than one third of the average resource level are considered to be under-resourced and are coloured red. Both yellow and red criteria are critical factors and provide decision makers with a list of improvement priorities (Liu et al. 2011).

3.4.6 Knowledge and technology (K/T) effect

SCAs are primarily knowledge-based, meaning that knowing how to do things is more important than having special access to resources. Besides, knowledge as intellectual property is considered to be a strategic resource for firms and can play a significant role in forming the basis of competitive advantage (Lubit 2001).

In order to include K/T effects in the S&R model, respondents should evaluate the share of technology in all criteria in terms of basic, core and spearhead technology, where the sum of all three is 100%. These three technology types depend on the life cycle stage of each piece of technology. Basic technology is technology that firms tend to outsource. Core technologies include technologies that offer competitive advantages and enable the company to grow, while spearhead technology focuses primarily on future needs (Takala & Uusitalo 2012). Figure 24 illustrates the connection between product life cycle and K/T requirements.

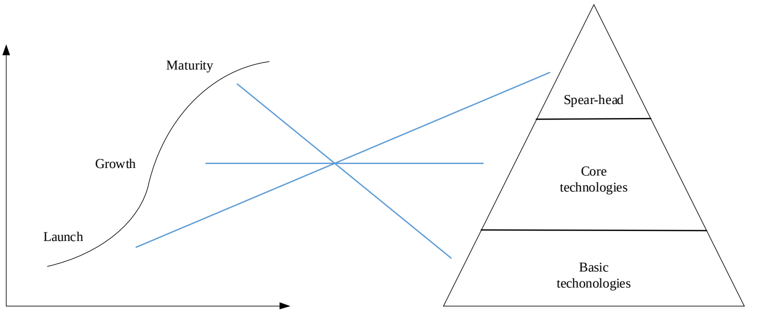

Figure 24. The relationship between technology life cycle and the technology pyramid (Tuominen et al. 2003: 5).

3.4.7 The case of Jyväskylän Energia Ltd: an investment decision-making method based on uncertainty modelling

Emphasis has shifted significantly from traditional risk management, which can be defined as various modes of “protecting the system and its users from failures in the system”, towards uncertainty management, since uncertainty can provide opportunities as well as threats to the performance of the system (Takala & Uusitalo 2012). In the case of Jyväskylän Energia Ltd, the uncertainty was measured and analysed via a model comprising three methods: AHP, the sand cone model and the K/T rankings. Each of these methods have been presented thoroughly in Chapters 3.4.1, 3.4.3 and 3.4.6. In what follows, the combination of these three methods into a model of uncertainty analysis is explained.

In this model, AHP is used to weight the selected criteria of investment decision-making (Takala et al. 2016). The investment criteria signify the aspects that the company wants to take into consideration when selecting and comparing possible investment options regarding its distribution infrastructure. Naturally, the investment budget is limited and not every potential investment can be realized, at least not within the same budget season. In the workshops arranged between the case company and the research partners, then, four criteria were selected and weighted with the AHP method.

Next the selected and weighted criteria were inserted into the sand cone model. Based on AHP prioritization, the two criteria that received two thirds of the total weight were located in the ground layer of the cone. This was introduced as a requirement when analysing the features of items considered to be first level basic pillars (Chapter 3.4.3). The sand cone is presented in Figure 25. However, in this sand cone, the desired effects of technology and knowledge remain invisible. This lack of transparency in the figure is illustrated with the black dotted line rectangle.

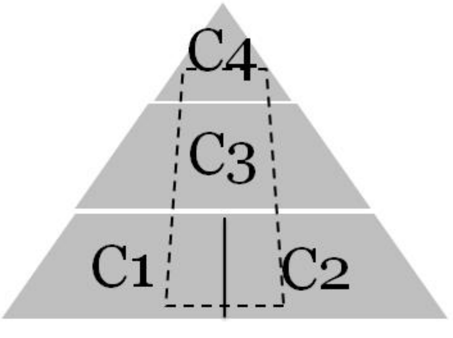

Figure 25. The company sand cone with an illustration of K/T invisibility.

In order to make the K/T factors and their effects visible, the aforementioned K/T requirement section of the S&R method (see Chapter 3.4.5) was utilized. In the process, so-called variability coefficients (VarCs) were calculated from the technology levels. Before such calculations, at least one example of the technologies used at each level (basic, core and spearhead) should be determined, along with the time perspective utilized (Takala et al. 2016). This procedure was conducted by case company experts from each department. However, as an example, the next table illustrates some possible relevant technologies in the field of electricity and it can be noticed this procedure immediately makes the case more practical and concrete.

Table 5. K/T technology levels example: electricity networks.

Basic:	Cables, transformers, substations, overhead lines, energy meters
Core:	Automation systems, protection systems, fault indicators
Spearhead:	LVDC, 1000-V systems, smart grids, self-healing networks

After naming the technologies, the K/T rankings were gathered with a questionnaire presented in Table 6. As can be seen, the technology levels are illustrated in the first row, with each department per technology level in the second row. In this questionnaire, each criterion (from the first column) is divided across the three technology levels so that the sum equals 100% both in terms of the department and the criterion in question (Takala et al. 2016). For example, C1 is divided across department A with 60% basic, 40% core and 0% spearhead technology (60% + 40% + 0% = 100%). This means that 60% of the company's current infrastructure related to the first criterion is basic technology. If this criterion were, for instance, dependability, this data would mean that the company has no spearhead technology affecting dependability in department A. Furthermore, it can be seen that the sum of the final row, marked in red, does not equal 100% (15% + 65% + 30% = 110%). Hence, the respondent must revisit their answers.

Table 6. The K/T questionnaire.

	Basic			**Core**			**Spearhead**		
	Dept. A	**Dept. B**	**Dept. C**	**Dept. A**	**Dept. B**	**Dept. C**	**Dept. A**	**Dept. B**	**Dept. C**
C1	60 %	-	-	40 %	-	-	0 %	-	-
C2	-	60 %	-	-	30 %	-	-	10 %	-
C3	-	-	70 %	-	-	30 %	-	-	0 %
C4	15 %	-	-	65 %	-	-	30 %	-	-

The respondents were the distribution company's executive board and some experts from each department. Four members of the board, ultimately, were able to complete the questionnaire. In addition, two experts from department A, one from department B and two from department C were able to participate. The number of participating experts was slightly lower than desired, but this number was ultimately found to be sufficient to complete the model. The board members answered for every department, while the experts answered on behalf of their respective departments only. From the data, the variability coefficients were calculated by using the following formula.

$$VarC_{C1,C2,C3,C4} = \sqrt{\sum_{i=B,C,SH} C1, (C2, C3, C4) \left(\frac{std_i}{mean_i}\right)^2} \tag{13}$$

Based on the questionnaire answers, the following variability coefficients (Figure 26, below) were identified for the case company. As can be observed from the figure, all three departments were assigned rather high variabilities under each criterion. In this case, department B has the highest variability in every criterion. Furthermore, only one criterion, C2, received variabilities lower than one in all three departments. Altogether it can be said that, according to the model, there is indeed some uncertainty in the investment decisions facing the case company.

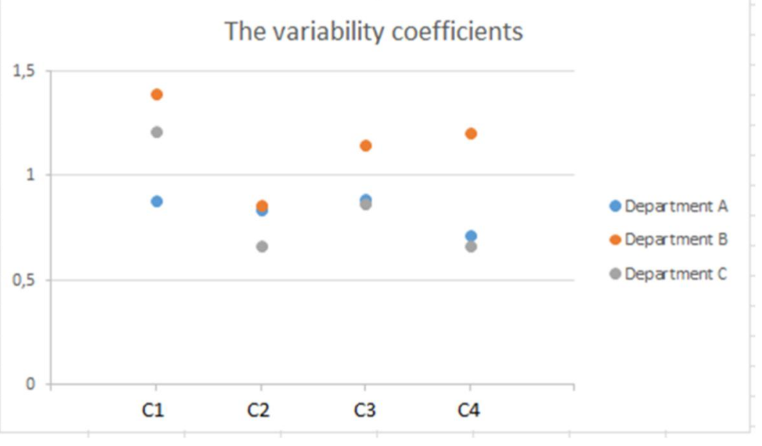

Figure 26. The variability coefficients of the case company.

When inserted into the sand cone model, the variability coefficients of the case company are illustrated in the form of collapses (darker grey in Figure 27 below). Those criteria with over 100% variability call into question the investment evaluation based on that criterion (Takala et al. 2016).

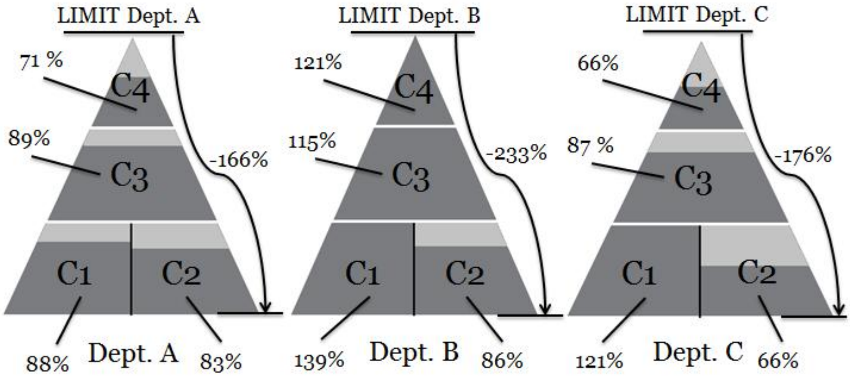

Figure 27. The sand cone model with K/T collapsed risks.

The total amount of technology and knowledge-affected risk in each department is presented in the figures alongside the sand cones. "This figure is called the T&K-uncertainty and it describes how much, in general, the department 'falls' under its competitive range when the T&K risk estimate materializes" (Takala et al. 2016). As can be noticed, the T&K-uncertainty is over 100% in each department. "This puts the investment evaluation into question, as well as the comparison of different departments" (Takala et al. 2016). The T&K-uncertainty figure is calculated for each department from the variability coefficients, as illustrated in the equation below.

$$T\&K - uncertainty = \sqrt{\sum_{i=C1,C2,C3,C4} VarC_i^2} \qquad (14)$$

What, then, is the source of this uncertainty? The next step is to study which aspect of the basic, core and spearhead classification caused the most variability in the answers. The image is very clear in this regard, as can be seen from Figure 28. – spearhead technology and knowledge is the main source of the uncertainty. Even the core technology returns rather high variabilities in every department. Therefore, a conclusion can be drawn that the company bases its technology and knowledge management mainly on basic technology. This can be seen as a means of securing the distribution of energy to customers (Takala et al. 2016). Moreover, the amount of spearhead technology might be small compared to the basic technology, which indicates low uncertainty with regard to basic technology as a reasonable and positive outcome (Takala et al. 2016).

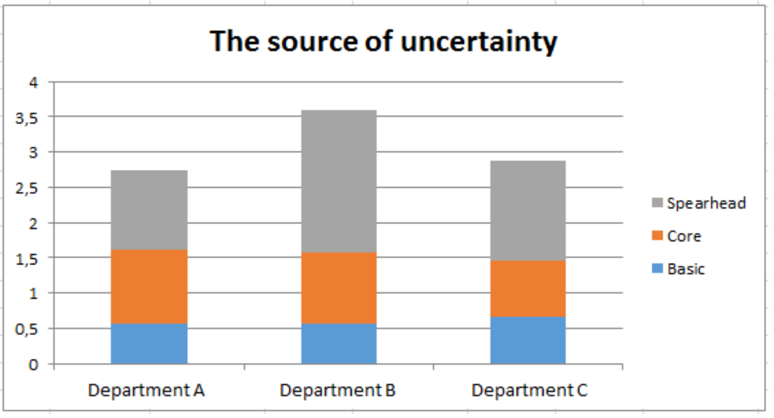

Figure 28. The source of uncertainty in the case company.

The same kind of analysis regarding the source of uncertainty can also be conducted with the sand cone model based on the technology levels (Figure 29, below). In this model, the department sand cones are replaced with sand cones depicting uncertainty in basic, core and spearhead technology. As can be noted, spearhead technology is the greatest source of uncertainty in this analysis too. Moreover, the sand cone model of technology levels facilitates deeper analysis of uncertainty between the individual criteria. For example, it can be observed how the uncertainty in C1, which is among the highest in each department's sand cone (in Figure 27), is almost solely caused by the variability of the spearhead technology.

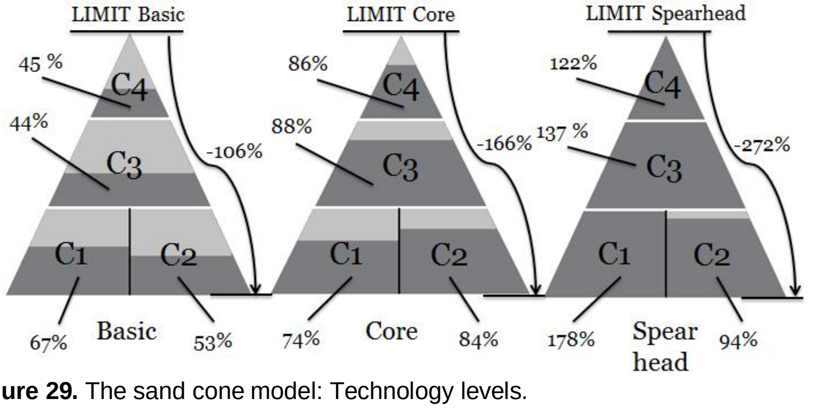

Figure 29. The sand cone model: Technology levels.

The sand cone model including the firm's technology levels can also be built for each department separately. As can be seen, the illustration in Figure 29 combines all three departments and thus depicts the overall situation in the company. The same illustration for department A can be seen in Figure 30. From this figure, we can see how good the department's situation is in terms of basic technology, finding consensus across decision makers. By contrast, the core and spearhead technology categories are slightly more challenging.

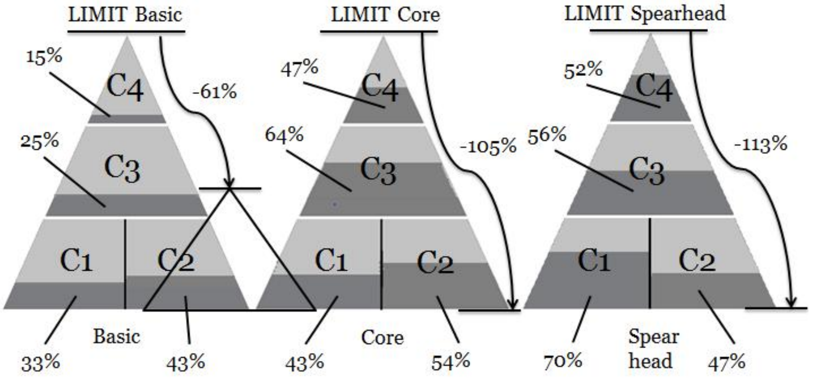

Figure 30. K/T sand cone: department A.

Figure 31 illustrates the same situation in department B. The collapse risks for department B, as presented Figure 27 are the highest of the three analysed departments and the uncertainty thus seems unbearable. However, from Figure 31 we can see how this variability is almost entirely attributable to the spearhead technology. In terms of basic technology, the total uncertainty (or T&K-uncertainty) is actually less than in the other two departments. The importance of this kind of sand cone illustration is thus underlined, as it offers crucial information regarding the overall situation.

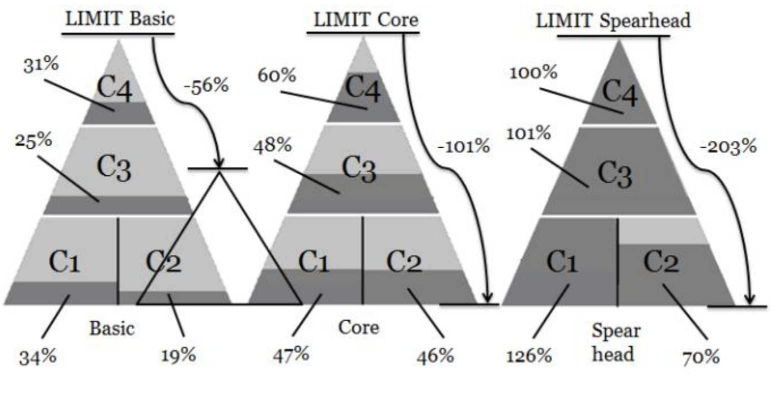

Figure 31. K/T sand cone: department B.

Finally, the last figure (Figure 32) illustrates the state of affairs in department C, which is in the best position of the three departments with regard to core technology. In the same manner as the above analyses, it can be observed that the high level of uncertainty in C1, which was the most worrying in Figure 27, is attributable to the variability of spearhead technology. Thus, this kind of analysis facilitates focus on the specific source of uncertainty to one department, a specific technology type and even to specific criteria, thereby saving time and resources as the company plans how to focus its efforts in its management of technology and knowledge.

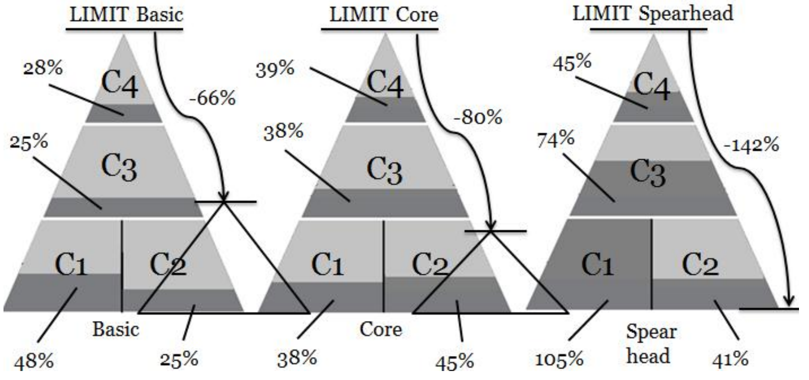

Figure 32. K/T sand cone: department C.

All the results illustrated in the above sand cones were validated through market-based validation, as introduced by Kasanen, Lukka and Siitonen in their article "The Constructive Approach in Management Accounting Research" (1993). Market-based validation comprises three market test, two of which were used in this study of uncertainty modelling. The first market test used in this research was the weak market test, which requires the manager responsible for financial results in their business unit to be willing to use the results in their actual decision-making. In other words, the weak market test can be passed only if the manager considers the results to be credible. The second test used was the semi-strong market test, which requires the company to provide practical data to support the results, rather than "just" requiring an individual manager to believing in the results. Finally, the strong market test requires financial data to back the results and, therefore, it is the most demanding of the market tests. (Kasanen et al. 1993: 253.)

3.4.8 The modelling of knowledge- and technology-based uncertainty

In order to model knowledge- and technology-based uncertainty, the decision-making criteria should first be selected. After identifying the criteria to be applied, AHP is used to determine the strategic weights, as explained in Chapter 3.4.1. Next, the weights are inserted into the sand cone model, based on principles introduced by Takala et al. (2006) and presented in this workbook in Chapters 3.4.3 and 3.4.7.

The actual process concerning K/T rankings is best initiated by naming some examples of each technology level (basic, core and spearhead), as illustrated in Table 5. A competitive strategy should take into account the fact that technology levels change over time. This can be seen, for example, in Chapter 3.4.6, in which technology levels and their connection to the product life cycle were presented, especially in Figure 24. Therefore, the utilized time perspective should also be determined, since technology levels are dynamic rather than static.

After naming the example technologies and thoroughly explaining the process to the participants, the K/T questionnaire can be completed by the respondents as explained in 3.4.7 (see Table 6). From the K/T questionnaire answers, variability coefficients can be calculated using equation 13. The calculation process is illustrated in the following Excel screenshot (Figure 33).

	A	B	C	D	E	F	G	H	I	J	K
1		**Department C**									
2		**Technology Average Value**			**Technology STDEV**			**Technology IMPL**			
3	Criteria	Basic	Core	Spearhead	Basic	Core	Spearhead	Basic	Core	Spearhead	**Variability coefficient**
4	**C1**	45,83	34,17	20	22,00	12,81	20,98	0,48	0,38	1,05	**1,21**
5	**C3**	55	34,17	10,83	13,78	12,81	8,01	0,25	0,38	0,74	**0,87**
6	**C4**	50,83	27,5	21,67	14,29	10,84	9,83	0,28	0,39	0,45	**0,66**
7	**C2**	55	26,67	18,33	13,78	12,11	7,53	0,25	0,45	0,41	**0,66**
8					**The source of uncertainty**			**0,66**	**0,80**	**1,42**	**T&K Uncertainty**
9											**1,76**

Figure 33. Calculating the variability coefficients.

The technology averages and standard deviations (STDEV) in Figure 33 are calculated for each criterion from the answered basic, core and spearhead technology levels. Next, a so-called implementation (IMPL) index is calculated by dividing the STDEV by the corresponding average value (Mäkipelto 2010: 29). The IMPL index is used to describe the relationship between the STDEV and the priority assigned to the criterion by the respondents (Leskinen & Takala 2005: 42). To calculate the variability coefficients (indicating the uncertainty) the root mean squared (RMS) sum of the IMPL indexes is taken. The coefficients are then inserted into the sand cones in the form of collapses (as can be seen in Figure 27). In addition, the total amount of technology- and knowledge-based risk is calculated from the individual departments' variability coefficients, using equation 14 (cell K9 in Figure 33). "The source of uncertainty" (as shown in Figure 28) is calculated by taking the sum and RMS of the IMPL indexes in the basic, core and spearhead columns (for example, with basic technology from cells H4:H7).

The variability coefficients of the technology levels in Figure 29 are also calculated using equation 13, and the values are illustrated in the Excel sheet below (Figure 34) For example, the value in cell AG4 is calculated from each department's IMPL index values, which are located under "basic" and after "C1". In the previous figure, this cell would be H4. The T&K-uncertainty values (cells AG9:AI9 in Figure 34) are then again derived from the variability coefficients using equation 14 (always above in the same column). Finally, the K/T sand cones for the individual departments (Figures 30–32) are directly based on IMPL index values and the total uncertainty values are then derived using the same calculation as in “the source of uncertainty” (in Figure 33).

	AF	AG	AH	AI
1				
2		Variablity coefficient		
3	Criteria	Basic	Core	Spearhead
4	C1	0,67	0,74	1,78
5	C3	0,44	0,88	1,37
6	C4	0,45	0,86	1,22
7	C2	0,53	0,84	0,94
8		T&K -uncertainty		
9		1,06	1,66	2,72

Figure 34. Variability coefficient for the sand cones regarding technology levels.

3.4.9 Roadmapping

Technology portfolio management is a strategic task that presents multilevel organizational challenges and must be integrated into the organization’s management process. The technology roadmap is tool that serves this purpose. A roadmapping process can be defined as: “mapping innovation elements to a timeline concerning the activities of identifying, allocating, ordering and interlinking innovation elements of technology foresight, long-term market encounters and product line evolutions on a map with a timeline related to the future” (Simonse et al. 2015).

A roadmap is a visual portrait of market/product/technology plans, plotted on a timeline and used to plan time pacing as well as synchronizing dialogue (Simonse et al. 2015). Most roadmaps in business are primarily targeted at supporting the synchronization of technology and product or service planning. Other types of roadmaps have evolved to fit other needs, such as integrating technology into organizational capabilities, exploring business opportunities, long-term planning, etc. (Phaal et al. 2001). Technology-related roadmaps can be roughly classified according to four categories (Albright & Schaller 1998):

1. Science and technology roadmaps
2. Industry technology roadmaps
3. Corporate or product-technology roadmaps
4. Product/portfolio management roadmaps.

Using innovation roadmapping enables firms to match their market dynamics and timing to “an excellent review of product direction and technology timing” (Willyard

& McClees 1987). The report maps the current status of technology and offers recommendations for further development. The timing of a firm's search for new innovations can be seen to be critical to its competitive position.

Assessment of a firm's innovative capabilities and existing technologies provides insights regarding the quality of fit between its current business strategy and innovative capabilities. The creation of a technology roadmap focuses initially on literature analysis to identify technologies and key experts in the area. A practical approach follows a six-step procedure:

1. Define the problem or opportunity to be addressed
2. Identify technology components
3. Examine the literature to identify critical technology components
4. Identify experts
5. Convene experts in workshops
6. Construct the roadmap.

The visual emphasis of roadmapping offers considerable potential in social sciences and business studies. Roadmaps can be utilized as visual narratives that describe the most critical elements and paths for the future development of the central topic. This visual emphasis facilitates the use of roadmaps as strategy pictures that open perspectives to both overall macro-level factors and selected micro-level developments. It also enables a vision of the future so as to identify critical paths within roadmap layers, including drivers or enabling technologies, and to link societal drivers to more specific product or solution developments (Ahlqvist et al. 2010).

VTT has developed a modular roadmapping process. Modularity provides opportunities to link different elements of the roadmap in a flexible manner. This facilitates, for example, tailoring of the roadmapping process to specific needs. The modules are as follows (Ahlqvist & Myllyoja 2011):

1. Drivers and bottlenecks, referring to societal development trajectories.

2. Markets, focusing on market dynamics and the business environment of the topic area.

3. Business concepts, characterizing the visionary business concepts of the topic area.

4. Applications/services, describing the visionary applications or services of the topic area.

5. Enabling technologies, describing technologies that enable the applications, services and business concepts of the topic area.

3.5 Combined use of methods

Assessing the value of investments can be considered to be a multidimensional problem and a continuous process wherein the decision maker is confronted with multiple needs, requirements and values as depicted in this workbook. This typically requires the use of various appraisal methods, which can give a balanced view to the achievement of investment goals. The "integration" of methods can be discussed in a variety of contexts (Bond et al. 2001):

- To enable various methods to be applied at similar points in time.
- To use consistent methods and, when combined in an overall appraisal, to avoid gaps and overlaps in their coverage.
- To provide cross-disciplinary insights that may not be fully acknowledged in a single appraisal.

The assessment framework depicted in this workbook is a practical framework for supporting the integrated impact and risk assessment of investments (see also Chapter 2.3). The appraisal focuses on the assessment of the risk, economic and social consequences of alternative investments and is based on the research and analysis of case studies (see Chapters 3.1.2, 3.2.2, 3.2.3, 3.3.4 and 3.4.7)), each of which have significant economic and social dimensions. The assessment is both semi-quantitative and quantitative in nature, based on quantitative data and expert judgement. The methodological approach followed is visualized in the following figure (Figure 35).

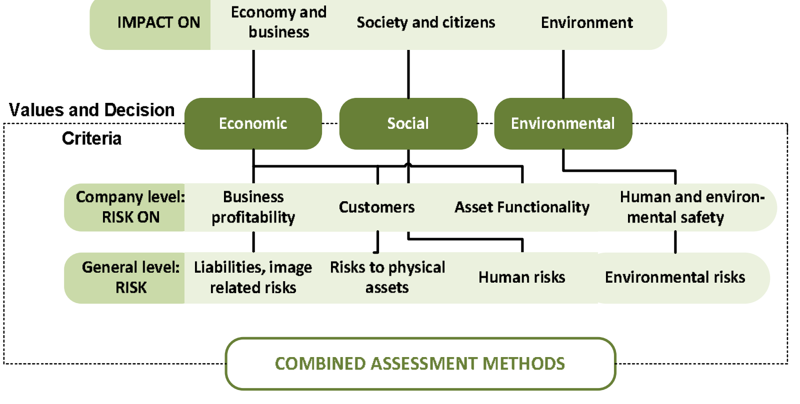

Figure 35. Combined assessment framework of investment options.

Recently, the trend towards and need for sustainable development and sustainable business growth has led to a growing interest in integrated impact and risk assessment. However, such combined assessment is still in its infancy and more development is needed to relate different assessment methods to one another.

Obviously, a single standardized method is insufficient for assessing investments and the actual decision should be based on several decision criteria. In practice, decision makers should also understand the key assumptions behind combined assessments, how the assessments were executed, and what the final results really mean. The nature of the appraisal also depends on the available time, financial resources and information, and the viewpoint (business, society, citizens) from which the assessment is made. It is essential that the assessment methods applied align with the quality and amount of data available. Moreover, the required depth of the assessment is dependent on the actual investment decision situation. Due to the multidisciplinary nature of the assessment, the various results must be interpreted together before the final synthesis or recommendations are offered.

In view of the long time horizon, applying a more integrated approach to such assessments generates several benefits, including advancing companies and stakeholders' abilities to manage investments and to support the goal of sustainable business growth. In the future, there will be greater need for more integrated investment assessment and for combining economic, social and environmental impact assessment procedures to support multi-objective investment decision-making.

4. Conclusions

Investments are vital to a company's future and must be carefully planned to deliver both immediate and long-term benefits. Hence, a company's ability to communicate impacts and risks of investments to the local society, people, investors and other stakeholders can provide a competitive advantage. The keys to future success are investments whose value is not only expressed in terms of money, but also in terms of sustainability, reliability, safety, quality, social acceptability and other typically intangible criteria.

The wider value perspective has rarely been included in such assessments up to now. This is mainly because these value elements are typically difficult to measure solely in economic terms, and there is thus a lack of models and approaches by which to address the importance of such indirect and intangible impacts. In addition, there is often pressure to demonstrate short-term effects rather than to emphasize the investment's entire life cycle.

As mentioned in the introductory chapter, the purpose of the MittaMerkki research project, and consequently of this workbook, was to support companies in their aim to make successful and risk-conscious investment decisions and to incorporate the wider value perspective into their investment decision-making. From this perspective, it enhances companies' abilities to plan investment processes, to assess investments and to support the related decision-making in a systematic manner. The procedures described are not tied to any specific branch of industry. However, the subject matter concerns, in the first place, companies that aim to generate social and environmental impact alongside financial return to investments.

The condition of knowledge uncertainty may compromise decision-making regarding investments for operational competitiveness within knowledge intensive business services (KIBS). This brand-new challenge is increasingly relevant due to strategic choices regarding local and global growth or scarcity, and different time perspectives of different investments – immediate outputs, short-term outcomes and long-term impacts – that we need to take into account, especially from a strategic perspective. Over the course of this two-year project, we have studied risk reduction methods for investment decisions within KIBS via case studies within different industries, including city energy and water infrastructure, housing, vocational training and humanitarian aid-related services. The operational competitiveness of the investments has been considered from the perspective of risk reduction by developing demonstration tools that these case industries may utilize for their own, more specific service developments.

Uncertainties regarding technology choices, especially from the strategy perspective, may compromise investment projects with regard to, for instance, their budgets and timetables. In this project, investments in city infrastructure were studied via risk reductions-based decision-making methods, in which strategy and uncertainties related to technology choices, primarily, are accounted for through sand cone models of operational competitiveness. Investment outputs, outcomes, impacts and (operational) macro- and micro-level SCA have been successfully studied, with demonstration tool presentations of the results for humanitarian aid and housing services investments, including some quite deep comparisons between a number of countries, chosen on the basis of collaboration with university partners.

Regarding the long-term horizon, applying a more integrated approach to investment assessments will generate several benefits, such as advancing companies and stakeholders' abilities to manage investments and to support their goal of sustainable business growth. We are convinced that, in the future, there will be growing need for more integrated assessment of investments and for combining economic, social and environmental impact assessment procedures to support multi-objective investment decision-making. We consider that the results of the MittaMerkki project can usefully inform further applications and developments of an integrated approach to investment assessment and risk-conscious investment decision-making in companies.

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Title	**Towards risk-conscious investment decision-making and value creation**
Author(s)	Minna Räikkönen, Josu Takala, Rayko Toshev, Tero Välisalo, Teuvo Uusitalo, Susanna Kunttu, Sara Tilabi, Hosein Daneshpour, Shah Rukh Shakeel, Patrick Zucchetti, Anne-Mari Vatunen
Abstract	Investments are vital to a company's future and must be carefully planned to deliver both immediate and long-term benefits. Hence, a company's ability to communicate the impact and risks of an investment to local society, people, investors and other stakeholders can provide a competitive advantage. The keys to future success are investments where value is not only expressed in terms of money, but also in terms of sustainability, reliability, safety, quality, social acceptability and other typically intangible criteria. The wider value perspective has rarely been included in such assessments up to now. This is mainly because these value elements are typically difficult to measure solely in economic terms, and there is thus a lack of models and approaches by which to address the importance of such indirect and intangible impacts. In addition, there is often pressure to demonstrate short-term effects rather than to emphasize the investment's entire life cycle. The purpose of this workbook is to support companies in their aim to make successful and risk-conscious investment decisions and to incorporate the wider value perspective into their investment decision-making. From this perspective, it will enhance companies' abiilities to plan investment process, to assess investments and to support the related decision-making in a systematic manner. The procedures described are not tied to any specific firm or branch of industry. However, the subject matter concerns, in the first place, companies that aim to generate social and environmental impact alongside financial return to investments. The workbook is aimed at all managers and staff involved in investment planning and decision-making, strategy and business development. The workbook is based on the results of MittaMerkki, a Tekes research project funded by the New Value Creation call. The project was carried out between 2015 and 2016 in close cooperation between the VTT Technical Research Centre of Finland Ltd and the University of Vaasa, as well as four companies from various sectors of industry and service business in Finland: TVT Asunnot Ltd, Jyväskylän Energia Ltd, TEAK Ltd and Humming World Ltd.
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Nimeke	**Merkityksellisyyden ja hyötyjen mittaaminen ja arvo päätöksenteossa**
Tekijä(t)	Minna Räikkönen, Josu Takala, Rayko Toshev, Tero Välisalo, Teuvo Uusitalo, Susanna Kunttu, Sara Tilabi, Hosein Daneshpour, Shah Rukh Shakeel, Patrick Zucchetti, Anne-Mari Vatunen
Tiivistelmä	Epävarmassa taloustilanteessa yritykset pyrkivät turvaamaan taloudellisen asemansa, eikä varsinkaan volyymin kasvuun tähtääviä investointeja tehdä. Yritysten tulisi kuitenkin myös kysynnän murroksessa pyrkiä jatkamaan strategista kehittämistään sekä toteuttaa liiketoiminnan muutosta tukevia aineellisia ja aineettomia investointeja. Onnistuneilla investointipäätöksillä pystytään varmistamaan yrityksen kyky tuottaa kestävää arvoa sidosryhmilleen. Investointipäätöksiin liittyy aina useita eri näkökohtia, jotka pitää ottaa huomioon. Päätöksenteon tukena tulisi hyödyntää menetelmiä, jotka integroivat laaja-alaisesti koko elinkaaren sosiaalisten, taloudellisten ja ekologisten hyötyjen sekä riskien arvioinnin ja jotka tukevat riittävästi myös asiakasarvon määrittämistä ja kytkentää osaksi investointien arviointia. Tällöin investointien kokonaishyöty ja merkityksellisyys tulevat esiin. Tämän työkirjan tavoitteena on vastata yritysten kasvaneeseen tarpeeseen kehittää kestävää kilpailukykyä ja edistää investointien kysyntää tukemalla investointien arviointia ja investointipäätöksentekoa. Työkirjassa kuvatut menetelmät ja niitä tukevat sovellukset tarjoavat päätöksentekijöille ja koko arvoverkostolle mahdollisuuden arvioida eri investointivaihtoehtojen vaikutuksia ja vaikuttavuutta järjestelmällisesti. Kehitettyjä menetelmiä hyödyntämällä voidaan varmistaa, että päätöksenteon ja sen eri vaihtoehtojen merkityksellisyys, arvo ja riskit on käsitelty laaja-alaisesti jo investointiprosessin suunnittelu- ja määrittelyvaiheessa. Sovellusten avulla on mahdollista vertailla eri investointivaihtoehtoja ja niiden vaikutuksia. Vertailussa on mahdollista ottaa huomioon sekä taloudelliset että vaikeasti rahassa mitattavat hyödyt ja riskit. Työkirja on tarkoitettu yritysjohdolle ja muille henkilöille, jotka ovat mukana investointien suunnittelussa ja päätöksenteossa sekä strategian ja liiketoiminnan kehittämisessä. Työkirja perustuu MittaMerkki-tutkimusprojektin (Merkityksellisyyden ja hyötyjen mittaaminen ja arvo päätöksenteossa) tuloksiin. Projekti toteutettiin vuosina 2015–2016 osana Tekesin Uusi arvonluonti -tutkimushakua. Projektin tutkimusosapuolina toimivat VTT ja Vaasan yliopisto. Tulokset pilotoitiin ja testattiin yhteistyössä projektiin osallistuneiden yritysten (TVT Asunnot Oy, Jyväskylän Energia Oy, TEAK Oy ja Humming World Oy) kanssa.
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VTT TECHNOLOGY 282 Towards risk-conscious investment...

Towards risk-conscious investment decision-making and value creation

This publication is the outcome of a Tekes project entitled MittaMerkki ("towards risk-conscious investment decision-making and value creation"). The project was conducted through an interdisciplinary research consortium consisting of the VTT Technical Research Centre of Finland Ltd and the University of Vaasa in close collaboration with the project's case companies: TVT Asunnot Ltd, Jyväskylän Energia Ltd, TEAK Ltd and Humming World Ltd.

The aim of this workbook is twofold:
- To provide information and insights on how to make risk-conscious investment decisions and how to incorporate the wider value perspective into the investment decision-making process.
- To introduce practical methods and tools by which to evaluate investments and to assess uncertainty and risk to support investment decision-making.

The workbook is aimed at all managers and staff involved in investment planning and decision-making, strategy and business development.

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