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"Project Selection under Risk with
Contingent Portfolio Programming -
A feasibility Study in an
International Funds and Asset Management Company"

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Preface

This master thesis was produced under the guidance of Prof. Dr. Kurt Heidenberger.

I really enjoyed working on a topic, which combines the analysis of theoretical models and the practical application thereof in a real world environment.

Special thanks go to my wife Maren and my children Luna and Paul for enabling me to finalise my studies.

Vienna, April 2012

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AuM……………………………………..……Assets under Management

CEO…………………………………………..Chief Executive Officer

CFO…………………………………………..Chief financial Officer

CIO…………………………………..………Chief information Officer

CPP………………………………………….. Contingent portfolio programming

DA …………………………………..………Decision analysis

EDR…………………………………………. Expected downside risk

LP……………………………..…………..…..Linear Programming

LSAD………………………………..………Lower semi absolute deviation

PDA…………………………………...……...Portfolio Decision Analysis

TCO…………………………………...…...Total Cost of Ownership

List of Variables

EV	expected value of the resource position of all terminal states
LSAD	lower semi absolute deviation,
EDR	mean-expected downside risk
CE	certainty equivalent, decision makers target to maximize the CE of his or her resource position
B	initial budget
λ	Risk aversion coefficient
ρ	Risk adjusted discount rate
r_f / RFIR	Risk free interest rate
z	project z (z for projects, where $z \in Z$); $Z = \{A, B, C, D, E; F, G, H, I, J\}$
S_0	Terminal state 0, decision if to start projects Yes / No
S	The set of all states and St denotes the set of states in period t**.**
X_{zSY}	Decision variable indicates to start project z at $S_{0,}$ Y (Yes), binary
X_{zCY1}	Decision variable to continue project z at state 1
X_{zCY2}	Decision variable to continue project z at state 2
RS_{S0}	Resource surplus at state S_0
V_S	denotes the value of the resource position in state S
ΔV^+_{S11}	deviation variable for risk measurement, indicates how much the value of the DMs resource position exceeds (+) in a specific terminal state (e.g. S_{11}) the expected value
ΔV^-_{S11}	deviation variable for risk measurement, indicates how much the value of the DMs resource position falls short (-) in a specific terminal state (e.g. S_{11}) the expected value

1 Introduction and Overview

This paper focuses on the practical application of a project selection approach defined in "contingent portfolio programming for the management of risky projects" by Janne Gustafsson and Athi Salo[1].

To prove the feasibility of the application, the following thesis has been put forward:
The model described in "contingent portfolio programming for the management of risky projects"[2] is able to support the project portfolio decision making process of an international funds- & asset management company.

The discussion of the thesis should provide insight as to where to allocate the application of the model in the corporate planning and decision making processes, so as to derive the necessary conditions for a successful implementation and analysis of the results.

To prove the thesis the following key questions will be elaborated on:

1. What is the model about? – Chapter 2 "Description of the model"
2. What are the preconditions for performing project selections within the surveyed company? – Chapter 3 "Excursus planning- and project portfolio theory"
3. What are the effects of a decision maker's behaviour? - Chapter 4 "Introduction of the company's situation" and Chapter 5 "Preparation of missing input"
4. How to setup the model? – Chapter 6 "Building the LP Model"
5. How applicable are the results? – Chapter 7 "Calculation and analysis of the results" and Chapter 8 "Interpretation of results"

Chapter 2 explains the theory of the model itself.

Chapter 3 will discuss the relevant planning and project portfolio theory to be able to describe the necessary framework for the elaboration of the decision parameters.

Chapter 4 describes the company, the understanding of innovation within the company, the existing decision authorities and the required adaptions.

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[1] Cf. Gustafsson and Salo, Operations Research, 2005
[2] Cf. Gustafsson and Salo, Operations Research, 2005

Chapter 5 explains the collection and preparation of missing input from strategic-, operational - and tactical planning.

Chapter 6 shows the application of the model, including the basic parameters. Furthermore a project portfolio decision will be prepared.

Chapter 7 analyses and interprets the results.

In Chapter 8 the findings are summarised and the potential for improvements to the model and its applications will be proposed.

2 Description of the Model

The theoretical model describing contingent portfolio programming is embedded in portfolio decision analysis a subfield of DA.

2.1 Decision Analysis

The analysed theoretical model belongs to the field of decision analysis (DA) that deals with the omnipresent problem of resource allocation and which is valid for all kinds of business and government organisations.

"Stated quite simply, we typically have more good ideas for projects and programs than funds, capacity, or time to pursue them. These projects and programs require significant initial investments in the present, with the anticipation of future benefits. This necessitates balancing the promised return on investment against the risk that the benefits do not materialize. An added complication is that organizations often have complex and poorly articulated objectives and lack a consistent methodology for determining how well alternative investments measure up against those objectives. "[3]

2.2 Portfolio Decision Analysis

Portfolio decision analysis (PDA) as a subset of DA is described as"…in contrast to traditional DA, it is important to recognize that resource allocation is a portfolio problem, where the decision makers must choose the best subset of possible projects or investments subject to resource constraints. "[4]

The application of models, like the one presented, in real-world organisations also requires state-of-the-art techniques and processes for defining probabilities and preferences, performing sensitivity analysis, and presenting clear and compelling results and recommendations.

[3] Cf. Salo, Keisler and Morton, 2011, page V
[4] Cf. Salo, Keisler and Morton, 2011, page V

Portfolio Decision Analysis (PDA) consits of a body of theories, methods, and practices, which support decision makers' selections from a discrete set of alternatives, by mathematical modeling and considering relevant constraints, preferences, and uncertainties.[5]

"A few introductory observations about this definition are in order. To begin with, *theory* can be viewed as the foundation of PDA in that it postulates axioms that characterize rational decision making and enable the development of functional representations for modeling such decisions. *Methods* build on theory by providing practicable approaches that are compatible with these axioms and help implement decision processes that seek to contribute to improved decision quality. *Practice* consists of applications where these methods are deployed to address real decision problems that involve decision makers and possibly even other stakeholders. Thus, applications build on decision models that capture the salient problem characteristics, integrate relevant factual and subjective information, and synthesize this information into recommendations about what subset of alternatives (or *portfolio*) should be selected. "[6]

In accordance to the PDA the mathematical model "contingent portfolio programming for the management of risky projects" developed in 2002 by Janne Gustafsson and Athi Salo will be discussed and its applicability will be analysed.

2.3 Contingent Portfolio-Programming

The model is based on the contingent portfolio-programming (CPP) concept. CPP defines projects as being risky if they consume or produce goods over several periods of time. Uncertainties are modelled using a state tree, which illustrates the structure of future states of nature – figure 1.
"In general terms, a decision tree describes the points at which decisions can be made and the way in which these points are related to unfolding uncertainties."[7]

At the terminal states shown at the times 0 and 1, project investments can be made. At the terminal states at time 2, project revenues will be collected. Using the CPP framework, projects are modelled using decision trees that span the state tree.

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[5] Cf. Salo, Keisler and Morton, 2011, page 4
[6] Cf. Salo, Keisler and Morton, 2011, page 4
[7] Cf. Gustafsson and Salo, Systems Analysis Laboratory Research Reports, 2005, page 3

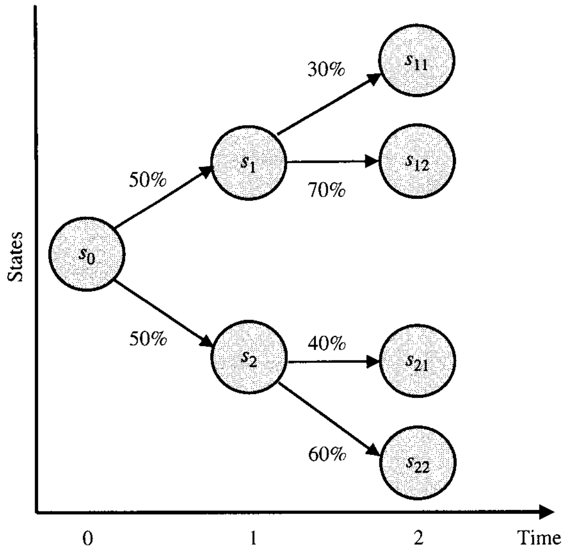

Figure 1: States of nature.

Source: Cf. Gustafsson and Salo, Operations Research, 2005, page 948

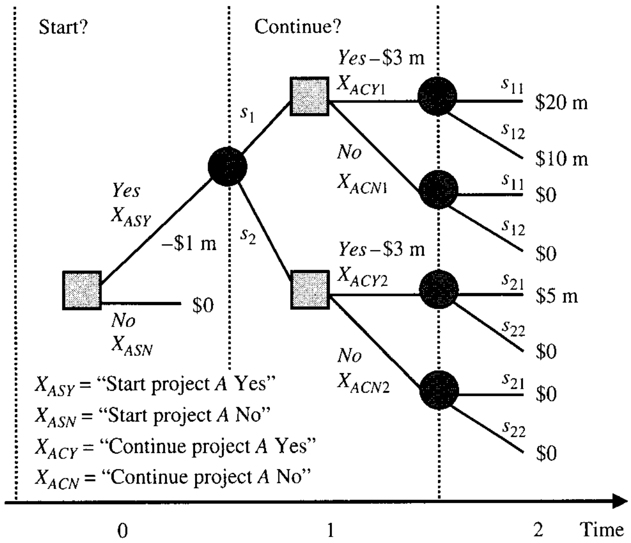

Figure 2: A decision tree for a project.

Source: Cf. Gustafsson and Salo, Operations Research, 2005, page 948

"Figure 2 describes how project decision (left part of the figure), when combined with the state tree in figure 1, lead to project specific decision trees (right part of the figure). The specific feature of these decision trees is that the chance nodes - since they are generated using the common tree – are shared by all projects."[8]

Contingent portfolio programming is furthermore based on a mean risk model (Markowitz 1959, 1987) and a multi attribute value function, especially subsets of these models: a mean lower semi absolute deviation model (LSAD; see Ogryczak and Ruszsynski 1999) and a mean expected downside risk model or mean EDR model (see Eppen et al. 1989).

In contrast to earlier approaches in decision analysis the CPP concentrates on:

- States of nature to capture exogenous uncertainties.
- Dynamic state variables to model resources.
- The risk attitude of the decision maker.

The CPP model is based on constraints and an objective function. These are defined based on resource types, a state tree and project specific decision trees.

Constraints

- Decision consistency constraints
- Resource constraints
- Optional constraints
- Deviation constraints

Objective function, the investor maximises her terminal wealth level:

- Linear preference model
- Risk measures
- Mean risk model

The following part explains the required approach towards resources, state trees and projects, then discusses the models constraints and its objective function.

[8] Cf. Gustafsson and Salo, Systems Analysis Laboratory Research Reports, 2005, page 3

2.4 Resources

Resources are considered as input or output, which are consumed or produced by projects. In general, a resource can be any asset in which the decision maker is interested.

r = a resource type

R = the set of all resource types

2.5 States of Nature

"The time-state model of CPP is a state tree that represents the structure of future states of nature"[9] Each state remains on the same period within the planning horizon t.

$t = \{0,...,T\}$

S is the set of all states and St denotes the set of states in period t**.**

$S = \bigcup_{t=0}^{T} S_t$

t(s) denotes the time period of a state $s \in S$. In period 0 the state tree starts with a single base state S_0. "Each state, $s' \in S_{t-1}$, $0 < t \leq T$, is followed by at least one state $s \in S_t$. This relationship is modelled by the function $B{:}S \rightarrow S$, which returns the unique (immediate) predecessor $s' \in S_{t-1}$ of state $s \in S_t$, $t>0$ (by convention, $B(s_0)=s_0$). The nth predecessor of $s \in S_t, t>0$ is defined recursively by $B^n(s)=B(B^{n-1}(s))$, where $B^0(s)=s$. This function can be used to obtain the states on a path from the base state s_0 to state s. These states, together with state s, are contained in $S^B(s)=\{s' \in S \mid \exists k \geq 0$ such that $B_k(s)=s'\}$."[10]

States are the results of uncertain events, for example market fluctuations.

"The probability that state $s \in S_t (t > 0)$ obtains, subject to the assumption that its predecessor B(s) has occurred, is given by the conditional probability $p_{B(s)}(s)$.

[9] Cf. Gustafsson and Salo, Operations Research, 2005, page 950
[10] Cf. Gustafsson and Salo, Operations Research , 2005 page 950

The base state s_0 occurs with probability one → $P(s_0)=1$.

Unconditional probabilities for the other states $s \in S_t, t > 0$, are computed recursively from the equation $p(s)=p_{B(s)}(s) \cdot p(B(s))$."[11]

2.6 Projects

Decision points and resource flows describe projects.

Decision Points:

The decision opportunities are structured as decision trees, the nodes are the decision points and at the decision points the decision maker takes decisions on single projects. At each decision point the decision maker knows the status $s(d) \in S$ assigned and action taken at previous stages of the individual project. Each decision point has one unique parent action, meaning a consistent tree is assumed.

Following notations will be used:

z for projects, where $z \in Z$

D_z for the set of decision points, $d \in D_z$

a as the action which can be taken at a decision point, $a \in A_d$

d(a) is the decision point where action a can be taken.

d_z^0 is the first decision point of project z

For each action a there is one action variable X_a. If it is decided to continue the project X=1 if not, X=0.

X_z describes a project management strategy defined by the action variables associated with the decision points of project z.

[11] Cf. Gustafsson and Salo, Operations Research, 2005 page 950

X describes the portfolio management strategy as the decision maker's plan of action for all projects and all states.

Resource Flows

"The project management strategy X_z induces the resource flow $RF_z^r(X_z,s)$ of resource type r in state s. Letting $c_a^r(s)$ denote the flow of resource type r in state s due to the action a, this flow is given by

$$RF_z^r(X_z, s) = \sum_{d \in D_z; s(d) \in S^B(s)} \sum_{a \in A_d} c_a^r(s) \cdot X_a$$

Where the restriction in the summation of decision points ensures that the actions influence resource flows only in the current state and relevant future states. The aggregate resource flow $RF^r(X,s)$ in state s is obtained by adding the flows for all projects: e.g.

$$RF^r(X,s) = \sum_{z \in Z} RF_z^r(X_z,s) = \sum_{z \in Z} \sum_{\substack{d \in D_z: \\ s(d) \in S^B(s)}} \sum_{a \in A_d} c_a^r(s) \cdot X_a \text{ ."}[12]$$

In the analysed model, linear action variables are used, which means that interactions like synergies within the projects are not considered.

2.7 Constraints

The CPP has 4 major categories of constraints. They are: decision contingency constraints, resource constraints, optional constraints and deviation constraints.

Decision Consistency Constraints

"Decision consistency constraints implement the projects' decision trees. They require that (i) at each decision point at which the investor arrives, only one action is selected, and that (ii) at each decision point at which the investor does not arrive, no action is taken, implying that the point does not incur any cash flows."[13]

[12] Cf. Gustafsson and Salo, Operations Research, 2005, page 950
[13] Cf. Gustafsson and Salo, Systems Analysis Laboratory Research Reports, 2005, page 11

At each decision point, the number of available actions from which you can choose is the same as the number available at the parent action's decision point, except starting node or base decision point d_z^0. The decision maker can choose only one of the alternatives for each project at each decision point.

L_z is the number of selected actions

$$\sum_{a \in A_{dz}^0} X_a = L_z \;\; \forall z \in Z \;\; \forall z \in Z\,, \tag{1}$$

$$\sum_{a \in A_{dz}^0} X_a = X_{ap(d)} \;\; \forall d \in D_z \setminus \left\{ d_z^0 \right\} \forall z \in Z \tag{2}$$

Resource Constraints

"Budget constraints ensure that there is a nonnegative amount of cash in each state. They can be implemented using continuous cash surplus variables CSω, which measure the amount of cash in state ω."[14] In Gustafsson and Salo[15] the notation V_s is used instead of CSω and s instead of ω.

Resource constraints are required to ensure that no more is spent than is available. They are modelled through resource surpluses in state $s \in S$. The surplus of portfolio strategy X of resource type r in state $s \in S$ is

$$\forall s \in S \setminus \left\{ s_0 \right\} \forall r \in R\,.$$

Where b is the initial stock of resource r in state $s \in S$ and $\alpha^r_{B(s) \to s}$ is the rate at which the surplus in state B(s) is transferred to s. "The transfer rate may depend on the resource type, e.g. for money it can be (1+risk free interest rate). The resource variables RS_s^r are continuous, for a given portfolio strategy X, they can be solved using following constraints."[16]

$$RF^r(X, s_0) - RS^r_{s0} = -b^r(s_0) \;\; \forall r \in R$$

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[14] Cf. Gustafsson and Salo, Systems Analysis Laboratory Research Reports, 2005, page 11

[15] Cf. Gustafsson and Salo, Operations Research, 2005

[16] Cf. Gustafsson and Salo, Operations Research, 2005, page 951

$$RF^r(X,s)+\alpha^r_{B(s)\to s}\cdot RS^r_{B(s)}-RS^r_s=-b^r(s)\ \forall s\in S\setminus\{s_0\}\forall r\in R$$

Resource surplus constraints are usually nonnegative. This can be changed if for example the borrowing of funds should be allowed.

Optional constraints

Within the optional constraints any kind of additional restrictions can be incorporated, e.g. should 2 similar projects arrive at a specific decision node, only one could be continued.

2.8 Objective Function

The decision maker's aim is to maximise the utility at the final resource position.

$$\max U[X]$$

"Where U denotes the decision maker's preference functional and X is the value of the resource position in period T.

Under expected utility theory, the preference functional is given by

$U[X]=E[u(X)]$, where u is the decision maker's von Neumann-Morgenstern utility function."[17]

Three types of constraints are forced on the model:

- Budget constraints,
- Decision consistency constraints, and
- Risk constraints, which apply to risk-constrained models only.

Linear Preference Model

Focus is on two special cases in which the objective function is used to implement a reasonable model of risk aversion, which leads to a linear programming model.

[17] Cf. Gustafsson and Salo, Operations Research, 2005, page 951

"It is assumed that the decision maker's preference functional can be approximated as a mean risk model. We also assume that the value of the final resource position is firstly additive with regard to the resource types, and secondly linear with respect to the amount of surplus of each resource. For a given state, the total value of resource surpluses can be obtained by associating state-dependent weights w_s^r with each resource type. These weights can be interpreted as unit prices so that the monetary value of resource surpluses in state s is given by

$$V_s\left(RS\right) = \sum_{r \in R} w_s^r RS_s^r,$$

where RS_s is the vector of all RS_s^rs related to s and w_s^r is the unit price of resource type r in state $s \in S_T$. The expected (monetary) value of the terminal resource position is thus given by

$$EV_T(RS_T) = \sum_{s \in S_T} p(s) \cdot V_s(RS_s) = \sum_{s \in S_T} p(s) \cdot \sum_{r \in R} w_s^r \cdot RS_s^r \qquad (3)$$

where RS_T is a vector of all RS_s^rs for which $r \in R$ and $s \in S_T$."[18]

Risk Measures Including Deviation Constraints

The measures used to analyse risk are: an expected downside risk (EDR) model, and a lower semi absolute deviation (LSAD) model. The EDR model was introduced by Eppen et al. 1989. "In situations involving large amounts of capital, a decision maker may set a target value for the desired profit. The risk associated with a decision is then measured by the failure to meet the target profit."[19]

$$EDR[X] = \sum_{\substack{all\,x: \\ x<t}} p(x)|x\text{-}t| = \sum_{\substack{all\,x: \\ x<t}} p(x)(t\text{-}x)$$

p(x) denotes the probability mass function of X.

t stands for the target value from which deviations are computed.

When the target value is equal to the expression $s \in S_T$ $t = \mu_x = E\left[X\right]$

[18] Cf. Gustafsson and Salo, Operations Research, 2005, page 951

[19] Cf. Eppen et al., 1989, page 523

$$LSAD[X] = \sum_{all x; x<\mu_x} p(x)|x-\mu_x| = \sum_{all x; x<\mu_x} p(x)(\mu_x - x).$$

"Both measures can be calculated from deviation constraints as follows. Let ΔV_s^+ and ΔV_s^- be nonnegative deviation variables that measure how much the total value of the resource surpluses in state $s \in S_T$ (i.e., V_s) differs from the risk measure's target value t. For EDR, these variables satisfy the equations

$$V_s(RS_t) - t - \Delta V_s^+ + \Delta V_s^- = 0 \;\; \forall s \in S_T \qquad (4)$$

where only one of the ΔV_s^+ and ΔV_s^- can be positive, because ΔV_s^- has a negative coefficient in the objective function.

The EDR of the value of the final resource position is given by the sum

$$\sum_{s \in S_T} p(s) \cdot \Delta V_s^- \qquad (5)$$

The LSAD measure can be computed by using $t=EV_T(RS_T)$ in (4) instead of a fixed target value t. This leads to

$$V_s\left(RS_s\right) - EV_T(RS_T) - \Delta V_s^+ + \Delta V_s^- = 0 \;\; \forall s \in S_T \qquad (6)$$

wherafter the LSAD can be obtained form (5)."[20]

Mean Risk Model

The objective function can now be stated in the mean risk form

$$\max EV \sum_T (RS_T) - RP_T(\Delta V_T^-), \qquad (7)$$

where EV_T is defined by equation (3), and $RP_T(\Delta V_s^-)$ is given by

$$RP_T(\Delta V_T^-) = \lambda \sum_{s \in S_T} p(s) \cdot \Delta V_s^- \qquad (8)$$

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[20] Cf. Gustafsson and Salo, Operations Research 2005, page 952

λ denotes a trade off coefficient between the risk and the mean

"Mean-risk approaches are based on comparing two scalar characteristics (summary statistics), the first of which - denoted μ represents the expected outcome (reward), and the second - denoted r – is some measure of risk." [21]

$0<\lambda\leq\alpha$

"In particular, for the risk measure r defined as the absolute semi deviation (1) or standard semideviation (2), the constant α turns out to be equal to 1." [22]

"Deviation variables ΔV_s^- terms are obtained either from (4) (EDR) or (6)(LSAD). When the mean –risk model gives a certainty equivalent for a random variable, like the mean-LSAD model does, RP_T can be interpreted as the decision maker's risk premium. By substituting equations (3) and (8) into (7), the objective function becomes."[23]

$$\max\left(\sum_{s\in S_T} p(s)\left(\sum_{r\in R} w_s^r \cdot RS_s^r - \lambda \cdot \Delta V_s^-\right)\right).$$

ρ Risk adjusted discount rate accounts for time and risk preferences and is calculated using the formula:

$EV/1(1+\rho)^2=CE/(1+r_f)^2$

$\rho=(1+r_f)\sqrt{EV/CE}-1$

[21] Cf. Ogryczak and Ruszczynski, 1999, page 35

[22] Cf. Ogryczak and Ruszczynski, 1999, page 35

[23] Cf. Gustafsson and Salo, Operations Research, 2005, page 952

3 Excursus on Planning - and Project Portfolio Theory

This chapter analyses the necessary environment for the application of the model and defines where and how the model can be applied within a company's decision making process.

"A physical *portfolio* is essentially a binder or folder in which some related documents are carried together, a meaning which arises from the Latin roots port (carry) and folio (leaf or sheet). Likewise, an investment portfolio is a set of individual investments which a person or a firm considers as a group, while a project portfolio is a set of projects considered as a group."[24]

The project selection is embedded within management processes where it is influenced mainly by top down and bottom up planning processes.

"A portfolio decision process should *frame* the decision problem by defining what is in the portfolio under consideration and what can be considered separately, who is to decide, and what resources are available for allocation. "[25]

Top down planning process are: setting company strategies, defining major areas for investments, setting the limitations on resources and defining the expected benefits.

Bottom up planning processes, on the other hand comprise of: identifying all the business's demand for bottom up planning, selecting ideas, formulating and evaluating potential projects, and optimising resource utilisation within the boundaries imposed by top down planning.

Planning processes in both directions – top down and bottom up – result in investment decisions having to be made, which will be supported by the analysed model.

"Resource allocation decisions often involve decision makers at different levels of the organization with differentiated roles and responsibilities, which leads to the question of how portfolio decision analysis (PDA) activities at different levels can be best interlinked. For instance, PDA activities may focus on strategic and long-term perspectives that provide "top-down" guidance for operational and medium-term activities. But one can also build "bottom-up" processes where individual departments first carry out their own PDA processes to generate inputs that are taken forward to higher levels of decision within corporate management teams

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[24] Cf. Salo, Keisler and Morton, 2011, page 31

[25] Cf. Salo, Keisler and Morton, 2011, page 30

or executive boards. Such processes can be complementary, which means that the design of a process that is most appropriate for a given organization calls for careful consideration. ”[26]

In the following, the method of project selection will be analysed from several points of view to ensure that the preconditions for the successful application of the model are adequately recognised and met.

The following 3 concepts will be used to elaborate the required environment for the application of the model:

1) Research and development investments, Brockhoff (1999)[27]
2) Preconditions for a successful project portfolio management implementation; Kendall and Rollins (2003)[28]
3) Focus on processes for investment decisions to optimise IT enabled business investments, Control objective for information and related technology (COBIT 4.1), 2007[29] and IT Value Delivery (Val IT), 2004[30]

3.1 Research and Development Investments

The first approach is derived from the analysis of the “research and development - planning and controlling” approach described in Brockhoff (1999)[31].

Brockhoff is mainly addressing Research and Development investments, but this approach could also be used for the making of broader investment decisions. The following terms are to be differentiated[32]:

- “Basic principles’ planning” is the planning level at which the decision to invest at all will be made.
- “Strategic planning” is setting qualitative basic conditions for project selection in tactical planning.

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[26] Cf. Salo, Keisler and Morton, 2011, page 19
[27] Cf. Brockhoff, 1999
[28] Cf. Kendall and Rollins, 2003
[29] Cf. COBIT, 2007
[30] Cf. Val IT, 2006
[31] Cf. Brockhoff, 1999
[32] Cf. Brockhoff, 1999, page 150

- "Operational planning" deals with the resource restrictions, which are the result of tactical planning and bottom up planning. On the other hand the availability of future resources in the future will be strongly influenced by the demand generated by tactical planning.
- "Tactical Planning" covers processes ranging from collecting and evaluating ideas, through pre selection and selecting and evaluating project proposals, to project execution and controlling.

Figure 3 describes the interdependencies of the different planning levels. The counter flow of the bottom up and the top down planning is illustrated on the upper left section. The section on the right of the figure shows the necessary interaction between other areas of the company surveyed. The lower left section shows the support effort provided by the controlling unit in the different planning phases.

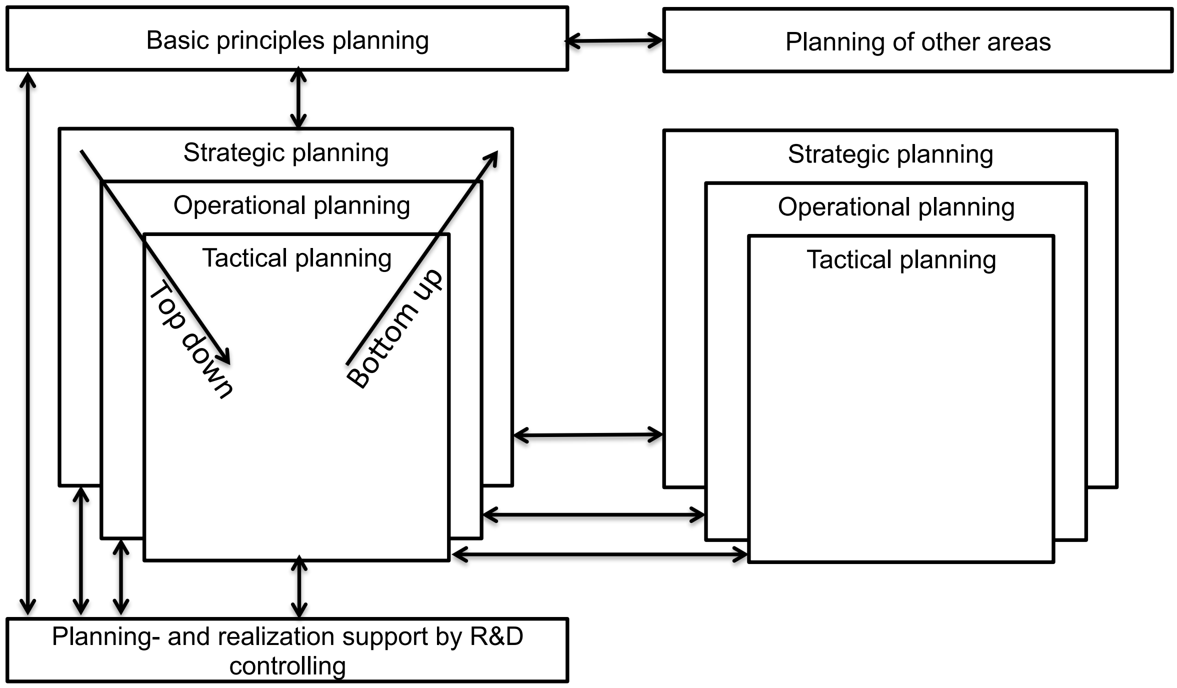

Figure 3: Schema of planning dependencies.

Source: Cf. Brockhoff, 1999, page 150

At the operational planning stage, Brockhoff places special emphasis on budget planning differentiated to the human resource (HR) planning. Human resource planning includes a baseline level for the standard amount of R&D. It also considers the increased demand derived from requirements of strategic importance. This is illustrated in the next figure:

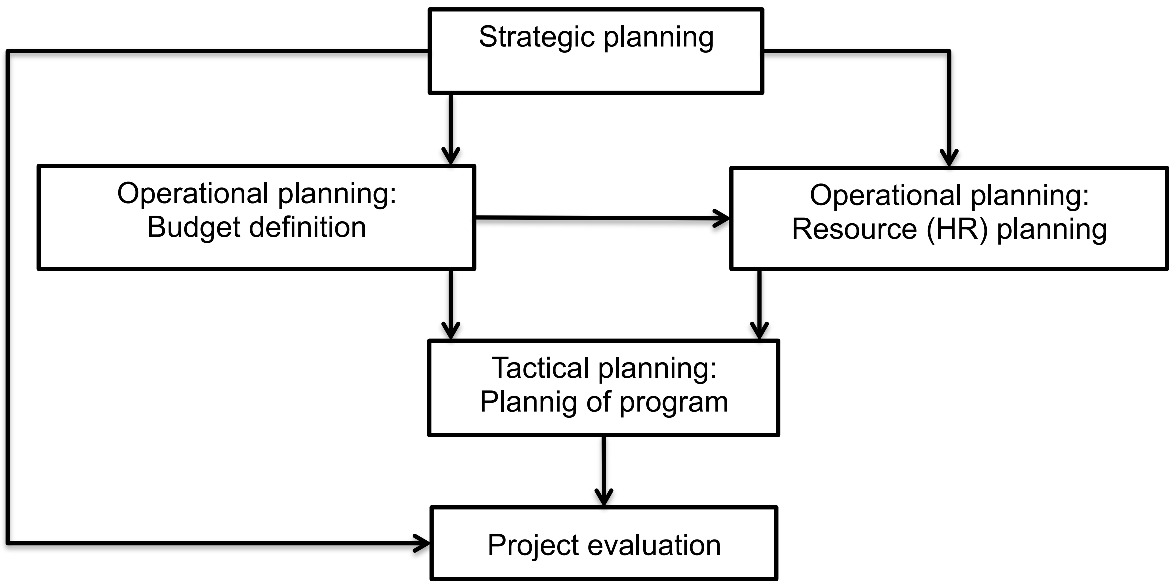

Figure 4: Illustration of planning correlations

Source: Cf. Brockhoff, 1999, page 322

In the subsequent chapters, the terminology introduced by Brockhoff, which relates to the planning phases will be kept.

3.2 Project Portfolio Management

The description of a project portfolio management function as a supporting set of roles and responsibilities to be established to support investment decisions, gives a different perspective from which we can elaborate on the requirements for creating appropriate project selection processes. Kendall, Gerald, I. and Rollins, Steven, C. (2003); provided[33] a detailed roadmap of how to implement a project portfolio management office in order to improve investment decisions.

Figure 5 gives an overview of all the major preconditions and dependencies, which need to be implemented. It begins by developing the company's strategies. From those goals, resource

[33] Cf. Kendall and Rollins, 2003

and asset portfolios are defined. Assets, in this case, refer to human capital. Selected projects will be evaluated and ranked based on their strategic fit, benefits, costs and risks. Company's management is in charge of setting the framework (top down), and then validating and adjusting that framework based on the changes happening. The project management office facilitates the processes, ensures good communication, prepares decisions, tracks and monitors execution and delivers decision material if the plans are changed.

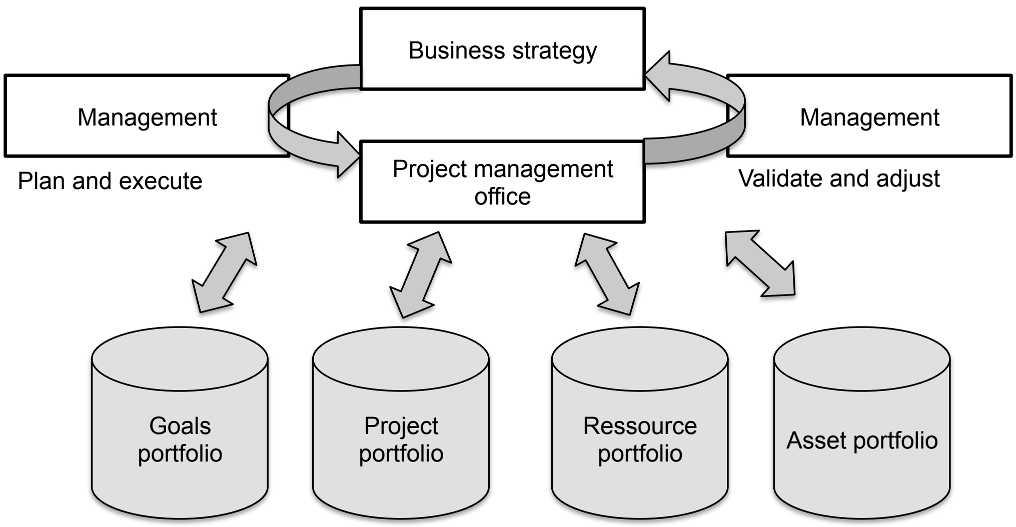

Figure 5: The portfolio management process.

Source: Cf. Kendall, Rollins, 2003, page 169

3.3 COBIT 4.1 and Val IT

COBIT (Control objective for information and related technology), is an international standard framework and supporting toolset that allows managers to bridge the gap between control requirements, technical issues and business risks.

Because the financial industry usually connects investment decisions in terms of innovation to IT investment, this framework seems to be appropriate.

It was created by ISACA (Information Systems Audit and Control Association), which is an international professional association that deals with IT Governance.

COBIT defines 34 processes for IT. It defines and aligns business targets with IT targets and processes.

Val IT (IT Value Delivery) is a governance framework that can be used to create business value from IT investments. It consists of guiding principles, processes and best practices to support and help executive management and boards at an enterprise level.

The latest release of the framework was published by IT Governance Institute (ITGI) was named *Enterprise Value: Governance of IT Investments, The Val IT Framework 2.0*.

Val IT is enhancing the COBIT approach to a company governance framework.

3.3.1 COBIT 4.1

"Every enterprise uses IT to enable business initiatives, and these can be represented as business goals for IT."[34]

COBIT is split into 4 domains "Plan and Organise", "Acquire and Implement", "Deliver and Support" and "Monitor and Evaluate", see Figure 6.

The important one for the implementation of the model is "Plan and organise (PO)"

Within the "Plan and organise"[35] domain there are 10 processes defined:

PO1 Define a Strategic IT Plan

PO2 Define the Information Architecture

PO3 Determine Technological Direction

PO4 Define the IT Processes, Organisation and Relationships

PO5 Manage the IT Investment

PO6 Communicate Management Aims and Direction

PO7 Manage IT Human Resources

PO8 Manage Quality

PO9 Assess and Manage IT Risks

PO10 Manage Projects

Two processes from the "Plan and organise" domain will be used to describe together with Val IT the conditions for the application of the CPP model.

PO1 Define a Strategic IT Plan

PO5 Manage the IT Investment

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[34] Cf. COBIT, 2007, page 11

[35] Cf. COBIT, 2007, page 28

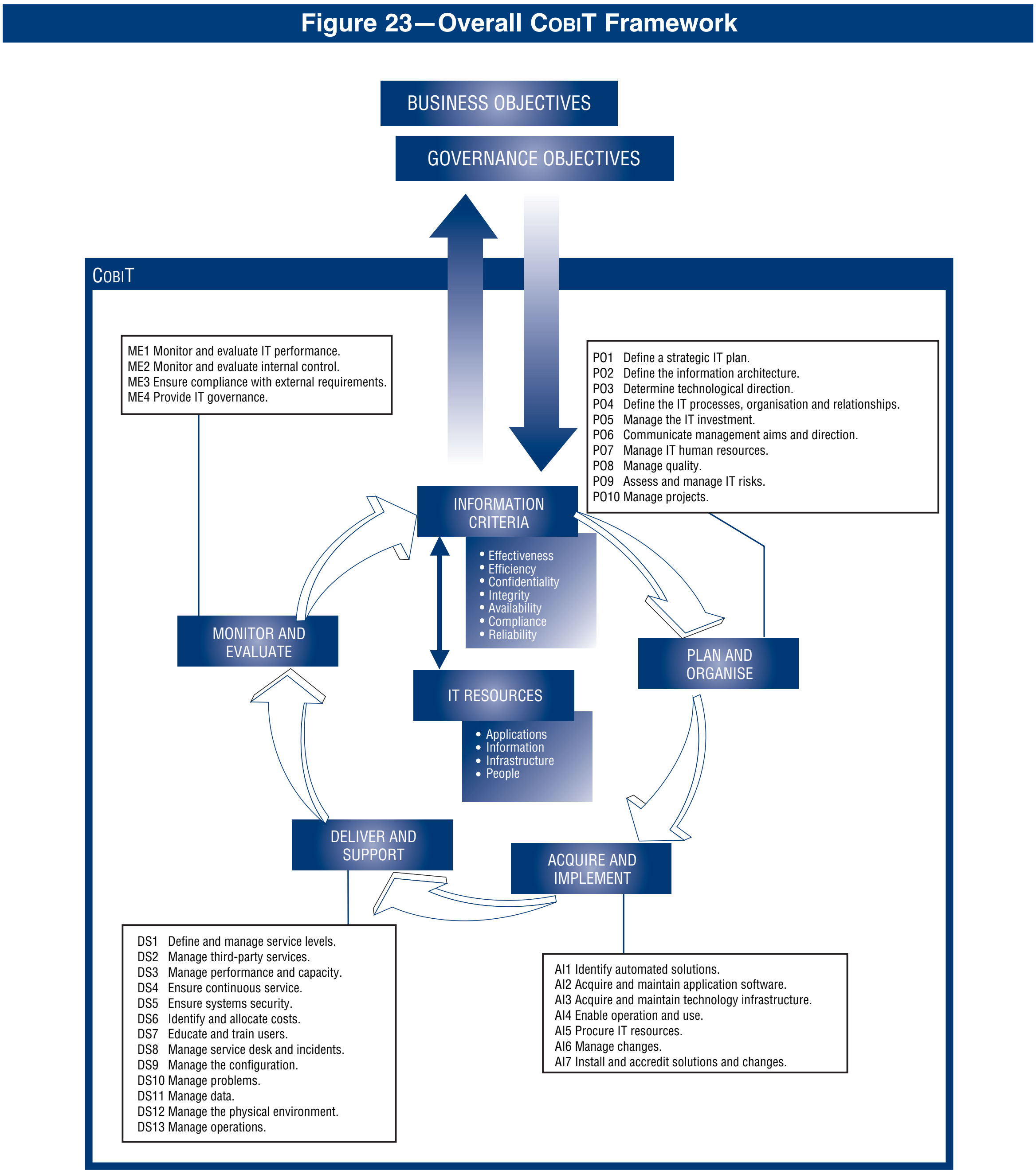

Figure 6: Overall COBIT framework

Source: Cf. COBIT, 2007, page 24

Process PO1 Define a Strategic IT Plan

„IT strategic planning is required to manage and direct all IT resources in line with the business strategy and priorities. The IT function and business stakeholders are responsible for ensuring that optimal value is realised from project and service portfolios. The strategic plan improves key stakeholders' understanding of IT opportunities and limitations, assesses current performance, identifies capacity and human resource requirements, and clarifies the level of investment required. The business strategy and priorities are to be reflected in portfolios and executed by the IT tactical plan(s), which specifies concise objectives, action plans and tasks that are understood and accepted by both business and IT."[36]

"PO1 Define a Strategic IT Plan" is explained in more detail by the following control objectives:

PO1.1 IT Value Management

> "Work with the business to ensure that the enterprise portfolio of IT-enabled investments contains programmes that have solid business cases. Recognise that there are mandatory, sustaining and discretionary investments that differ in complexity and degree of freedom in allocating funds. IT processes should provide effective and efficient delivery of the IT components of programmes and early warning of any deviations from plan, including cost, schedule or functionality, that might impact the expected outcomes of the programmes. IT services should be executed against equitable and enforceable service level agreements (SLAs). Accountability for achieving the benefits and controlling the costs should be clearly assigned and monitored. Establish fair, transparent, repeatable and comparable evaluation of business cases, including financial worth, the risk of not delivering a capability and the risk of not realising the expected benefits."[37]

PO1.2 Business-IT Alignment

> "Establish processes of bi-directional education and reciprocal involvement in strategic planning to achieve business and IT alignment and integration. Mediate between business and IT imperatives so priorities can be mutually agreed."[38]

[36] Cf. COBIT, 2007, page 29
[37] Cf. COBIT, 2007, page 30
[38] Cf. COBIT, 2007, page 30

PO1.3 Assessment of Current Capability and Performance

"Assess the current capability and performance of solution and service delivery to establish a baseline against which future requirements can be compared. Define performance in terms of IT's contribution to business objectives, functionality, stability, complexity, costs, strengths and weaknesses."[39]

PO1.4 IT Strategic Plan

"Create a strategic plan that defines, in co-operation with relevant stakeholders, how IT goals will contribute to the enterprise's strategic objectives and related costs and risks. It should include how IT will support IT-enabled investment programmes, IT services and IT assets. IT should define how the objectives will be met, the measurements to be used and the procedures to obtain formal sign-off from the stakeholders. The IT strategic plan should cover investment/operational budget, funding sources, sourcing strategy, acquisition strategy, and legal and regulatory requirements. The strategic plan should be sufficiently detailed to allow for the definition of tactical IT plans."[40]

PO1.5 IT Tactical Plans

"Create a portfolio of tactical IT plans that are derived from the IT strategic plan. The tactical plans should address IT-enabled programme investments, IT services and IT assets. The tactical plans should describe required IT initiatives, resource requirements, and how the use of resources and achievement of benefits will be monitored and managed. The tactical plans should be sufficiently detailed to allow the definition of project plans. Actively manage the set of tactical IT plans and initiatives through analysis of project and service portfolios."[41]

PO1.6 IT Portfolio Management

"Actively manage with the business the portfolio of IT-enabled investment programmes required to achieve specific strategic business objectives by identifying, defining, evaluating, prioritising, selecting, initiating, managing and controlling programmes. This should

[39] Cf. COBIT, 2007, page 30
[40] Cf. COBIT, 2007, page 30
[41] Cf. COBIT, 2007, page 30

include clarifying desired business outcomes, ensuring that programme objectives support achievement of the outcomes, understanding the full scope of effort required to achieve the outcomes, assigning clear accountability with supporting measures, defining projects within the programme, allocating resources and funding, delegating authority, and commissioning required projects at programme launch."[42]

In order to add the responsibilities to the described processes the major activities are described in a responsibility (RACI) matrix. It shows, for each specific activity exactly who is responsible for what.

RACI Chart

Activities \ Functions	CEO	CFO	Business Executive	CIO	Business Process Owner	Head Operations	Chief Architect	Head Development	Head IT Administration	PMO	Compliance, Audit, Risk and Security
Link business goals to IT goals.	C	I	A/R	R	C						
Identify critical dependencies and current performance.	C	C	R	A/R	C	C	C	C	C		C
Build an IT strategic plan.	A	C	C	R	I	C	C	C	C	I	C
Build IT tactical plans.	C	I		A	C	C	C	C	C	R	I
Analyse programme portfolios and manage project and service portfolios.	C	I	I	A	R	R	C	R	C	C	I

A **RACI** chart identifies who is **R**esponsible, **A**ccountable, **C**onsulted and/or **I**nformed.

Figure 7: P01 RACI chart

Source: Cf. COBIT, 2007, page 31

Process "PO5 Manage the IT Investment":

"A framework is established and maintained to manage IT-enabled investment programmes and that encompasses cost, benefits, prioritisation within budget, a formal budgeting process and management against the budget. Stakeholders are consulted to identify and control the total costs and benefits within the context of the IT strategic and tactical plans, and initiate corrective action where needed. The process fosters partnership between IT and business stakeholders; enables the effective and efficient use of IT resources; and provides transparency and accountability into the total cost of ownership (TCO), the realisation of business bene-

[42] Cf. COBIT, 2007, page 30

fits and the ROI of IT-enabled investments."[43]

Process "PO5 Manage the IT Investment" is described in more details by the following control objectives:

PO5.1 Financial Management Framework

> "Establish and maintain a financial framework to manage the investment and cost of IT assets and services through portfolios of IT- enabled investments, business cases and IT budgets."[44]

PO5.2 Prioritisation Within IT Budget

> "Implement a decision-making process to prioritise the allocation of IT resources for operations, projects and maintenance to maximise IT's contribution to optimising the return on the enterprise's portfolio of IT-enabled investment programmes and other IT services and assets."[45]

PO5.3 IT Budgeting

> "Establish and implement practices to prepare a budget reflecting the priorities established by the enterprise's portfolio of IT-enabled investment programmes, and including the on-going costs of operating and maintaining the current infrastructure. The practices should support development of an overall IT budget as well as development of budgets for individual programmes, with specific emphasis on the IT components of those programmes. The practices should allow for on-going review, refinement and approval of the overall budget and the budgets for individual programmes."[46]

PO5.4 Cost Management

> "Implement a cost management process comparing actual costs to budgets. Costs should be monitored and reported. Where there are deviations, these should be identified in a timely manner and the impact of those deviations on programmes should be assessed. Together with the business sponsor of those programmes, appropriate remedial action should

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[43] Cf. COBIT, 2007, page 45
[44] Cf. COBIT, 2007, page 49
[45] Cf. COBIT, 2007, page 49
[46] Cf. COBIT, 2007, page 49

be taken and, if necessary, the programme business case should be updated."[47]

PO5.5 Benefit Management

"Implement a process to monitor the benefits from providing and maintaining appropriate IT capabilities. IT's contribution to the business, either as a component of IT-enabled investment programmes or as part of regular operational support, should be identified and documented in a business case, agreed to, monitored and reported. Reports should be reviewed and, where there are opportunities to improve IT's contribution, appropriate actions should be defined and taken. Where changes in IT's contribution impact the programme, or where changes to other related projects impact the programme, the programme business case should be updated."[48]

The major activities and assigned responsibilities are described in figure 8.

RACI Chart **Functions**

Activities	CEO	CFO	Business Executive	CIO	Business Process Owner	Head Operations	Chief Architect	Head Development	Head IT Administration	PMO	Compliance, Audit, Risk and Security
Maintain the programme portfolio.	A	R	R	R	C					I	I
Maintain the project portfolio.	I	C	A/R	A/R	C		C	C		C	I
Maintain the service portfolio.	I	C	A/R	A/R	C	C				C	I
Establish and maintain the IT budgeting process.	I	C	C	A		C	C	C	R	C	
Identify, communicate and monitor IT investments, cost and value to the business.	I	C	C	A/R		C	C	C	R	C	C

A **RACI** chart identifies who is **R**esponsible, **A**ccountable, **C**onsulted and/or **I**nformed.

Figure 8: P05 RACI chart

Source: Cf. COBIT, 2007, page 49

3.3.2 Val IT

A slightly different approach is used in the Val IT framework. Val IT aims to improve decisions about investing in business and IT.
"Val IT extends and compliments the COBIT (Control objectives for IT) framework by three

[47] Cf. COBIT, 2007, page 49
[48] Cf. COBIT, 2007, page 49

processes: value governance, portfolio management and investment management."[49] COBIT is a framework issued by ISACA for information technology (IT) management and IT Governance. It provides a toolset for managers to bridge the gap between control requirements, technical issues and business risks.

Figure 9 provides an overview of the Val IT core process. As with top down and bottom up planning addressed in chapter 3.1, 3.2 and 3.3.1 – the focus of Val IT is on the project selection process. The model is linked to the process "IM4 Perform Alternatives Analysis".

IM4 Perform Alternatives Analysis is explained as follows:

> "Identify alternative courses of action to achieve benefits, costs, risks and timing for each identified course of action. Select the course of action that has the highest potential value, at an affordable cost with an acceptable level of risk. Document the rationale for recommending the selected courses of action, and the IT function should assess the technical impact."[50]

The responsibility is proposed as business areas accountable and responsible, IT as consulting (see figure 7 and 8).

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[49] Cf. Val IT, 2006, page 6f

[50] Cf. Val IT, 2006, page 27

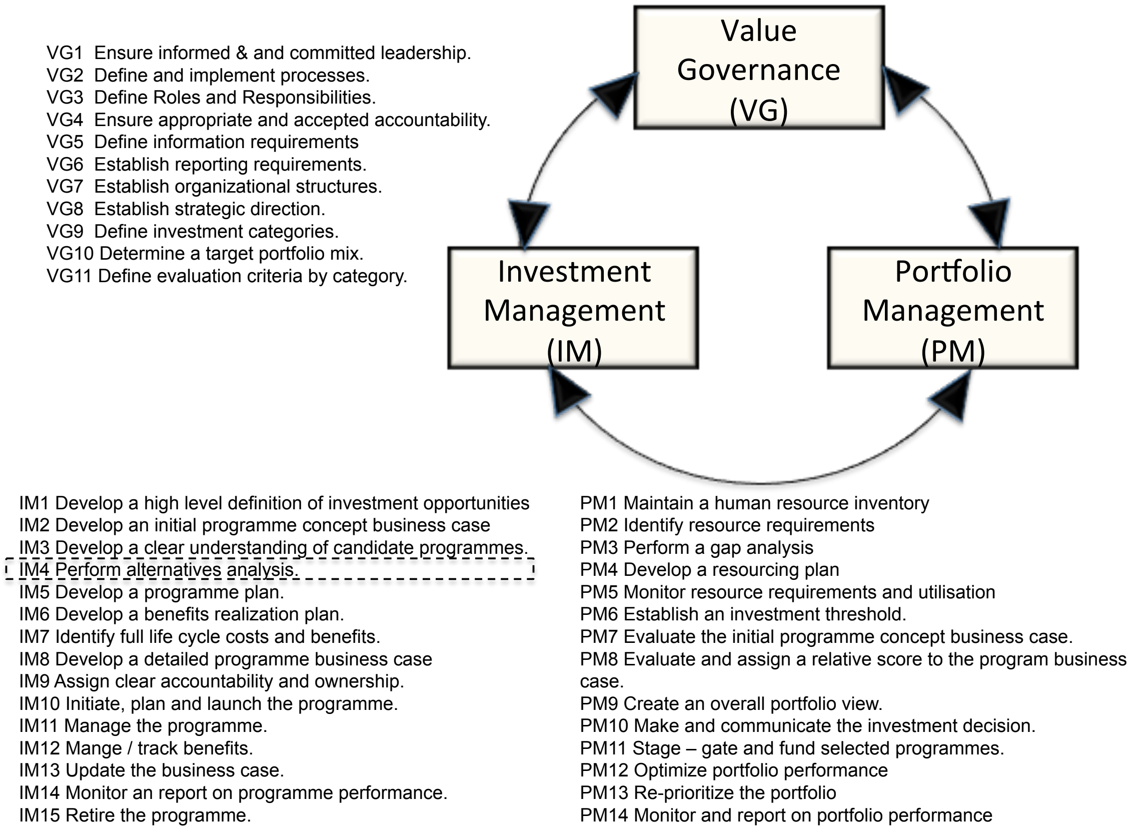

Figure 9: The Val IT framework.

Source: Cf. Val IT, 2006, page 17

It is important to understand that although the processes are shown as a sequence they have dependencies, which should be followed in parallel and iteratively.

At a high level the interactions could be illustrated as shown in the figure 10:

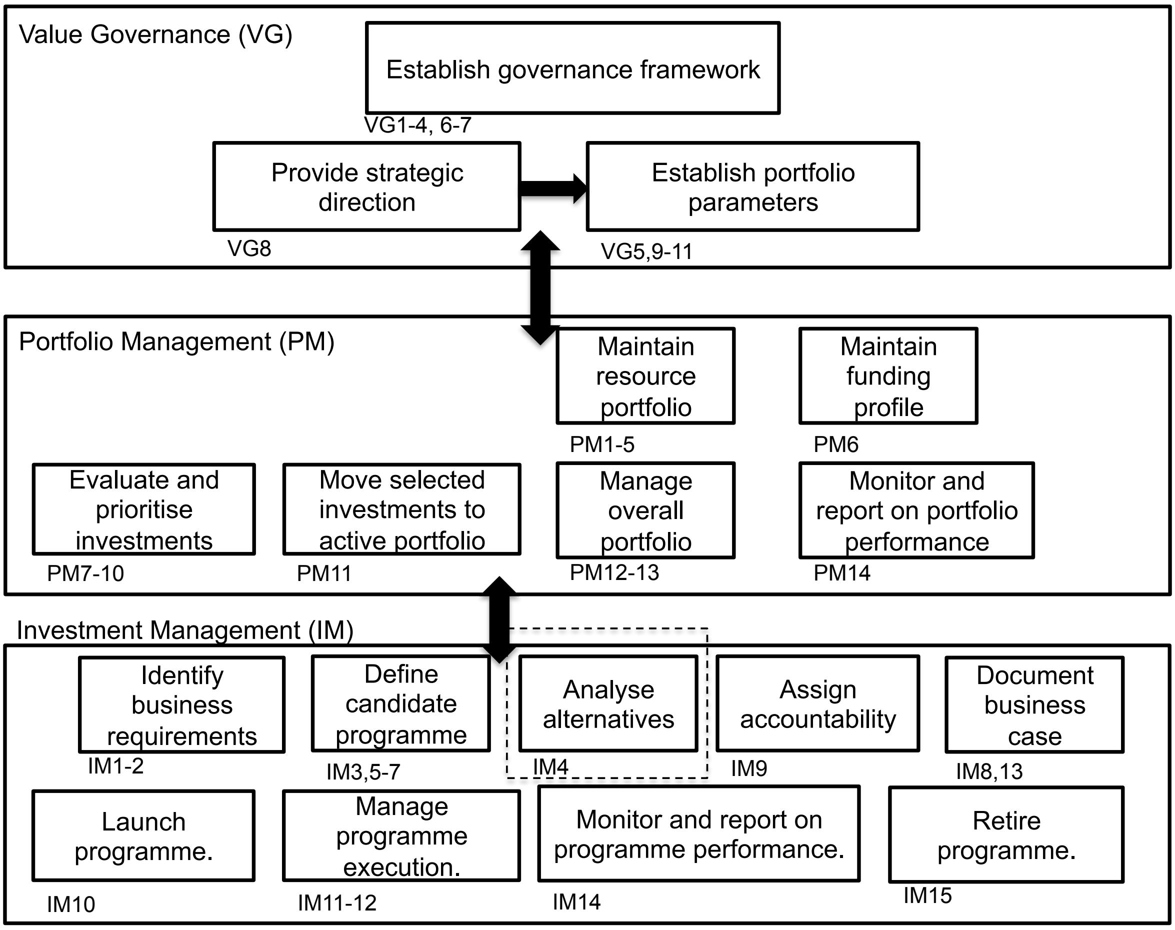

Figure 10: Relationship amongst VAL IT Processes and management practices

Source: Cf. Val IT, 2006, page 18

3.4 Derived Framework for the Model Implementation

Finally, all analysed approaches describe in a similar way the major cornerstones that have to be in place in order to make good investment decisions for new projects.

The structure of the summary is based on the planning phases defined by of Brockhoff, described in chapter 3.1., which can be used as a check list for the model implementation.

- Strategic planning:
  - Ensure that there is someone willing to make the decision, take the responsibility and be accountable for the results.
  - Identify key areas in which to invest.
  - Identify your targets and derive strategies to reach them.
- Operational planning:
  - Ensure that there are sufficient resources available, in terms of both their quality and their quantity.
  - Define benefits expectations.
- Tactical planning:
  - Implement a demand management process that covers collecting ideas, formulating projects and projects evaluation.
  - Perform project portfolio management.
  - Ensure that the project's progress is monitored and plan deviations will lead to actions and decisions on the monitored project and on other projects in the portfolio.
- Top down and bottom up planning.
  - Ensure that the planning process is not a one time and one direction effort.

4 The Sample Company's Situation

This chapter will describe the surveyed company's specific situation, the major external and internal influences and the current planning and decision making approach.

Company History

The evaluated funds Management Company is one of the largest in Austria and was set up as a holding with several local daughter companies in Austria and other CEE countries. The head office, located in Austria, was founded more then 50 years ago.

4.1 Factors of Major Influence on Portfolio Decisions

The company is influenced by many external and internal factors:

External factors:

- Market environment:
  The company's investment strategy changed during the financial crisis of 2007. It went from operating in a very fast growing market with a lot of investment possibilities and low cost pressure, to operating in a market that demanded efficiency driven changes.
  Currently the Mother Company is evaluating a stronger integration of its CEE daughter companies on the one hand, while facing a very difficult financial markets environment on the other.
  Furthermore a tremendous increase in regulatory restrictions is binding resources, which would be required for implementing innovative measures.
- Corporate governance:
  The company is steered by its supervisory board, which is driven by the biggest owner. The supervisory board sets targets. These include the amount of profit to be distributed to the owner and cost and headcount targets.
- Legal and regulatory changes:
  Several external regulators bind a major share of the resources by additional obstacles like "capital gains"- tax in Austria, the Foreign Account Tax Compliance Act (FATCA) issued by the US and other regulations. This burden is, on the one hand lim-

iting the potential to develop, but on the other hand, regulatory changes like UCITS 4 (Undertaking for Investments in Transferable Securities release 4) enable centralisation and changes in the segregation of authorities. This, in turn, allows a start to be made on the standardisation and centralisation of business functions.

Internal factors:

- Preparation for innovation
  The whole IT infrastructure, which is core to financial institutions ability to support innovation, is undergoing change. This will support centralisation across the daughter companies and allows 3rd party market enhancements with business and IT services. However, this requires strict investment control.
- Corporate development
  The surveyed organisation is setup as a holding. The change management effort necessary to finalise the corporate structure is consuming a lot of resources.

The following illustrates the efforts invested in decision making by the company's senior decision makers. Their views were collected in interviews.

CEO:

In general, the current focus is on company risk. If there is confidence in our risk mitigation measures and a business case study is positive, even projects with long term pay back periods are acceptable. A rise in our internal headcount cannot be accepted. Costs have to remain stable at the level of our cost base in 2010. Additional revenue has to be generated.

Chief of Sales:

Sales have to be increased. We have to develop more creativity to ensure that the market development can be at least partly compensated by additional business. New services supporting the legal & regulatory needs of the clients have to be implemented.

CFO:

The market situation leads to cost optimisation requirements. Positive investment decisions will only be supported if positive results are forecast in the P&L statements for the next two planning periods.

COO:

Based on current market conditions there is high pressure for cost reduction and a greater aware of the risks. The general behaviour with regards to risky investments changes from having an affinity for risk to demanding a positive impact on the short term Profit & Loss statement. The possibilities of increasing the use of internal resources for cheaper project production are very limited. There is a focus on adhering to legal and regulatory requirements.

2 local CEOs

The focus of our investment should be on creating opportunities to get in closer contact with the client. This could be through creating new sales channels, or through investments supporting the analysis of the client's needs and improving the relationship to the clients

4.2 Company's Understanding of Innovation

The companies core business in Austria is based in a very mature market. Change is mainly driven by the need for efficiency caused by the overall economic situation. For the local units the situation is different, here the variety starts from green field operations in the newer markets and goes to more well mature operations, like the one in Austria.

Overall the company is considering the following kinds of innovation:

- Market innovation (market penetration and market diversification)
    - Market penetration by enhancing the services offered along the company's own value chain like funds management, risk management or reporting
    - Market diversification by
        - Offering production services to its own subsidiaries, partners and competitors like IT services.
        - Conquering new markets (countries)
- Product innovations
    - There is some room for innovation as market needs drive the demand for new products like foreign currency hedging of share classes, corporate social responsibility products or sustainability products.

- Process innovations
    - Optimisation along the whole value chain, considering processes involving external and internal partners, and realising synergy effects with the mother company
- Organisational and or social innovations
    - Change management for forming the individual daughter companies into a holding
    - Centralisation of processes
    - Corporate social responsibility (CSR) related innovations like products which exclude assets of companies which produce prohibited weapons

4.3 The Company's Resource Allocation Approach – Current Status

This part describes the current approach to planning and decision-making based on the terms defined in chapter 3 according to Brockhoff 1999.

4.3.1 Strategic Planning:

The vision is derived from the management interviews and states that the company will be the number one in the region it serves. The criteria for defining the status number one are factors like the ability to offer sustainable investment products, the level of trust shown by clients and employees, and quantitative targets like assets under management (AuM) key performance indicators (KPIs).

There exists a "focused planning" which sums up the project proposals, which are derived from the major business needs. A central cost committee comprising the management board decides regularly on projects based on the overall project portfolio status.

4.3.2 Operational Planning:

The supervisory board sets targets like profit contribution for the owner, total cost targets and head count targets. From these, the management board of the company derives top down revenue and cost targets, whereas some of the individual business areas prepare a bottom up plan. Top down and bottom up will be synchronised in an iterative process. Next step is the separation into change- or run the business investments.

The costs of all the services, which are already established and have to be delivered in the next planning phase, will be cumulated from bottom up. Additionally, new or adopted services based on changes in the previous periods will be considered. Any kind of optimisation of existing services from the last period will be added.

The overall available budget will be reduced by the total sum of the investment required to run the company. The result is the first budget draft available for innovations.

4.3.3 Tactical Planning:

When considering innovations, there are different possibilities for reaching a go or no-go decision. These depend on the size of the effort required. The decision as to whether innovations are treated as projects is based on their complexity and the amount of specific effort they would require. All new project ideas are collected by the business organisation from the business units and are evaluated to an extent that a decision can be made. For this purpose, standardised project descriptions including business case templates are available.

Some basic rules are established. For example: no project decision is to be made without IT involvement, or project decisions have to be made by the cost committee, which decides on the utilisation of the company's resources. The Committee meets on a monthly basis. It consists of the managing board, CFO and CIO. Each meeting is hosted by the CFO. The agenda of the meeting consist of two parts: the first part is a standardised status report on all projects and services, and the second part consists of deciding on the investments/projects under review. To reach decisions on the projects, standardised decision making material is used. The material consists mainly of: the target, defining what is in scope/out of scope, a business case (financial evaluation of costs and benefits), and sponsor and funding information. The cost committee accepts or rejects based on that information. Project portfolio information on running projects and projects, which are in the pipeline is prepared as well.

The discussed CPP model is evaluated whether it is suited to support the decision making process at the tactical planning phase.

5 Preparation of Missing Input

The target of this chapter is to develop all prerequisites for the application of the project selection model as described in Chapter 3.

The approach used on the specific level of the planning process will be explained and all parameters defined.

5.1 Strategic Planning

Basic planning conditions, as elaborated in chapter 3, have to be established. Strategic planning sets the cornerstones for the Project Portfolio Management, which should serve as the framework for project selection. In the course of the preparation of the strategic planning phase key questions have been identified and can be used as a guidelines for strategic planning.

- **Prepare vision or "where will we be in 2015 - 2017?"**
  The following questions can help define the company's vision:
  - What will be the unique selling proposition (USP) of the company?
  - In which areas will the company be established? (Regions / markets / business lines)
  - Which products / services will we offer?
  - How will we produce?
  - How will the market develop?
  - Who will our competitors be?
  - For what will we be competing?
  - In what markets will we compete?
  - What will be the clients' needs?
  - What will be the legal environment?
  - What will be the sales channels about?
  - What will be the employees about?
  - What is the fundamental purpose of the company?
  - Why does it exist?
  - Who are the customers?

- What are the Key Processes?

- **Define measurable and achievable targets**
- **Define strategies as the roadmap achieving the Vision** or how do they support the vision?
- **Prepare KPIs:** Define the Key to your business and ensure that its performance is measurable and that it will be monitored. The development of the target values has to be dependent on the progress towards the vision
- **Define measures / projects to fulfil the strategies and achieve the targets**

In top management interviews, the following investment strategy was developed:

1. Increase business
   - Enhance business in existing markets by product and service improvement. Increase service quality to stand out from the competitors.
   - Issue new products to existing markets.
2. Cost efficiency
   - Streamline the value chain and reduce redundancies by centralising services within the company.
   - Sell parts of the value chain to 3rd party market to reduce fixed costs.
3. Legal & regulatory requirements
   - Focus on mandatory investments.

5.2 Operational Planning

Within operational planning the focus is on resource restrictions.

Firstly, top down budget targets were collected.

Secondly, a standard bottom up budgeting process was executed.

Thirdly, investment potential for innovations was identified.

Collection of top down budget targets:

4. Deliver € mill. net revenue.
5. Increase costs by a maximum of 2%.
6. No increase off internal headcount.

7. Pay back period for projects max 2 years.
8. Provide risk analysis for all projects.
9. Ensure that legal and regulatory requirements can be met and implemented using mainly internal resources.

Bottom up budget planning

One approach to deriving the investment potential of innovations is to split the total budget into the budget required to run the company and the budget required for change.

The budget for running the company can be estimated by considering last year's budget, adapted by the impacts of last year's investments, uncontrollable increases and mandatory changes. By taking the result, adding the budget required for new investments and then including potential budget increases or reduction targets, the new budget can be calculated in a similar way to that described in the "Dynamic IT Baseline Budget Model", by Martin Curly[51].

New budget =	Initial baseline
	+ Impact of previous investments
	+ Uncontrollable increases
	+ New investments
	- Cost savings
	+ / - Target for expansion / reduction

Figure 11: Dynamic IT Baseline Budget Model

Source: Cf. Curly, 2004, page 36

This approach is also to be applied to human resource planning. In addition to the above-described approach different kinds of resource pools have to be identified. Based on the size of the analysed company, the available and required skill set has to be taken into consideration as well.

Finally the impact off resource planning on the number of external personnel required will influence the budget situation.

The resources needed for projects, which are already running also have to be considered.

[51] Cf. Curly, 2004, page 36

Examples of resource pools:

1. Business area mid office (funds & asset management controlling, risk and performance analysis)
2. Business area legal & taxes
3. Business area funds management
4. Business area portfolio management
5. Business organisation
6. IT developer Web/data ware house/core system

Summary:
The described approach leads to an overall budget for innovation related investments of only X € mill.

From this amount 1,5 mio € is dedicated to investments into new 3rd party services. This investment should serve the business growth and the cost reductions, which were set as the first and second priorities of the investment strategy. The project portfolio identified to support that target will be the application of the CPP model.

In the specific situation of the considered company, human resources are not counted as limitations because one of the major projects, which were staffed externally, is finalised and any required skill set can be bought on the market. This means that a lack of internal staff does not hinder the project's execution. It only has an impact on the budget.

5.3 Tactical Planning

This part will describe how the projects identification process is embedded in the company and how the final set of projects are selected.

The process is split into 3 steps:

Ideas gathering

Project pipeline preparation

Identification of the candidate projects

Ideas gathering

A centralised demand management is implemented and a comprehensive list of ideas and the potential demand across all business lines is collected from bottom up.

Project pipeline preparation

Collected ideas are regularly reviewed, prioritised and bundled into projects. Projects are documented and project information is maintained in a central database. The list of projects not executed is called a project pipeline.

To identify potential investment candidates for innovation, the project pipeline has to be split into projects supporting the daily operations ("keep the lights on", e.g. infrastructure projects), legal or regulatory driven projects and projects which support business growth or cost reduction, e.g. like product- or process innovations.

"Keep the lights on" projects will usually be evaluated using operational risk assessment.

Legal and regulatory requirements are usually mandatory, there is only a small amount of freedom in the question of how to implement them.

Identification of project candidates

The list of projects, which are identified to increase business growth or reduce costs will be roughly described in terms of costs, required manpower, duration, risk, expected benefits and pay back period.

Impact on operational planning

As the analysis focuses solely on the selection of projects and not on optimising their execution, when managing the portfolio the resource requirements of all running projects have to be considered. For example: legal driven projects consume human effort and money. This has to be considered at the operational planning phase.

Summary: Considered projects

The list of candidate projects s is filtered based on the conditions which were elaborated in the strategic planning phase, see results from chapters 5.1. and 5.2.

The project pre-selection process, based on the analysis of high-level costs, benefits, risks and the implementation duration, results in a list of 10 projects which are summarised in a "service oriented Funds- and Asset Management Company" program. The basic idea is that all the required services that can be performed in-house, can also be offered to the market l. This means that these services will be offered to smaller competitors, which will enable market leadership in the design of services and in the interpretation of legal and statutory requirements. Additionally, the investment costs already incurred to establish the new infrastructure are distributed.

5.4 Summary of Planning Assumptions

A project portfolio comprising of 10 projects will be analysed, with each project aiming to reach the targets of increasing business growth and reducing fixed costs, as defined in strategic planning.

The reserved budget, as elaborated in operational planning (Chapter 5.2.9, is fixed at 1,5 mill. €. Resources, in terms of human resources, are not critical because there are plenty of external consultants available following the recent completion of a big change project.

6 Building the LP Model

In this chapter the basic assumptions will be explained and the CPP model will be applied.

6.1 Basic Assumptions

This chapter sums up the necessary assumptions like project steps, periods, business case and resources, which need to be made to build the linear programming model.

6.1.1 States of Nature

It is assumed that all probabilities for success or failure are the same for all projects as required in the theoretical model.[52]

From the starting point $S_{0,}$ in period 0 S_1 will be reached if the business development is positive, S_2 will be reached if it's negative. From S_1 it will develop to S_{11} if business development is positive again, or to S_{21} if the development is negative. The same is valid from S_2 to S_{21} and S_{22}.

6.1.2 Project Steps

It is assumed that investments are made in **2 steps,** which are interpreted as follows:
Step 1: Starts at period 0. Here, the first investment per project is required. The first project step contains a proof of concept, or a pilot implementation, or a detailed analysis for a potential second phase.

Period 0 starts on 1st January 2012 and ends on 31st December 2012.

Step 2: Starts at period 1. A decision is required as to whether to continue or to close the project. What happens at the 2nd implementation phase of the projects is dependent on the reached state of nature 1 or 2.
Period 1 starts on 1st January 2013 and ends on 31st December 2013.

At step 3, which is at the end of period 1, 31st December 2013, the projects will be finalised and will begin to deliver results in terms of benefits.

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[52] Cf. Gustafsson and Salo, Systems Analysis Laboratory Research Reports, 2005, page 11

6.1.3 Business Case and Resources

All projects will end up in combined business and IT services. For all projects a total cost of ownership (TCO) calculation is provided.

Basically, two types of resource need to be considered. Human resources groups - based on different skill sets like “business organisation”, “IT”, “Legal & Taxes”, etc. - and money.

Based on the analysed environment there is, at least from a knowledge point of view, no resource limitation. Any kind of know-how can be bought on the market. Basic assumptions are that approximately 30% of project work can be done internally and external partners will provide 70%. This ratio enables the internal resources to ensure proper specifications, vendor management, integration and deployment.

6.1.4 Projects

As the major focus is on new services, a set of 10 projects in the area of new combined business and IT services was selected.

The projects scope is about developing an ASP (application service provider) model enriched by parts of the company’s own business services and integrated into the external clients’ value chain.
The potential revenue is based on a three-year total cost of ownership (TCO) calculation.

The projects are indicated from A to J.

The projects financials are described by:

- Investments in period 0
- Investments in period 1
- Investments in period 2
- Revenues in S11
- Revenues in S12
- Revenues in S21
- Revenues in S22

Description of Project A:

There are already four exiting customers using business and IT services. Adding another part of the company's value chain can enhance these services. The project proposal is about adding Front Office functionality.

The pre-analysis, consisting of detailed analysis and pilot implementation, leads to initial costs of 105.000€. The cost at the second decision point will vary pending on if the financial market develops positively or not. If the market develops well, stage S_1, it is assumed that three or for customers will buy the new service. If the market develops less well, stage S_2, the assumption is that none or only one customer will buy. These assumptions lead to investments of 245.000€ at S_1, or 122.500€ at S_2.

For the revenues, it is assumed that at S_{11} 3, at S_{12} 2, at S_{21} 1 and at S_{22} no customers will buy the new service.

Description of Project B:

The second project is also aimed at the four clients, which already exist. It focuses on the ex post and ex ante limit checks. For the initial analysis and proof of concept (PoC) a cost of 45.000€ has been estimated. If the market develops well it is assumed that three to four customers will take the new service. Investments in S_1 are estimated at 105.00€, and at S_2 at 52.500€. The income per service, per client is estimated at 400.000€.

Description of Project C:

Project C covers new performance calculation services for the existing four clients. The assumptions on positive acceptance are that there will be four takers at S_{11}, three at S_{12} and only one at S_{21} and S_{22}. The initial investment is estimated at 60.000€, at S_1 at 140.000€, and at S_2 at 70.000€. And the potential revenue per service is estimated at 150.000€ per customer.

Description of Project D:

Project D delivers new risk measurements services. Initial costs are estimated at 60.000€, the second phase is estimated at 140.000€ or 70.000€. Up to four customers will accept the offers, each for 150.000€.

Description of Project E:

Project E is about creating new reports for the back office. This service is focused on legal and statutory reporting and can be provided to a broader range of customers.

It is assumed that the internal service set up will cost about 45.000€. The effort for the external clients is mainly driven by the IT integration costs. The assumed costs for the second phase are 105.000€ or 52.500€. The revenue is projected as 100.000€ per reporting package, per client. For S_{11} five clients, for S_{12} three, and for S_{21} two clients are assumed. It is assumed that at S_{22} there will be one client.

Description of Project F:

Project F will deliver services for calculating fees. Initial cost are assumed to be 9.000€, period 1 is estimated at 21.000€ or 10.500€. The assumption is that there will be one major new client at S_{12}, S_{21} and S_{22} (40.000€) and a second, smaller client at S_{11} (75.000€).

Description of Project G:

Project G covers special mid office reporting services. Set up costs are estimated at 12.000€. The second phase is evaluated with 21.000€ or 10.500€. Planning assumptions is for three clients at S_{11}, two at S_{12} and only one atS_{21} and S_{22}. The planned price is set at 25.000€ per customer.

Description of Project H:

Project H covers risk and performance calculation services for portfolio management. The assumption is that at S12, S21 and S22 there will be only one external client. S11 covers additional parts of the service for another client.

Description of Project I:

Project I covers reporting services for portfolio management. The assumption is that at S12, S21 and S22 there will be only one external client. S11 covers additional parts of the service for another client.

Description ofProject J:

Project J covers SWIFT Integration service. The assumption is that at S12, S21 and S22 a small increase in institutional business will result from the new service. S11 reflects that this service really helps in gaining institutional business.

Table 1 summarises the projects specific parameters.

	Projects	Investments in period 0	S1 / Investments in period 1	S2 / Investments period 1	potential revenue in S11	potential revenue in S12	potential revenue in S21	potential revenue in S22
A	FO	105.000	245.000	122.500	1.500.000	1.000.000	500.000	-
B	MO limits	45.000	105.000	52.500	1.600.000	1.200.000	800.000	400.000
C	MO Performance	60.000	140.000	70.000	600.000	450.000	150.000	150.000
D	MO Risk	60.000	140.000	70.000	600.000	450.000	300.000	150.000
E	BO - reporting	45.000	105.000	52.500	500.000	300.000	200.000	100.000
F	BO - fees	9.000	21.000	10.500	75.000	40.000	40.000	40.000
G	MO - special services	12.000	28.000	14.000	75.000	50.000	25.000	25.000
H	PM - MO	120.000	280.000	140.000	500.000	400.000	400.000	400.000
I	PM - reporting	165.000	385.000	192.500	800.000	550.000	550.000	550.000
J	SWIFT integration	45.000	105.000	52.500	250.000	75.000	50.000	25.000

Table 1: Key figures

6.2 Definition of Variables and Equations

In this chapter the variables and equations explained in chapter 2 are applied. Figure 12 shows the decision tree. The probabilities have been chosen after intense discussions with the decision makers.

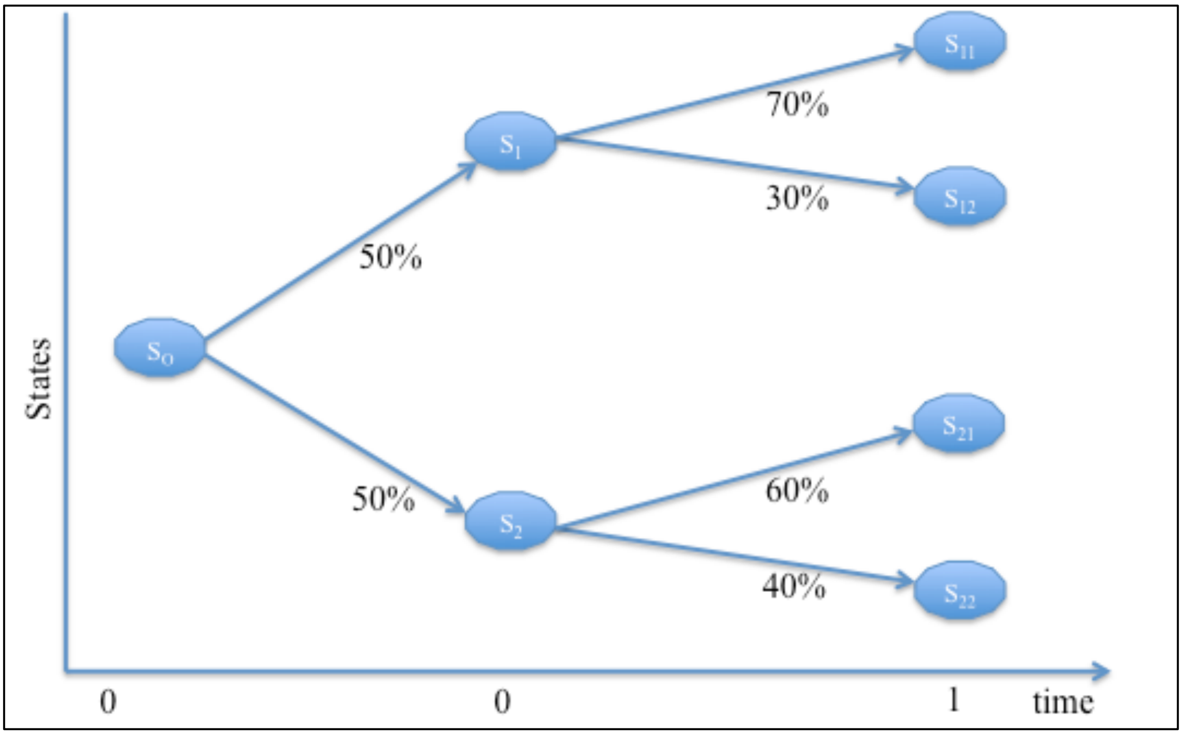

Figure 12: Decision Tree

In the following part, all the equations and conditions for calculating the resource surpluses at all states, deviation variables, expected value (EV) and consistency constraints are developed.

6.2.1 Resource Flows

In the following section the resources surplus (RS) will be calculated.

To calculate the resource surplus, at calculation Period 0 costs are shown as negative cash flows and will be multiplied by the binary decision variable and the initial budget will be added. The initial budget is 1500. All values in the following equations are stated in thousand €.

$-105*X_{ASY}-45*X_{BSY}-60*X_{CSY}-60*X_{DSY}-45*X_{ESY}-9*X_{FSY}-12*X_{GSY}-120*X_{HSY}-165*X_{ISY}-45*X_{JSY}+1500-RS_{S0}=0$

Period 1 / S_1

For all the following stages the resource surplus from the previous stages will be multiplied by the risk free interest rate.

$-245*X_{ACY1}-105*X_{BCY1}-140*X_{CCY1}-140*X_{DCY1}-105*X_{ECY1}-21*X_{FCY1}-28*X_{GCY1}-280*X_{HCY1}-385*X_{ICY1}-105*X_{JCY1}+1,08*RS_{S0}-RS_{S1}=0$

Period 1 / S_2

$-122,5*X_{ACY2}-52,5*X_{BCY2}-70*X_{CCY2}-70*X_{DCY2}-52,5*X_{ECY2}-10,5*X_{FCY2}-14*X_{GCY2}-140*X_{HCY2}-192,5*X_{ICY2}-52,5*X_{JCY2}+1,08*RS_{S0}-RS_{S2}=0$

Period 2 / S_{11}

$1500*X_{ACY1}+1600*X_{BCY1}+600*X_{CCY1}+600*X_{DCY1}+500*X_{ECY1}+75*X_{FCY1}+75*X_{GCY1}+500*X_{HCY1}+800*X_{ICY1}+250*X_{JCY1}+1,08*RS_{S1}-RS_{S11}=0$

Period 2 / S_{12}

$+1000*X_{ACY1}+1200*X_{BCY1}+450*X_{CCY1}+450*X_{DCY1}+300*X_{ECY1}+40*X_{FCY1}+50*X_{GCY1}+400*X_{HCY1}+550*X_{ICY1}+75*X_{JCY1}+1,08*RS_{S1}-RS_{S12}=0$

Period 2 / S_{21}

$+500*X_{ACY2}+800*X_{BCY2}+300*X_{CCY2}+150*X_{DCY2}+200*X_{ECY2}+40*X_{FCY2}+25*X_{GCY2}+400*X_{HCY2}+550*X_{ICY2}+50*X_{JCY2}+1,08*RS_{S2}-RS_{S21}=0$

Period 2 / S_{22}

$+0*X_{ACY2}+400*X_{BCY2}+150*X_{CCY2}+150*X_{DCY2}+100*X_{ECY2}+40*X_{FCY2}+25*X_{GCY2}+400*X_{HCY2}+550*X_{ICY2}+25*X_{JCY2}+1,08*RS_{S2}-RS_{S22}=0$

Expected Value (EV)

$EV=50\%*70\%*RS_{S11}+50\%*30\%*RS_{S12}+50\%*60\%*RS_{S21}+50\%*40\%*RSS_{22}$

ΔV_s^+ and ΔV_s^- measure how much the total value of the resource surpluses in states differs from the risk measure's target value t. Only the negative values will be used for the LSAD calculation.

$RS_{S11}-EV=\Delta V^+_{S11}-\Delta V^-_{S11}$

$RS_{S12}-EV=\Delta V^+_{S12}-\Delta V^-_{S12}$

$RS_{S21}-EV=\Delta V^+_{S21}-\Delta V^-_{S21}$

$RS_{S22}-EV=\Delta V^+_{S22}-\Delta V^-_{S22}$

6.2.2 Decision Consistency Constraints

The first part supports the binary function of the decision variables. X_{ASY} stands for starting projects A at S_0, whereas X_{ASN} means that it will not be started. The constraint ensures that project A is either started or not started and that this decision can only be made once.

$X_{ASY} + X_{ASN}=1$

$X_{BSY} + X_{BSN}=1$

$X_{CSY} + X_{CSN}=1$

$X_{DSY} + X_{DSN}=1$

$X_{ESY} + X_{ESN}=1$

$X_{FSY} + X_{FSN}=1$

$X_{GSY} + X_{GSN}=1$

$X_{HSY} + X_{HSN}=1$

$X_{ISY} + X_{AIN}=1$

$X_{JSY} + X_{AJN}=1$

The following constraints ensure that the project can only be continued if started at all.

$X_{ACY1}+X_{ACN1}= X_{ASY}$

$X_{BCY1}+X_{BCN1}= X_{BSY}$

$X_{CCY1}+X_{CCN1}= X_{CSY}$

$X_{DCY1}+X_{DCN1}= X_{DSY}$

$X_{ECY1}+X_{ECN1}= X_{ESY}$

$X_{FCY1}+X_{FCN1}= X_{FSY}$

$X_{GCY1}+X_{GCN1}= X_{GSY}$

$X_{HCY1}+X_{HCN1}= X_{HSY}$

$X_{ICY1}+X_{ICN1}= X_{ISY}$

$X_{JCY1}+X_{JCN1}= X_{JSY}$

$X_{ACY2}+X_{ACN2}= X_{ASY}$

$X_{BCY2}+X_{BCN2}= X_{BSY}$

$X_{CCY2}+X_{CCN2}= X_{CSY}$

$X_{DCY2}+X_{DCN2}= X_{DSY}$

$X_{ECY2}+X_{ECN2}= X_{ESY}$

$X_{FCY2}+X_{FCN2}= X_{FSY}$

$X_{GCY2}+X_{GCN2}= X_{GSY}$

X_{HCY2}+X_{HCN2}= X_{HSY}

X_{ICY2}+X_{ICN2}= X_{ISY}

X_{JCY2}+X_{JCN2}= X_{JSY}

All X_{zCS} and $X_{zNS} \in \{0,1\}$

z∈a-j

6.2.3 Resource Constraints

Restrictions for resource surplus variables for each state are formulated.

$RS_{S0} \geq 0$

$RS_{S1} \geq 0$

$RS_{S11} \geq 0$

$RS_{S12} \geq 0$

$RS_{S2} \geq 0$

$RS_{S21} \geq 0$

$RS_{S22} \geq 0$

In this calculation a loan for investments is not considered.

6.2.4 Objective Function

The EDR of the value of the final resource position is given by the sum

$$EDR= \sum_{s \in S_T} p(s) \cdot \Delta V_s^-$$

t was set to EV therefore EDR equals LSAD.[53]

$EDR=LSAD= 50\%*70\%*\Delta V^-_{S11}+50\%*30\%*\Delta V^-_{S12}+50\%*60*\Delta V^-_{S21}+50\%*40\%* \Delta V^-_{S22}$

[53] Cf. Gustafsson and Salo, Operations Research, 2005, page 952

Maximise CE

λ is fixed with 0,5

CE=EV-λ*LSAD

=50%*70%*RS_{S11}+50%*30%*RS_{S12}+50%*60%*RS_{S21}+50%*40%*RS_{S22}-0,5*(50%*70%* ΔV^{-}_{S11}+50%*30% *ΔV^{-}_{S12}+50%*60%* ΔV^{-}_{S21}+50%*40%* ΔV^{-}_{S22})

NPV=CE/$(1,04)^2$-1.500

The risk free interest rate is set with 4% p.a.

$\boldsymbol{\rho}$ =1,04*$\sqrt{\frac{EV}{CE}} - 1$

7 Calculation and Analysis of Results

Chapter seven describes the software solution that was used, the analysis of the concept results based on the example described in the analysed paper, the calculation and documentation of the results, and the sensitivity analysis based on changes of the input parameters.

7.1 Used Software

Firstly, the concept is tested based on the example model and solved in Microsoft Excel 2003. The detailed approach is explained in Chapter 7.2. Overall the results looked promising, as they were stable and reproducible.

During the application of the model defined in Chapter 6, it was identified that the linear programming application (Solver) embedded in Excel for Office 2003 is not capable of solving the model. The calculations were not stable, recalculations without changing the input lead to different results.

Further analysis was continued in Microsoft Excel as part of Office 2010 for windows. Here the first results were quite promising, only during the sensitivity analysis was it identified that the calculation results were again not stable.

The approach was changed from using the limited version of the “Solver” embedded within Microsoft Excel and Excel Version 14.1.3 for Mac was used, which seemed to be the newest available. Unfortunately, the results were again unstable.

As the embedded “Solver” application in all Excel products offers only limited functions, the next trial was with the unlimited version (Solver professional for Mac, www.solver.com). Trial runs showed that the model cannot be solved and the official support of “solver” application explained that there is a bug in the software application.

All “solver” solutions at this point of time showed errors, like the inability to find a solution, the solutions not being stable, or the binary conditions for the decision variables were not being applied.

Additionally, GNULP as a freeware based on LINUX was analysed. Unfortunately, it was not able to calculate the full model. The next solution approach was to change to the open source software “Open Office” which leads to fast and stable calculations. Only the user interface, compared to the Microsoft Excel application, is buggy meaning data storage functions do not work.

7.2 Test of the Concept

To ensure that the software solution package is able to solve the model, firstly the example explained in the paper was analysed and used to test of concept. The results calculated in Microsoft Excel 2003 are the same as the solution explained in the analysed paper.

Figures 13, 14 and 15 illustrate the first implementation of the example model in Microsoft Excel. Figures 16 and 17 contain the solver parameter settings and options.

MAX formula	**EV- 0,5 * LSAD** 17,32239959	**17,33**
LSAD formula	-2,952000122	**2,95**
EV formula	50% * 30% * RS11+ 50% * 70% * RS12 + 50%*40% *RS21 + 50% * 60% * RS22 18,79839965	**18,8**
	action variables	
XASY	1	
XASN	0	
XACY1	1	
XACN1	0	
XACY2	0	
XACN2	1	
XBSY	1	
XBSN	0	
XBCY1	0	
XBCN1	1	
XBCY2	1	
XBCN2	0	
RS0	6,0000	
RS1	3,4800	
RS2	4,4800	
RS11	23,7584	
RS12	13,7584	
RS21	29,8384	
RS22	14,8384	

Figure 13: Example model 1st draft, part 1

consistency constraints	formula	value	
XASY+XASN=1	1,00	1	
XACY1+XACN1=XASY	1,00	1	
XACY2+XACN2=XASY	1,00	1	
XBSY+XBSN=1	1,00	1	
XBCY1+XBCN1=XBSY	1,00	1	
XBCY2+XBCN2=XBSY	1,00	1	
resource constraints	formula	value	
-1 XASY - 2 XBSY +9 - RS0 = 0	6	6	RS0
-3 XACY1 - 2 XBCY1 + 1,08 RS0 - RS1 = 0	3,48	3	RS1
-3 XACY2 - 2 XBCY2 + 1,08 RS0 - RS2 = 0	4,48	4	RS2
20 XACY1+2,5 XBCY1 + 1,08 RS1 - RS11=0	23,76	24	RS11
10 XACY1+1 XBCY1 + 1,08 RS1 - RS12 = 0	13,76	14	RS12
5 XACY2+25 XBCY2 + 1,08 RS2 - RS21 = 0	29,84	30	RS21
10 XBCY2 + 1,08 RS2 - RS22 = 0	14,84	15	RS22
risk constraints	formula	value	
RS11-EV-dVS11p+dVS11n=0	9,92	0	
RS12-EV-dVS12p+dVS12n=0	-10,08	0	
RS21-EV-dVS21p+dVS21n=0	22,08	0	
RS22-EV-dVS22p+dVS22n=0	-7,92	0	

Figure 14: Example model 1st draft, part 2

initial budget	risk var		downside risk	
9	dV11	-5	-4,96000035	-0,744
	dV12	5	0	
	dV21	-11	-11,04000035	-2,208
	dV22	4	0	
		-7,000000399		-2,952

Figure 15: Example model 1st draft, part 3

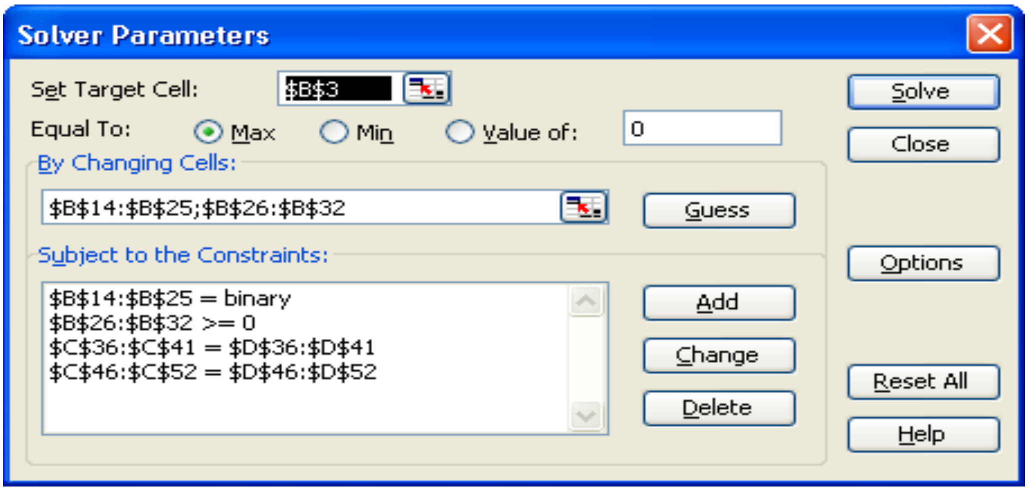

Figure 16: Example model screen shot “solver parameter”

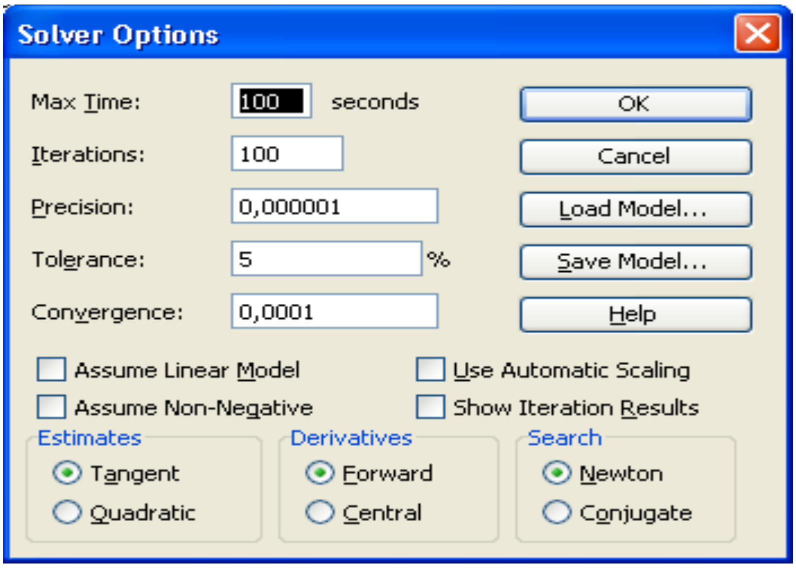

Figure 17: Example model screen shot “solver options”

To make the changes in the parameters more comfortable and the model easier to handle, the following optimised view was developed and also used for the later stages of the implementation of the model, see figure 18.

	Projects	Investments total	Start	Continue at S1	Continue at S2	Investments period 0	S1 / Investments period 1	S2 / Investments period 1	potential revenue S11	potential revenue S12	potential revenue S21	potential revenue S22
A	Project A	7				1,0	3,0	3,0	20,0	10,0	5,0	-
B	Project B	6				2,0	2,0	2,0	2,5	1,0	25,0	10,0
	Initial budget					9						
	Risk free interest rate						1,08	1,08	1,08	1,08	1,08	1,08
	λ					0,5						
	Probability S occurs						50%	50%	30%	70%	40%	60%

Decision variables						consistency constraints							
XASY	XACY1	XACY2	1,00	1,00	0,00	$X_{ASY}+X_{ASN}=1$	1	1	$X_{ACY1}+X_{ACN1}=X_{ASY}$	1	1	$X_{ACY2}+X_{ACN2}=X_{ASY}$	1
XASN	XACN1	XACN2	0,00	0,00	1,00	$X_{BSY}+X_{BSN}=1$	1	1	$X_{BCY1}+X_{BCN1}=X_{BSY}$	1	1	$X_{BCY2}+X_{BCN2}=X_{BSY}$	1
XBSY	XBCY1	XBCY2	1,00	0,00	1,00								
XBSN	XBCN1	XBCN2	0,00	1,00	0,00								

		Period 0	Period 1 (S1)	Period 1 (S2)	S11	S12	S21	S22		
Resource constraint at period formula		6,0	3,5	4,5	23,8	13,8	29,8	14,8		
Resource constraint at period solver variables		6,0	3,5	4,5	23,8	13,8	29,8	14,8		
Expected Value (EV)	%*30%*RSS								18,8	EV
Risk constaints					RS_{S11}-EV= ΔV^+_{S11}- ΔV^-_{S11}	RS_{S12}-EV= ΔV^+_{S12}-ΔV^-_{S12}	RS_{S21}-EV= ΔV^+_{S21}-ΔV^-_{S21}	RS_{S22}-EV= ΔV^+_{S22}-ΔV^-_{S22}		
					4,96	-5,04	11,04	-3,96		
					ΔV^+_{S11}	ΔV^+_{S12}	ΔV^+_{S21}	ΔV^+_{S22}		
					4,96	-	11,04	-		
					ΔV^-_{S11}	ΔV^-_{S12}	ΔV^-_{S21}	ΔV^-_{S22}		
					-	-5,04	-	-3,96		
LSAD								LSAD	-3,0	LSAD
Maximize CE								EV-λ*LSAD	17,3	CE

risk adjusted interest rate ρ — the optimal portfolio leads to a risk adjusted interest rate that exceed the assumed risk free interest rate accounts for time and risk preferences — 12,5% ρ

Present value of optimal project portfolio — 5,9 NPV

NPV= discounting CE by the risk free interest rate and deducting initial budget

lowest resource surplus at S22 — 13,8 wheras initial investment * interest rate period 1 * interest rate period 2

---> no Risk for loss!!! 13,8 >= 10,50 !!!!

worst case would mean a loss compared to a risk free investment of

Figure 18: Overview solution of example

All the grey cells (upper part of the table) are potential input cells. Those marked blue (below the fat line) are the output cells. The target, CE value, is highlighted orange. The decision variables block shows if the projects are started at a specific decision point. Additionally, traffic lights were implemented in the upper part to increase the transparency of portfolio decisions. The risk free interest rate is 8% p.a.

7.3 Calculation and Documentation of Results

As described in chapter 7.1 the model was applied in Open Office 3.3.0. The graphical distribution looks the same as that previously explained in 7.2. In the following, the application will be explained. Figure 19 shows the applied model in total. The specific sections are explained and displayed in figures 21-24.

	Projects	Investments total	Start	Continue at S1	Continue at S2	Investments in period 0	S1 / Investments in period 1	S2 / Investments in period 1	revenue in S11	revenue in S12	revenue in S21	revenue in S22
A	FO	350.000	1	1	1	105.000	245.000	122.500	1.500.000	1.000.000	500.000	-
B	MO limits	150.000	1	1	1	45.000	105.000	52.500	1.600.000	1.200.000	800.000	400.000
C	MO Performance	200.000	1	1	1	60.000	140.000	70.000	600.000	450.000	150.000	150.000
D	MO Risk	200.000	1	1	1	60.000	140.000	70.000	600.000	450.000	300.000	150.000
E	BO - reporting	150.000	1	1	1	45.000	105.000	52.500	500.000	300.000	200.000	100.000
F	BO - fees	30.000	1	1	1	9.000	21.000	10.500	75.000	40.000	40.000	40.000
G	MO - special services	40.000	1	1	1	12.000	28.000	14.000	75.000	50.000	25.000	25.000
H	PM - MO	400.000	1	1	1	120.000	280.000	140.000	500.000	400.000	400.000	400.000
I	PM - reporting	550.000	-	-	-	165.000	385.000	192.500	800.000	550.000	550.000	550.000
J	SWIFT integration	150.000	-	-	-	45.000	105.000	52.500	250.000	75.000	50.000	25.000
	Initial budget					1.500.000						
	Risk free interest rate						1,04	1,04	1,04	1,04	1,04	1,04
	λ					0,5						
	Probability S occurs						50%	50%	70%	30%	60%	40%

Decision variables						consistency constraints					
XASY	XACY1	XACY2	1,00	1,00	1,00	$X_{ASY}+X_{ASN}=1$	1	1	$X_{ACY1}+X_{ACN1}=X_{ASY}$	1	1
XASN	XACN1	XACN2	0,00	0,00	0,00	$X_{BSY}+X_{BSN}=1$	1	1	$X_{BCY1}+X_{BCN1}=X_{BSY}$	1	1
XBSY	XBCY1	XBCY2	1,00	1,00	1,00	$X_{CSY}+X_{CSN}=1$	1	1	$X_{CCY1}+X_{CCN1}=X_{CSY}$	1	1
XBSN	XBCN1	XBCN2	0,00	0,00	0,00	$X_{DSY}+X_{DSN}=1$	1	1	$X_{DCY1}+X_{DCN1}=X_{DSY}$	1	1
XCSY	XCCY1	XCCY2	1,00	1,00	1,00	$X_{ESY}+X_{ESN}=1$	1	1	$X_{ECY1}+X_{ECN1}=X_{ESY}$	1	1
XCSN	XCCN1	XCCN2	0,00	0,00	0,00	$X_{FSY}+X_{FSN}=1$	1	1	$X_{FCY1}+X_{FCN1}=X_{FSY}$	1	1
XDSY	XDCY1	XDCY2	1,00	1,00	1,00	$X_{GSY}+X_{GSN}=1$	1	1	$X_{GCY1}+X_{GCN1}=X_{GSY}$	1	1
XDSN	XDCN1	XDCN2	0,00	0,00	0,00	$X_{HSY}+X_{HSN}=1$	1	1	$X_{HCY1}+X_{HCN1}=X_{HSY}$	1	1
XESY	XECY1	XECY2	1,00	1,00	1,00	$X_{ISY}+X_{AIN}=1$	1	1	$X_{ICY1}+X_{ICN1}=X_{ISY}$	0	0
XESN	XECN1	XECN2	0,00	0,00	0,00	$X_{JSY}+X_{AJN}=1$	1	1	$X_{JCY1}+X_{JCN1}=X_{JSY}$	0	0
XFSY	XFCY1	XFCY2	1,00	1,00	1,00						
XFSN	XFCN1	XFCN2	0,00	0,00	0,00						
XGSY	XGCY1	XGCY2	1,00	1,00	1,00						
XGSN	XGCN1	XGCN2	0,00	0,00	0,00						
XHSY	XHCY1	XHCY2	1,00	1,00	1,00						
XHSN	XHCN1	XHCN2	0,00	0,00	0,00						
XISY	XICY1	XICY2	0,00	0,00	0,00						
XISN	XICN1	XICN2	1,00	0,00	0,00						
XJSY	XJCY1	XJCY2	0,00	0,00	0,00						
XJSN	XJCN1	XJCN2	1,00	0,00	0,00						

Resource constraint at period		1.044.000	21.760	553.760	5.472.630	3.912.630	2.990.910	1.840.910		
	Cash Out	-456.000	-1.064.000	-532.000						
	remaining	1.044.000	1.085.760	1.085.760						
	Surplus in period	1.044.000	21.760	553.760						
Expected Value (EV)	EV=50%*70%*RSS11+50%*30%*RSS12+50%*60%*RSS21+50%*40%*RSS22								3.767.770	EV
RS development based on applied risk free ir on initial budget		1.500.000	1.560.000	1.560.000	1.622.400	1.622.400	1.622.400	1.622.400		
Risk constaints					$RS_{S11}-EV=\Delta V^{+}_{S11}-\Delta V^{-}_{S11}$	$RS_{S12}-EV=\Delta V^{+}_{S12}-\Delta V^{-}_{S12}$	$RS_{S21}-EV=\Delta V^{+}_{S21}-\Delta V^{-}_{S21}$	$RS_{S22}-EV=\Delta V^{+}_{S22}-\Delta V^{-}_{S22}$		
					1.704.860	144.860	-776.860	-1.926.860		
					ΔV^{+}_{S11}	ΔV^{+}_{S12}	ΔV^{+}_{S21}	ΔV^{+}_{S22}		
					1.704.860	144.860	-	-		
					ΔV^{-}_{S11}	ΔV^{-}_{S12}	ΔV^{-}_{S21}	ΔV^{-}_{S22}		
					-	-	-776.860	-1.926.860		
LSAD								LSAD	-618.430	LSAD
Maximize CE	Cash equivalent							EV-λ*LSAD	3.458.555	CE

Figure 19: Model applied in Open Office

Figure 20 shows the input screen for the solver parameters. In the upper part, the target value has to be fixed. In the middle section all constraints have to be set. The calculated values will be inserted in the spread sheet as shown in figure 19.

Figure 20: Solver input screen

In the upper section of figure 19, as shown in figure 21, all grey cells are reserved for the input parameters. The white shaded fields summarise the results on project decisions. The column "Start" shows all project started at S_0 with "1", column "continue at S_1" and column "continue at S_2" show which projects are to be continued at the specific node, which is also indicated with "1".

	Projects	Investments total	Start	Continue at S1	Continue at S2	Investments in period 0	S1 / Investments in period 1	S2 / Investments in period 1	revenue in S11	revenue in S12	revenue in S21	revenue in S22
A	FO	350.000	1	1	1	105.000	245.000	122.500	1.500.000	1.000.000	500.000	-
B	MO limits	150.000	1	1	1	45.000	105.000	52.500	1.600.000	1.200.000	800.000	400.000
C	MO Performance	200.000	1	1	1	60.000	140.000	70.000	600.000	450.000	150.000	150.000
D	MO Risk	200.000	1	1	1	60.000	140.000	70.000	600.000	450.000	300.000	150.000
E	BO - reporting	150.000	1	1	1	45.000	105.000	52.500	500.000	300.000	200.000	100.000
F	BO - fees	30.000	1	1	1	9.000	21.000	10.500	75.000	40.000	40.000	40.000
G	MO - special services	40.000	1	1	1	12.000	28.000	14.000	75.000	50.000	25.000	25.000
H	PM - MO	400.000	1	1	1	120.000	280.000	140.000	500.000	400.000	400.000	400.000
I	PM - reporting	550.000	-	-	-	165.000	385.000	192.500	800.000	550.000	550.000	550.000
J	SWIFT integration	150.000	-	-	-	45.000	105.000	52.500	250.000	75.000	50.000	25.000
	Initial budget					1.500.000						
	Risk free interest rate						1,04	1,04	1,04	1,04	1,04	1,04
	λ					0,5						
	Probability S occurs						50%	50%	70%	30%	60%	40%

Figure 21: Upper part of applied model

Figure 22 shows the middle section of figure 19. All decision variables are listed there. The graphical distribution of variable names and values is given by the application. "Solver" could not solve the problem in another constellation. The decision variables have to be set as binary in the "solver" options. The 2 digits display in the cells format settings is chosen to verify adherence to the binary condition.

Decision variables					
XASY	XACY1	XACY2	1,00	1,00	1,00
XASN	XACN1	XACN2	0,00	0,00	0,00
XBSY	XBCY1	XBCY2	1,00	1,00	1,00
XBSN	XBCN1	XBCN2	0,00	0,00	0,00
XCSY	XCCY1	XCCY2	1,00	1,00	1,00
XCSN	XCCN1	XCCN2	0,00	0,00	0,00
XDSY	XDCY1	XDCY2	1,00	1,00	1,00
XDSN	XDCN1	XDCN2	0,00	0,00	0,00
XESY	XECY1	XECY2	1,00	1,00	1,00
XESN	XECN1	XECN2	0,00	0,00	0,00
XFSY	XFCY1	XFCY2	1,00	1,00	1,00
XFSN	XFCN1	XFCN2	0,00	0,00	0,00
XGSY	XGCY1	XGCY2	1,00	1,00	1,00
XGSN	XGCN1	XGCN2	0,00	0,00	0,00
XHSY	XHCY1	XHCY2	1,00	1,00	1,00
XHSN	XHCN1	XHCN2	0,00	0,00	0,00
XISY	XICY1	XICY2	0,00	0,00	0,00
XISN	XICN1	XICN2	1,00	0,00	0,00
XJSY	XJCY1	XJCY2	0,00	0,00	0,00
XJSN	XJCN1	XJCN2	1,00	0,00	0,00

Figure 22: Central section of applied model – decision variables

Figure 23 shows the right middle section of figure 19. Within the "Solver", the consistency constraints have to be set as left hand side and right hand side parts of the equations to be calculated.

consistency constraints								
$X_{ASY}+X_{ASN}=1$	1	1	$X_{ACY1}+X_{ACN1}=X_{ASY}$	1	1	$X_{ACY2}+X_{ACN2}=X_{ASY}$	1	1
$X_{BSY}+X_{BSN}=1$	1	1	$X_{BCY1}+X_{BCN1}=X_{BSY}$	1	1	$X_{BCY2}+X_{BCN2}=X_{BSY}$	1	1
$X_{CSY}+X_{CSN}=1$	1	1	$X_{CCY1}+X_{CCN1}=X_{CSY}$	1	1	$X_{CCY2}+X_{CCN2}=X_{CSY}$	1	1
$X_{DSY}+X_{DSN}=1$	1	1	$X_{DCY1}+X_{DCN1}=X_{DSY}$	1	1	$X_{DCY2}+X_{DCN2}=X_{DSY}$	1	1
$X_{ESY}+X_{ESN}=1$	1	1	$X_{ECY1}+X_{ECN1}=X_{ESY}$	1	1	$X_{ECY2}+X_{ECN2}=X_{ESY}$	1	1
$X_{FSY}+X_{FSN}=1$	1	1	$X_{FCY1}+X_{FCN1}=X_{FSY}$	1	1	$X_{FCY2}+X_{FCN2}=X_{FSY}$	1	1
$X_{GSY}+X_{GSN}=1$	1	1	$X_{GCY1}+X_{GCN1}=X_{GSY}$	1	1	$X_{GCY2}+X_{GCN2}=X_{GSY}$	1	1
$X_{HSY}+X_{HSN}=1$	1	1	$X_{HCY1}+X_{HCN1}=X_{HSY}$	1	1	$X_{HCY2}+X_{HCN2}=X_{HSY}$	1	1
$X_{ISY}+X_{AIN}=1$	1	1	$X_{ICY1}+X_{ICN1}=X_{ISY}$	0	0	$X_{ICY2}+X_{ICN2}=X_{ISY}$	0	0
$X_{JSY}+X_{AJN}=1$	1	1	$X_{JCY1}+X_{JCN1}=X_{JSY}$	0	0	$X_{JCY2}+X_{JCN2}=X_{JSY}$	0	0

Figure 23: Right section of the applied model – consistency constraints

Figure 24 shows the lower section of figure 19. The following calculation results are shown:

Resource constraint at period formula		1.044.000	21.760	553.760	5.472.630	3.912.630	2.990.910	1.840.910	
	Cash Out	-456.000	-1.064.000	-532.000					
	remaining	1.044.000	1.085.760	1.085.760					
	Surplus in period	1.044.000	21.760	553.760					
Expected Value (EV)									3.767.770
RS development based on applied risk free interest rate on initial budget		1.500.000	1.560.000	1.560.000	1.622.400	1.622.400	1.622.400	1.622.400	
Risk constaints					RS_{S11}-EV= $\Delta V^{+}_{S11}-\Delta V^{-}_{S11}$	RS_{S12}-EV= $\Delta V^{+}_{S12}-\Delta V^{-}_{S12}$	RS_{S21}-EV= $\Delta V^{+}_{S21}-\Delta V^{-}_{S21}$	RS_{S22}-EV= $\Delta V^{+}_{S22}-\Delta V^{-}_{S22}$	
					1.704.860	144.860	-776.860	-1.926.860	
					ΔV^{+}_{S11}	ΔV^{+}_{S12}	ΔV^{+}_{S21}	ΔV^{+}_{S22}	
					1.704.860	144.860	-	-	
					ΔV^{-}_{S11}	ΔV^{-}_{S12}	ΔV^{-}_{S21}	ΔV^{-}_{S22}	
					-	-	-776.860	-1.926.860	
LSAD								LSAD	-618.430
Maximize CE	Cash equivalent							EV-λ*LSAD	3.458.555

Figure 24: lower section of the applied model – calculation results

Calculation of risk adjusted interest rate ρ;

The optimal portfolio leads to a risk adjusted interest rate that exceeds the assumed risk free interest rate.

$$\rho = 1{,}04 * \sqrt{\frac{EV}{CE}} - 1 = 8{,}55\%$$

Present value of optimal project portfolio

By reducing the CE by the risk free interest rate and deducting the initial budget, you can calculate the project portfolio's optimal present value:

NPV=CE/(1,04)^2-1.500.000 =1.697.629

Expected down side risk EDR / LSAD

In this specific case the risk target value t is set equal to EV therefore EDR equals LSAD.

The EDR of the value of the final resource position is given by the sum:

EDR= $\sum_{s \in S_T} p(s) \cdot \Delta V_s^-$ =50%*70%*0+50%*30%*0+50%*60%*(-776.680)+50%*40%*(-1.926.680)= -618.430

7.4 Sensitivity Analyses

A sensitivity analyses which will supplement the model, is done in MS Excel / Open Office by analysing the impact of changes to the following parameters:

- Budget
- Risk free interest rate - RFIR
- λ - Risk parameter
- Probabilities that a specific node will be reached

7.4.1 Budget Changes

Table 2 shows the calculation results based on the budget changes in the grey column. The initial budget of 1.500.000 € is highlighted.

Budget	RFIR	λ	EV	LSAD	CE	ρ	NPV
500.000	4%	0,5	1.995.366	-419.730	1.785.501	9,94%	1.150.796
550.000	4%	0,5	2.070.776	-430.395	1.855.578	9,87%	1.165.586
600.000	4%	0,5	2.136.286	-437.380	1.917.596	9,77%	1.172.926
650.000	4%	0,5	2.327.034	-476.080	2.088.994	9,77%	1.281.392
700.000	4%	0,5	2.435.090	-480.280	2.194.950	9,54%	1.329.354
750.000	4%	0,5	2.521.930	-497.930	2.272.965	9,55%	1.351.484
800.000	4%	0,5	2.576.010	-497.930	2.327.045	9,42%	1.351.484
850.000	4%	0,5	2.766.758	-536.630	2.498.443	9,44%	1.459.951
900.000	4%	0,5	2.853.598	-554.280	2.576.458	9,45%	1.482.081
950.000	4%	0,5	2.916.654	-580.980	2.626.164	9,60%	1.478.037
1.000.000	4%	0,5	2.970.734	-580.980	2.680.244	9,49%	1.478.037
1.050.000	4%	0,5	3.161.482	-619.680	2.851.642	9,50%	1.586.503
1.100.000	4%	0,5	3.248.322	-637.330	2.929.657	9,51%	1.608.633
1.150.000	4%	0,5	3.302.402	-637.330	2.983.737	9,41%	1.608.633
1.200.000	4%	0,5	3.356.482	-637.330	3.037.817	9,32%	1.608.633
1.250.000	4%	0,5	3.410.562	-637.330	3.091.897	9,23%	1.608.633
1.300.000	4%	0,5	3.464.642	-637.330	3.145.977	9,14%	1.608.633
1.350.000	4%	0,5	3.518.722	-637.330	3.200.057	9,06%	1.608.633
1.400.000	4%	0,5	3.572.802	-637.330	3.254.137	8,97%	1.608.633
1.450.000	4%	0,5	3.702.260	-611.445	3.396.537	8,58%	1.690.289
1.500.000	4%	0,5	3.767.770	-618.430	3.458.555	8,55%	1.697.629
1.550.000	4%	0,5	3.821.850	-618.430	3.512.635	8,48%	1.697.629
1.600.000	4%	0,5	3.936.428	-624.045	3.624.405	8,38%	1.750.966
1.650.000	4%	0,5	4.001.938	-631.030	3.686.423	8,36%	1.758.306
1.700.000	4%	0,5	4.056.018	-631.030	3.740.503	8,30%	1.758.306
1.750.000	4%	0,5	4.110.098	-631.030	3.794.583	8,24%	1.758.306
1.800.000	4%	0,5	4.164.178	-631.030	3.848.663	8,18%	1.758.306
1.850.000	4%	0,5	4.218.258	-631.030	3.902.743	8,12%	1.758.306
1.900.000	4%	0,5	4.272.338	-631.030	3.956.823	8,07%	1.758.306
1.950.000	4%	0,5	4.375.660	-604.975	4.073.173	7,79%	1.815.877
2.000.000	4%	0,5	4.455.876	-611.027	4.150.362	7,76%	1.837.243
2.050.000	4%	0,5	4.521.386	-618.541	4.212.116	7,75%	1.844.338
2.100.000	4%	0,5	4.575.466	-618.541	4.266.196	7,70%	1.844.338
2.150.000	4%	0,5	4.629.546	-618.541	4.320.276	7,66%	1.844.338
2.200.000	4%	0,5	4.683.626	-618.541	4.374.356	7,61%	1.844.338
2.250.000	4%	0,5	4.737.706	-618.541	4.428.436	7,57%	1.844.338
2.300.000	4%	0,5	4.791.786	-618.541	4.482.516	7,53%	1.844.338
2.350.000	4%	0,5	4.845.866	-618.541	4.536.596	7,49%	1.844.338
2.400.000	4%	0,5	4.899.946	-618.541	4.590.676	7,45%	1.844.338
2.450.000	4%	0,5	4.954.026	-618.541	4.644.756	7,41%	1.844.338
2.500.000	4%	0,5	5.008.106	-618.541	4.698.836	7,37%	1.844.338

Table 2: Sensitivity analysis on budget changes

Figure 25 shows how the Cash Equivalent and the Expected Value change if the budget is increased. The correlation between the calculated results and the input parameters is triggered by the fact that not invested money will yield interest.

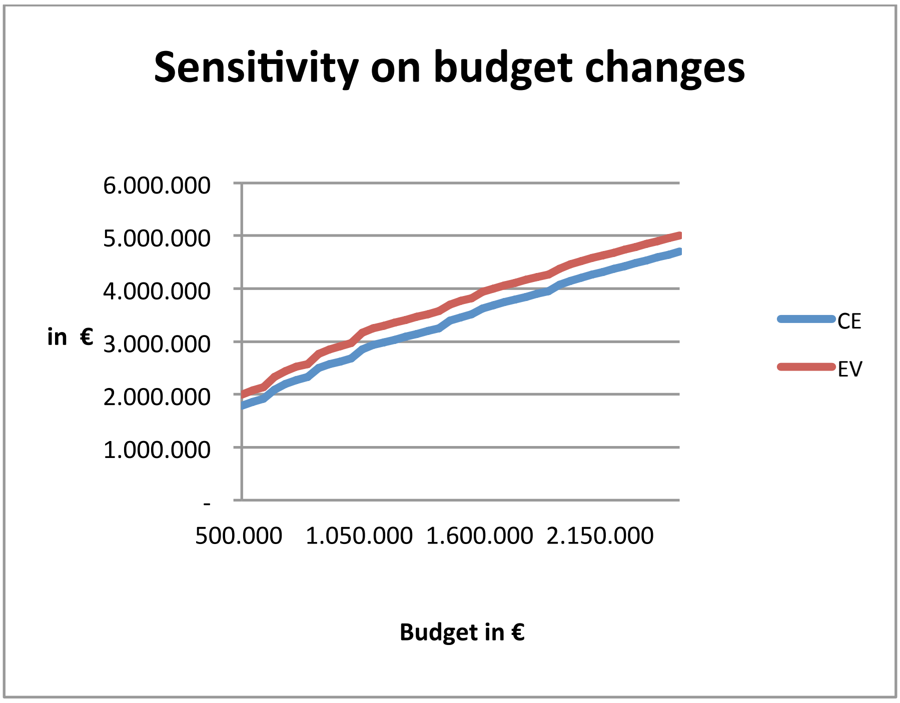

Figure 25: Sensitivity of CE and EV on budget changes

Figure 26 shows the correlation of the NPV, which is similar as the correlation with CE and EV.

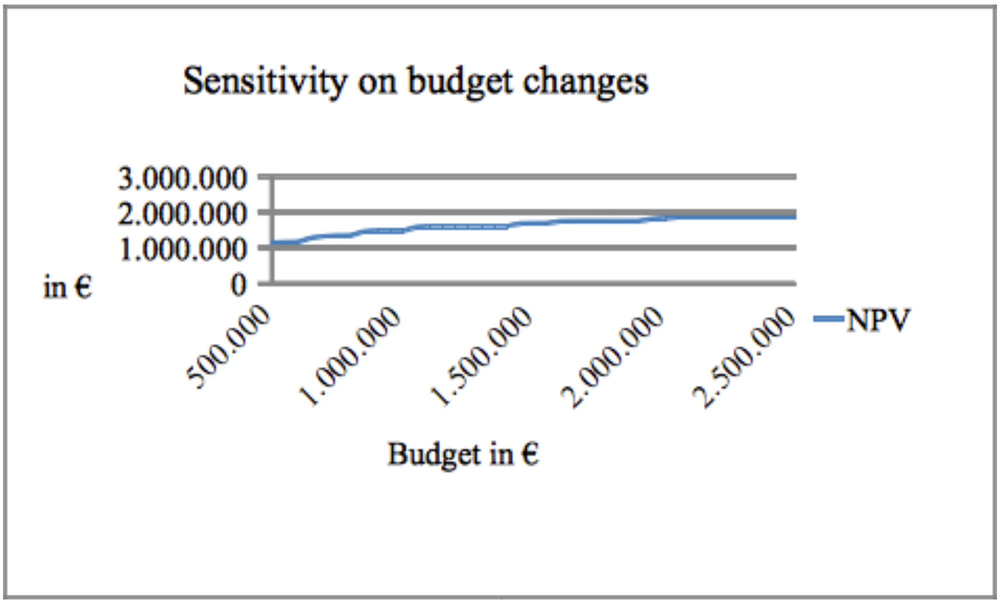

Figure 26: Sensitivity of NPV to budget changes

Figure 27 shows the negative correlation caused by increasing budget and decreasing ρ. The higher the budget with unchanged investment opportunities, the more money is to be invested at the risk free interest rate of 4%, with the result that ρ goes down.

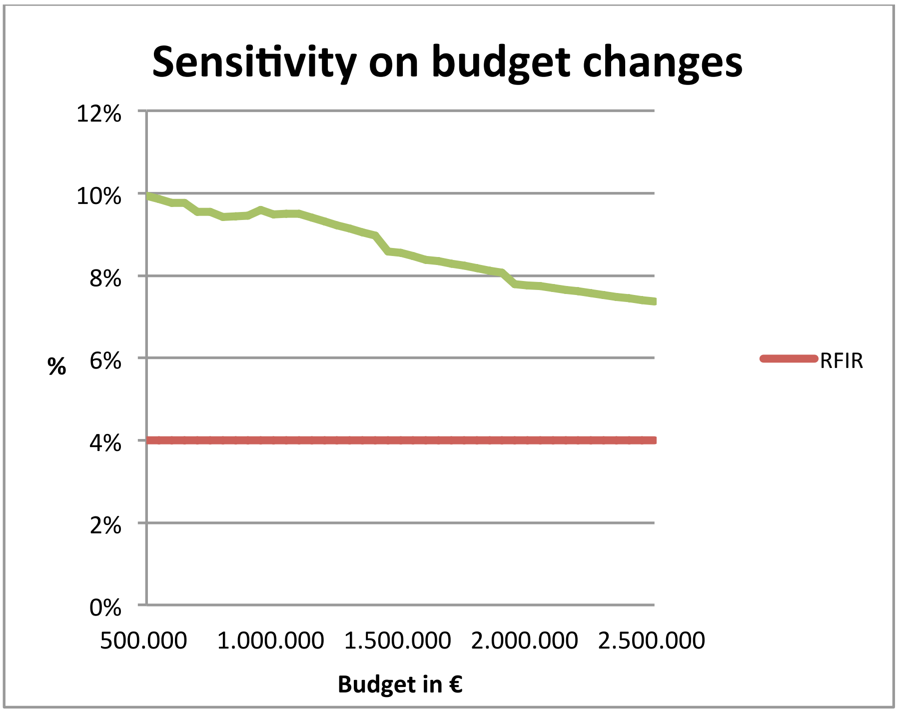

Figure 27: Sensitivity of ρ on budget changes

Figure 28 summarises project decisions. Green fields mark the specific stages at which the decision was taken to start or continue projects, and white fields mark those at which the decision was taken not to start or to discontinue projects.

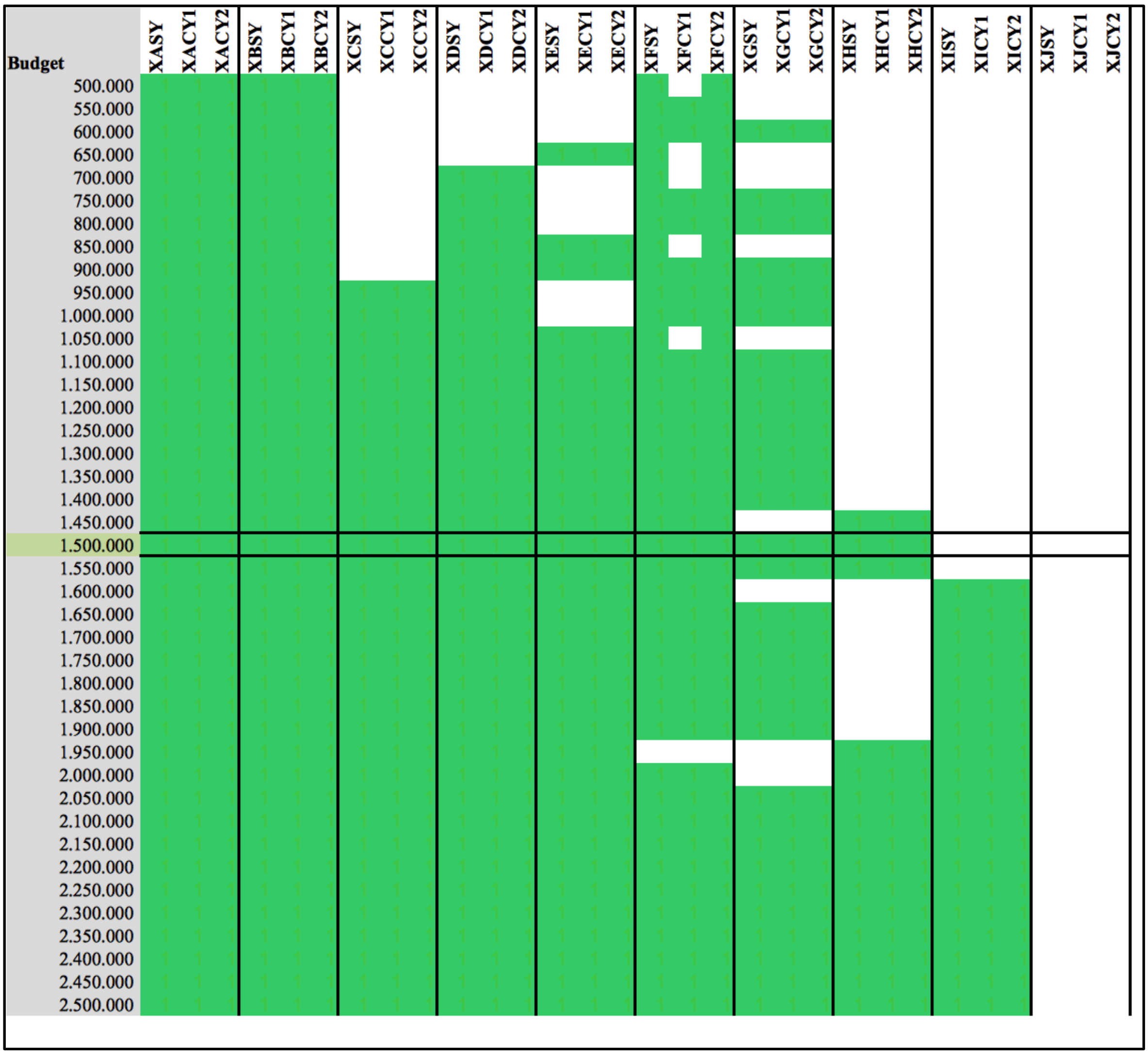

Figure 28: Impact of budget changes on project decisions

Two examples to illustrate the interpretation:

With a budget of 500.000 €, projects A, B will be started and finalised regardless of whether S1 or S2 is reached. Project F is to be started, and if S_1 is reached will be discontinued, while if S_2 is reached it will be continued

If the initial budget is set at 2.500.000 €, projects A to I are all to be started and continued independent of if S_1 or S_2 is reached. Project J will not be started.

7.4.2 Changes of Risk Free Interest Rate

The working assumption is that external triggers, like a financial crisis, could provoke changes to the risk free interest rate. As the financial markets have been quite unstable over recent years, this analysis has become more relevant.

Table 5 shows the impact of the RFIR changes on the calculated parameters.

Budget	RFIR	λ	EV	LSAD	CE	ρ	NPV
1.500.000	1%	0,5	3.714.706	-615.330	3.407.041	5,46%	1.839.908
1.500.000	2%	0,5	3.740.718	-621.090	3.430.173	6,52%	1.796.975
1.500.000	3%	0,5	3.754.140	-619.760	3.444.260	7,53%	1.746.545
1.500.000	4%	0,5	3.767.770	-618.430	3.458.555	8,55%	1.697.629
1.500.000	5%	0,5	3.781.610	-617.100	3.473.060	9,56%	1.650.168
1.500.000	6%	0,5	3.795.658	-615.770	3.487.773	10,58%	1.604.106
1.500.000	7%	0,5	3.809.916	-614.440	3.502.696	11,59%	1.559.390
1.500.000	8%	0,5	3.824.382	-613.110	3.517.827	12,61%	1.515.969
1.500.000	9%	0,5	3.839.056	-611.780	3.533.166	13,62%	1.473.795
1.500.000	10%	0,5	3.882.700	-612.250	3.576.575	14,61%	1.455.847

Table 3: Sensitivity of the results to RFIR changes

Figure 29 shows the positive correlation between a rising RFIR and the CE and EV. These values are positive because any kind of resource surplus in the model will yield interest.

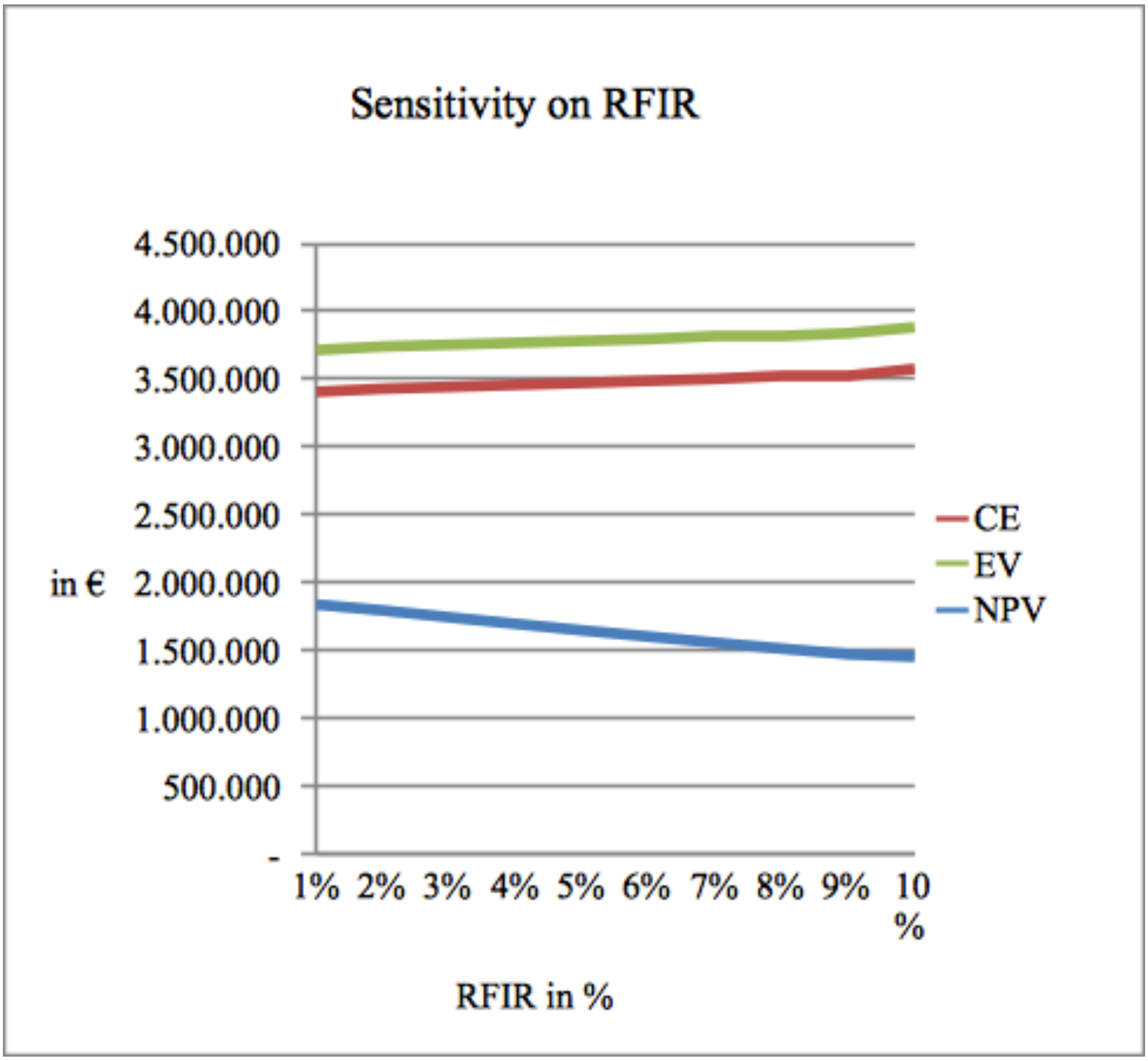

Figure 29: Sensitivity of CE, EV and NPV to RFIR changes

Figure 30 illustrates how the project decisions are based on the variance of the risk free interest rate.

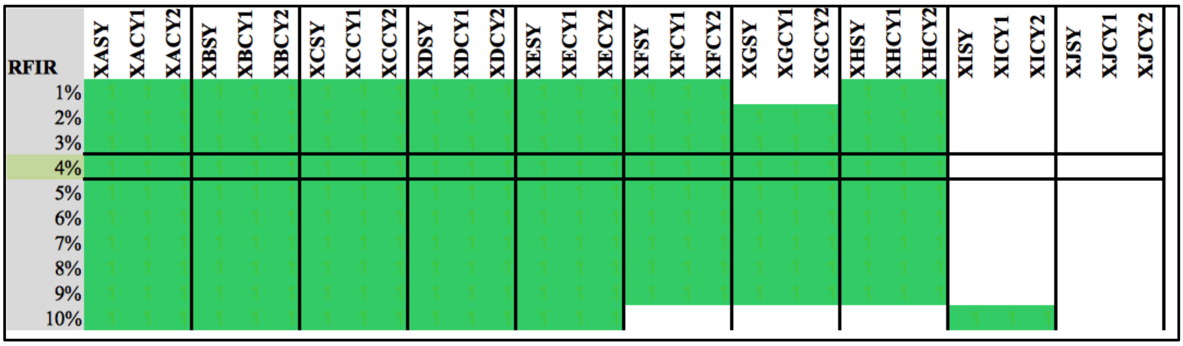

Figure 30: Impact of risk free interest rate changes on project decisions

7.4.3 Changes of Probabilities in the Decision Tree

This chapter focuses on the impact of changes on the probabilities. The unstable financial situation leads to huge fluctuations in the estimations, depending on when and by how great a percentage the economy grows.

Four decision makers (DM) in evaluating the probabilities:

DM1

Positive economic development in the first period: 60%, in second period: 70% if already positive in first period, otherwise 60%

DM2

Economy develops positive in first period: 60%, in the second period: 75% in any case

DM3

Economy develops positive in first period: 30%, in the second period: 50% in any case

DM4

Economy develops positive in the first period: 60%, in the second period: 70% in any case

Table 4 shows the impact of the calculated CE varies from 3.013.286 (30%) to 3.709.070 (60%). This shows that the estimation of the probabilities will be a key factor in achieving proper results on the project portfolio, see figure 31.

	P									
S0	**S1**	**S2**	**Budget**	**RFIR**	**λ**	**EV**	**LSAD**	**CE**	**ρ**	**NPV**
0, 100	70, 30	60, 40	1.500.000	4%	0,5	2.645.754	-156.000	2.567.754	5,57%	874.033
10, 90	70, 30	60, 40	1.500.000	4%	0,5	2.896.504	-317.418	2.737.794	6,97%	1.031.245
20, 80	70, 30	60, 40	1.500.000	4%	0,5	3.088.222	-343.500	2.916.472	7,02%	1.196.442
30, 70	70, 30	60, 40	1.500.000	4%	0,5	3.273.026	-519.481	3.013.286	8,39%	1.285.952
40, 60	70, 30	60, 40	1.500.000	4%	0,5	3.520.398	-593.693	3.223.552	8,68%	1.480.355
50, 50	70, 30	60, 40	1.500.000	4%	0,5	3.767.770	-618.430	3.458.555	8,55%	1.697.629
60, 40	70, 30	60, 40	1.500.000	4%	0,5	4.015.142	-612.145	3.709.070	8,21%	1.929.244
70, 30	70, 30	60, 40	1.500.000	4%	0,5	4.262.514	-592.957	3.966.036	7,82%	2.166.823
80, 20	70, 30	60, 40	1.500.000	4%	0,5	4.509.886	-539.137	4.240.318	7,25%	2.420.412
90, 10	70, 30	60, 40	1.500.000	4%	0,5	4.757.258	-450.684	4.531.916	6,55%	2.690.011
100, 0	70, 30	60, 40	1.500.000	4%	0,5	5.004.630	-327.600	4.840.830	5,74%	2.975.620

Table 4: Sensitivity of the results to changes of probability to reach S_1 and S_2

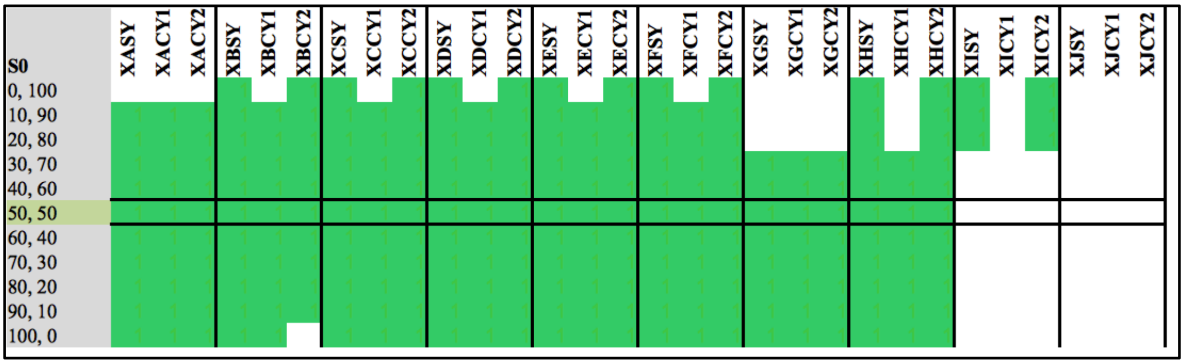

Figure 31: Impact of changes on the probability of reaching S_1 and S_2

Table 5 indicates the results of changing the probabilities at S_1 to S_{11} and S_{12}.

	P									
S0	**S1**	**S2**	**Budget**	**RFIR**	**λ**	**EV**	**LSAD**	**CE**	**ρ**	**NPV**
50, 50	0, 100	60, 40	1.500.000	4%	0,5	3.219.090	-342.820	3.047.680	6,88%	1.317.751
50, 50	10, 90	60, 40	1.500.000	4%	0,5	3.295.840	-381.195	3.105.242	7,14%	1.370.971
50, 50	20, 80	60, 40	1.500.000	4%	0,5	3.377.770	-423.430	3.166.055	7,42%	1.427.196
50, 50	30, 70	60, 40	1.500.000	4%	0,5	3.455.770	-462.430	3.224.555	7,66%	1.481.283
50, 50	40, 60	60, 40	1.500.000	4%	0,5	3.533.770	-501.430	3.283.055	7,90%	1.535.369
50, 50	50, 50	60, 40	1.500.000	4%	0,5	3.611.770	-540.430	3.341.555	8,12%	1.589.456
50, 50	60, 40	60, 40	1.500.000	4%	0,5	3.689.770	-579.430	3.400.055	8,34%	1.643.542
50, 50	70, 30	60, 40	1.500.000	4%	0,5	3.767.770	-618.430	3.458.555	8,55%	1.697.629
50, 50	80, 20	60, 40	1.500.000	4%	0,5	3.845.770	-657.430	3.517.055	8,75%	1.751.715
50, 50	90, 10	60, 40	1.500.000	4%	0,5	3.923.770	-696.987	3.575.277	8,95%	1.805.544
50, 50	100, 0	60, 40	1.500.000	4%	0,5	4.001.770	-735.430	3.634.055	9,13%	1.859.888

Table 5: Sensitivity on the results based on changes of probability to reach S_{11} and S_{12}

Figure 32 shows that the impact on project decisions caused by making changes to the probabilities at S_{11} and S_{12} is limited.

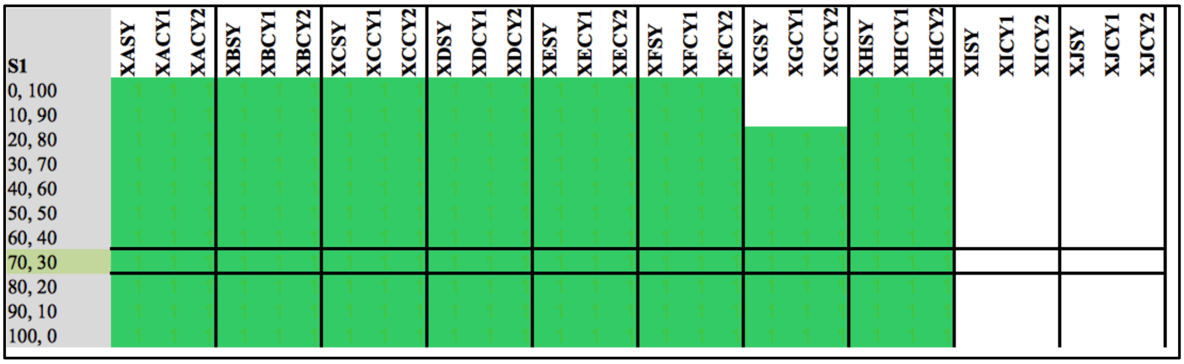

Figure 32: Impact of making probability changes at S_{11} and S_{12} on project decisions

Table 6 shows the sensitivity analysis results when changing the probabilities at S_2 to S_{21} and S_{22}.

	P									
S0	S1	S2	Budget	RFIR	λ	EV	LSAD	CE	ρ	NPV
50, 50	70, 30	0, 100	1.500.000	4%	0,5	3.486.470	-759.080	3.106.930	10,17%	1.372.532
50, 50	70, 30	10, 90	1.500.000	4%	0,5	3.518.970	-742.830	3.147.555	9,96%	1.410.092
50, 50	70, 30	20, 80	1.500.000	4%	0,5	3.551.470	-726.580	3.188.180	9,77%	1.447.652
50, 50	70, 30	30, 70	1.500.000	4%	0,5	3.583.970	-710.330	3.228.805	9,57%	1.485.212
50, 50	70, 30	40, 60	1.500.000	4%	0,5	3.652.770	-675.930	3.314.805	9,17%	1.564.724
50, 50	70, 30	50, 50	1.500.000	4%	0,5	3.710.270	-647.180	3.386.680	8,86%	1.631.176
50, 50	70, 30	60, 40	1.500.000	4%	0,5	3.767.770	-618.430	3.458.555	8,55%	1.697.629
50, 50	70, 30	70, 30	1.500.000	4%	0,5	3.825.270	-589.680	3.530.430	8,26%	1.764.081
50, 50	70, 30	80, 20	1.500.000	4%	0,5	3.882.770	-560.930	3.602.305	7,97%	1.830.534
50, 50	70, 30	90, 10	1.500.000	4%	0,5	3.940.270	-536.326	3.672.107	7,73%	1.895.070
50, 50	70, 30	100, 0	1.500.000	4%	0,5	3.997.770	-516.201	3.739.670	7,53%	1.957.535

Table 6: Sensitivity on the results based on changes of probability to reach S_{21} and S_{22}

Regardless of what probability changes are made, they have a low impact on the project decisions.

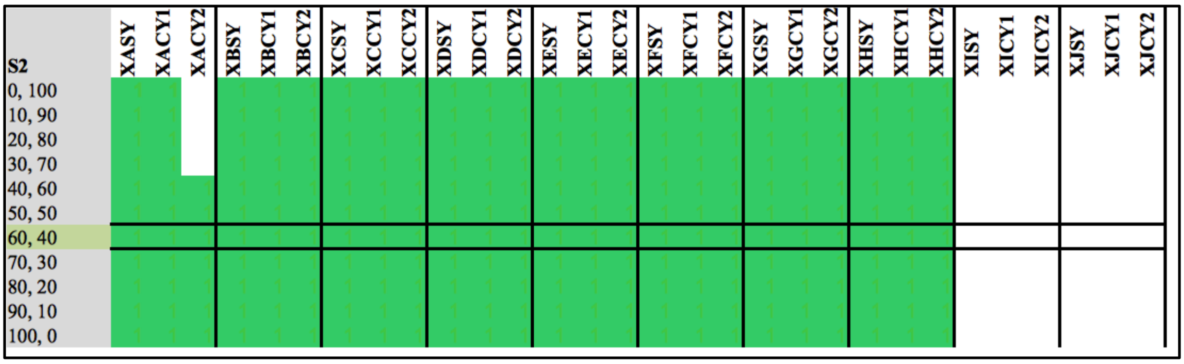

Figure 33: Impact of probability changes to reach S_{21} and S_{22}

7.4.4 Risk Parameter λ Changes

The risk parameter can vary from 0 to 1. The decision maker's interviews lead to results: 0,4; 0,5; 0,6 to 1. The impact of this spread on the CE is a range from 3.520.398 to 3.039.187.

Table 7 summarises the calculation results.

Budget	RFIR	λ	EV	LSAD	CE	ρ	NPV
1.500.000	4%	0,0	3.926.506	-618.541	3.926.506	4,00%	2.130.276
1.500.000	4%	0,1	3.767.770	-618.430	3.705.927	4,86%	1.926.338
1.500.000	4%	0,2	3.767.770	-618.430	3.644.084	5,75%	1.869.161
1.500.000	4%	0,3	3.767.770	-618.430	3.582.241	6,66%	1.811.984
1.500.000	4%	0,4	3.767.770	-618.430	3.520.398	7,59%	1.754.806
1.500.000	4%	0,5	3.767.770	-618.430	3.458.555	8,55%	1.697.629
1.500.000	4%	0,6	3.767.770	-618.430	3.396.712	9,53%	1.640.452
1.500.000	4%	0,7	3.767.770	-618.430	3.334.869	10,54%	1.583.274
1.500.000	4%	0,8	3.767.770	-618.430	3.273.026	11,58%	1.526.097
1.500.000	4%	0,9	3.680.962	-637.330	3.107.365	13,19%	1.372.934
1.500.000	4%	1,0	3.669.532	-630.345	3.039.187	14,28%	1.309.899

Table 7: Sensitivity on the results based on changes of λ

Figure 26 shows a negative correlation between λ and CE, NPV and EV.

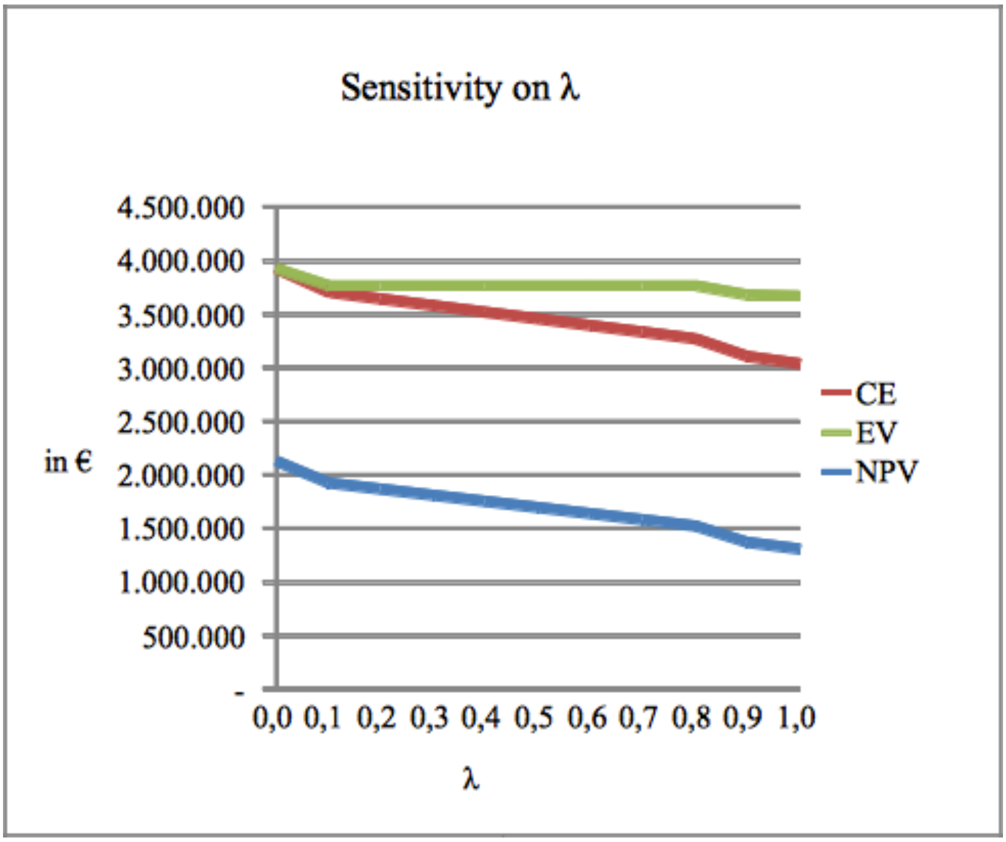

Figure 34: Impact of risk parameter on CE, EV and NPV

Figure 27 shows a positive correlation between λ and ρ.

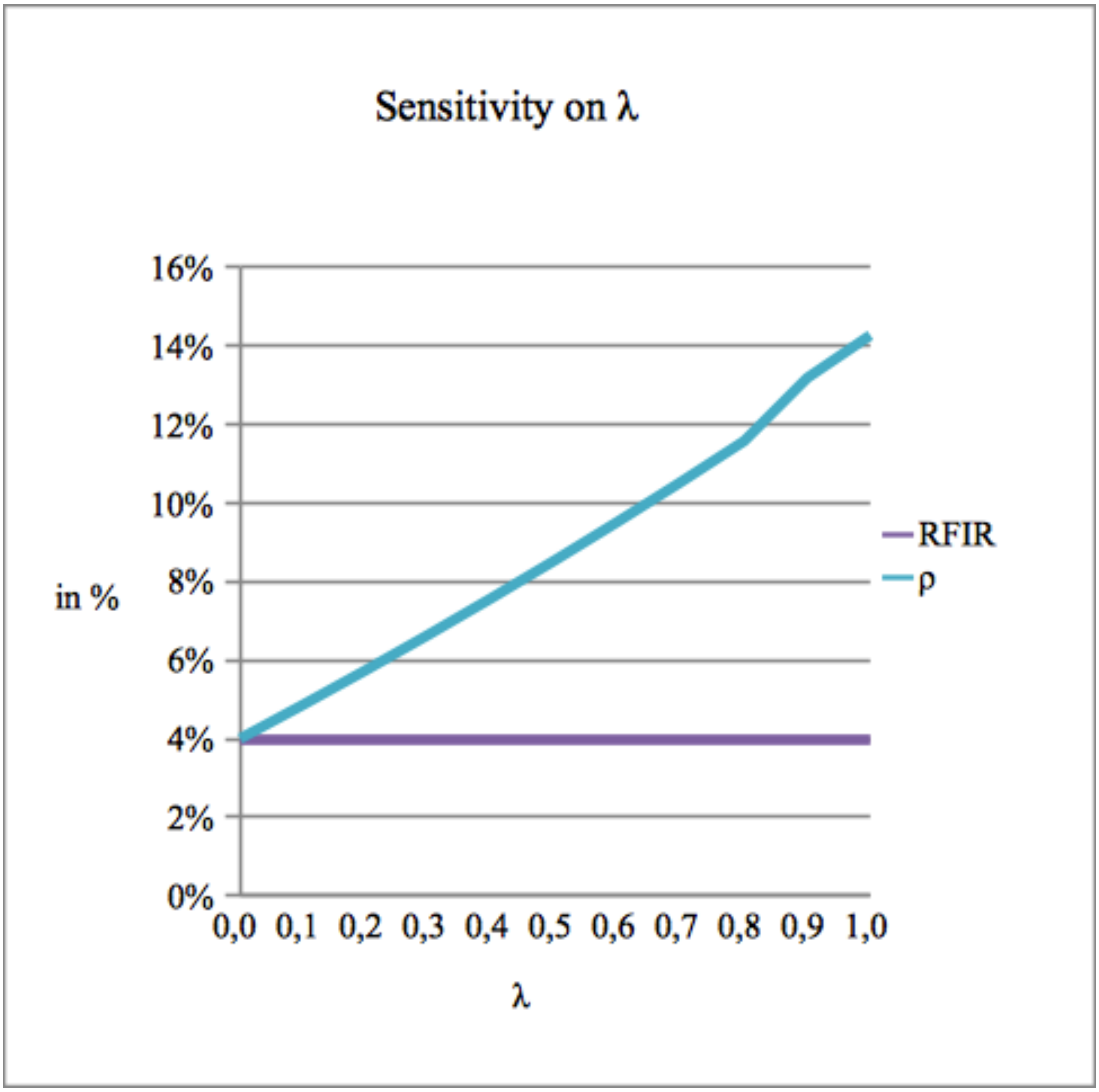

Figure 35: Sensitivity to λ changes on ρ

Figure 36 shows that at λ levels between 0,1 and 0,8 the same project decisions will be made.

λ	XASY	XACY1	XACY2	XBSY	XBCY1	XBCY2	XCSY	XCCY1	XCCY2	XDSY	XDCY1	XDCY2	XESY	XECY1	XECY2	XFSY	XFCY1	XFCY2	XGSY	XGCY1	XGCY2	XHSY	XHCY1	XHCY2	XISY	XICY1	XICY2	XJSY	XJCY1	XJCY2
0,0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			
0,1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1						
0,9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									
1,0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1												

Figure 36: Sensitivity of project decisions on λ changes

7.4.5 Changes of Project Costs

Investments made in periods 1 and 2 will be put on the level of period 1 to show the importance of properly estimating costs. Figure 37 shows the entry parameters and figures. Figures 38 and 39 illustrate the calculation results.

	Projects	Investments total	Investments in period 0	S1 / Investments in period 1	S2 / Investments period 1	potential revenue in S11	potential revenue in S12	potential revenue in S21	potential revenue in S22
A	FO	350.000	105.000	245.000	245.000	1.500.000	1.000.000	500.000	-
B	MO limits	150.000	45.000	105.000	105.000	1.600.000	1.200.000	800.000	400.000
C	MO Performance	200.000	60.000	140.000	140.000	600.000	450.000	150.000	150.000
D	MO Risk	200.000	60.000	140.000	140.000	600.000	450.000	300.000	150.000
E	BO - reporting	150.000	45.000	105.000	105.000	500.000	300.000	200.000	100.000
F	BO - fees	30.000	9.000	21.000	21.000	75.000	40.000	40.000	40.000
G	MO - special services	40.000	12.000	28.000	28.000	75.000	50.000	25.000	25.000
H	PM - MO	400.000	120.000	280.000	280.000	500.000	400.000	400.000	400.000
I	PM - reporting	550.000	165.000	385.000	385.000	800.000	550.000	550.000	550.000
J	SWIFT integration	150.000	45.000	105.000	105.000	250.000	75.000	50.000	25.000
	Initial budget		**1.500.000**						
	Risk free interest rate			**1,04**	**1,04**	**1,04**	**1,04**	**1,04**	**1,04**
	λ		**0,5**						
	Probability S occurs			**50%**	**50%**	**70%**	**30%**	**60%**	**40%**

Figure 37: Project cost in 2nd phase doubled

Decision variables					
XASY	XACY1	XACY2	1,00	1,00	0,00
XASN	XACN1	XACN2	0,00	0,00	1,00
XBSY	XBCY1	XBCY2	1,00	1,00	1,00
XBSN	XBCN1	XBCN2	0,00	0,00	0,00
XCSY	XCCY1	XCCY2	1,00	1,00	1,00
XCSN	XCCN1	XCCN2	0,00	0,00	0,00
XDSY	XDCY1	XDCY2	1,00	1,00	1,00
XDSN	XDCN1	XDCN2	0,00	0,00	0,00
XESY	XECY1	XECY2	1,00	1,00	1,00
XESN	XECN1	XECN2	0,00	0,00	0,00
XFSY	XFCY1	XFCY2	1,00	1,00	1,00
XFSN	XFCN1	XFCN2	0,00	0,00	0,00
XGSY	XGCY1	XGCY2	1,00	1,00	0,00
XGSN	XGCN1	XGCN2	0,00	0,00	1,00
XHSY	XHCY1	XHCY2	0,00	0,00	0,00
XHSN	XHCN1	XHCN2	1,00	0,00	0,00
XISY	XICY1	XICY2	0,00	0,00	0,00
XISN	XICN1	XICN2	1,00	0,00	0,00
XJSY	XJCY1	XJCY2	0,00	0,00	0,00
XJSN	XJCN1	XJCN2	1,00	0,00	0,00

Figure 38: Changes of project costs to portfolio decisions

Projects	Investments total	Continue at S1	Investments in period 0	S1 / Investments in period 1	S2 / Investments period 1	potential revenue in S11	potential revenue in S12	potential revenue in S21	potential revenue in S22		
Resource constraint at period formula			1.164.000	426.560	699.560	5.393.622	3.933.622	2.217.542	1.567.542		
		Cash Out	-336.000	-784.000	-511.000						
		remaining	1.164.000	1.210.560	1.210.560						
		Surplus in perio	1.164.000	426.560	699.560						
Expected Value (EV)										3.456.582	EV
RS development based on applied risk free interest rate on initial budget			1.500.000	1.560.000	1.560.000	1.622.400	1.622.400	1.622.400	1.622.400		
Risk constaints						RS_{S11}-EV= ΔV^+_{S11}-ΔV^-_{S11}	RS_{S12}-EV= ΔV^+_{S12}-ΔV^-_{S12}	RS_{S21}-EV= ΔV^+_{S21}-ΔV^-_{S21}	RS_{S22}-EV= ΔV^+_{S22}-ΔV^-_{S22}		
						1.937.040	477.040	-1.239.040	-1.889.040		
						ΔV^+_{S11}	ΔV^+_{S12}	ΔV^+_{S21}	ΔV^+_{S22}		
						1.937.040	477.040	-	-		
						ΔV^-_{S11}	ΔV^-_{S12}	ΔV^-_{S21}	ΔV^-_{S22}		
						-	-	-1.239.040	-1.889.040		
LSAD									LSAD	-749.520	LSAD
Maximize CE	Cash equivalent								EV-λ*LSAD	3.081.822	CE
risk adjusted interest rate ρ										10,14%	ρ
Present value of optimal project portfolio										1.349.318	NPV

Figure 39: Project cost in 2nd phase doubled - results

The calculation of ρ for the optimal portfolio, leads to a risk adjusted interest rate that exceeds the assumed risk free interest rate of 10,14%ρ and accounts for time and risk preferences.

Present value of the optimal project portfolio   NPV= 1.349.318

Figure 40 highlights the differences in the project decisions.

The original values are shown in the first row, the second row shows the result if costs for the second phase are doubled. As there are no resource shortages in the analysed example, the impact on the calculated results is small.

Figure 40: Optimal portfolio based on input cost effects

7.4.6 Practical Application of the Sensitivity Analysis

To sum up the previously described results of the sensitivity analysis, the results of four decision makers will be compared.

The decision makers were asked to estimate the probability of the economy growing in the next 12 months and in the 12 months following those. Additionally they were invited to set the risk parameter λ (0 for risk neutral, 1 for an aversity to taking risks).

The input parameters of 4 decision makers (DM) is summarised and the results are compared to each other.

Decision maker DM1

Economy develops positive in the first period: 60%, in the second period: 70% if positive already positive in first period, otherwise 60%,

λ=0,5

Decision maker DM2

Economy develops positive in the first period: 60%, in the second period: 75% in any case

λ=0,4

Decision maker DM3

Economy develops positive in the first period: 30%, in the second period: 50% in any case

λ=0,6

Decision maker DM4

Economy develops positive in the first period: 60%, in the second period: 70% in any case

λ=1

Figure 41 reflects the difference of the expected NP

	Budget	RFIR	λ	EV	LSAD	CE	ρ	NPV
DM1	1.500.000	104%	0,5	4.015.142	-612.145	3.709.070	8,21%	1.929.244
DM2	1.500.000	104%	0,4	4.130.942	-603.760	3.889.439	7,18%	2.096.005
DM3	1.500.000	104%	0,6	3.094.584	-473.294	2.810.607	9,13%	1.098.564
DM4	1.500.000	104%	1,0	3.981.894	-592.926	3.388.969	12,73%	1.633.292

Figure 41: DM 1-4 calculation results

Figure 42 shows that the different assumptions about the probability and the parameters, lead to different project selections.

Figure 42: DM 1-4 project selection results

Although the assumptions are set quite differently there is only a small deviation in the project selections.

8 Interpretation of the Results

In this chapter, the calculation results are explained. Based on the sensitivity analysis the stability of the model, with regards to changes in the input variables and system parameters, is summarised. Finally, the model results are compared with the subjective decisions made by the decision makers without using the model.

8.1 Findings

Based on the sensitivity analysis on defined parameters the stability of the system depending on the input parameters is explained.

Budget Changes

The results of the budget sensitivity analysis show that, as long as risk free interest is gained on any budget money not invested in projects and on the resource surplus gains, additional money will lead to additional benefits.

Figures 25 and 26 highlight the positive correlation between budget increase CE, EV and NPV.

Figure 27 shows that the above described fact, that there is no alternative investment allowed, leads to a decrease of ρ when the budget is increased.

The project decision matrix in figure 28 demonstrates the impact that the budget has on the project selection and one can see that the differences in the decisions are driven by the different contribution margins of the projects.

Figure 43 shows the CE of the optimal portfolio based on budget changes, all other parameters are fixed.

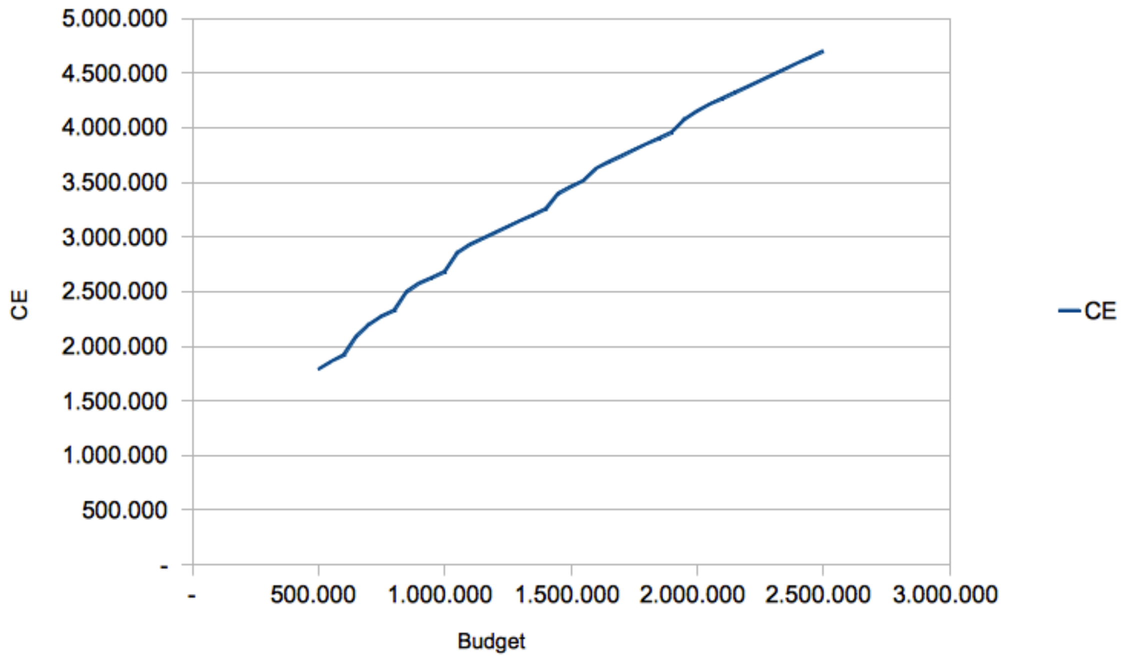

Figure 43: Optimal portfolio based on input budget changes

Risk Free Interest Rate

The determination of the risk free interest rate is most probably the easiest part of the settings of the model as it can be collected easily in real markets. On the other hand it is more or less fully externally steered. Within the observation period of two years a development by plus or minus 50% is possible.

In figure 29 the positive correlation of the risk free interest rate with CE and EV and negative correlation with the NPV is presented.

Figure 30 shows that the project selection results are quite stable. The same decisions are made from 2% to 8%, only 1% and 10% led to different results.

Changes of Probabilities in the Decision Tree

The estimation of the probabilities for the environmental changes is probably one of the biggest issues in the model. As described in chapter 7.4.3, the collection of the estimations from different decision makers shows huge differences. Most probably each estimation is dependent on the market situation a decision maker is in. As there is still a financial crisis, it is obvious that different people make different estimations.

The figures 31 to 33 show that, based on the derived project decisions, variations to the probabilities required to reach node S_0 to S_1 and S_2, do have more impact than others.

Risk Parameter

The identification of a parameter to explain how averse to risk the decision maker is was quite tricky. The statement that 1 is the most negative attitude to taking risks and 0 is the most positive, raises the question of what impact this has on the results.

Figure 35 shows the positive correlation between λ and ρ.

The project selection results for λ were the same for the values from 0,1 to 0,8.

Costs

Project cost and revenues have to be estimated. The quality of the estimations can lead to different results. For illustration purposes, the costs estimated for the 2nd phase have been doubled.

The majority of the project decisions are the same, because, again, there is no budget shortage and most of the selected projects have a high contribution margin.

8.2 Comparison of Calculated Results and Management Decisions

In general, the probability of achieving S_{11} to S_{22} depends on the probability of the markets developing positively and a potential client taking the new service. For the decision maker, this increases the complexity in making estimations.

One management decision maker prefers project J that is one of the projects which was not selected in most of the scenarios calculated by the model. The reason for the management decision maker's choice is that the project should bring big data quality improvements, which should therefore reduce operational risk. This advantage was not considered in the revenue calculations and could be enhanced by adding operational risk costs to the TCO calculation.

9 Potential Enhancements

During the application of the model and the analysis of the required framework, potential enhancements and model adaptations have been identified. These enhancements can be split into three categories:

- Mathematical model
- Application of the model
- Software

9.1 Enhancements of the Mathematical Model

Probability Distribution

To simplify the estimation of the probabilities used to shift from one stage to another there could be used a probability function and some thresholds could be applied.

Dependency Analysis

Another area of complexity could be added by dependencies e.g. between projects or project phases.

In the analysed model only linear action variables are used, as a result interactions like synergies within the projects are not considered.

Impact of Environmental Changes (e.g. financial crisis)

The model could be enhanced by the inclusion of scenarios e.g. a worst-case status could be implemented to see calculate the maximal risk.

Loans

A further enhancement would be the inclusion in periods 0 and 1 of the possibility to increase the available budget by borrowing money or other resources for predefined costs.

Enhance the Project-specific Decision Tree on Standardised and Individual Investments

Gustafsson and Salo [54] [55]developed a model enhancement. It is based on a mixed asset portfolio selection (MAPS) model – a portfolio model including both projects and securities – and the concepts of break-even selling and buying prices, which compares the values of optimal portfolios, both with and without the analysed project. They extended CPP to include securities and to generalise its objective function to several types of preference models, ranging from the expected utility model to various non-expected utility models.

9.2 Application of the Model

Different Resource Types

Including different resource types like human resources, various resource pools, specific skill sets or production goods could enhance the application.

Common Estimation Model for Environmental Changes

Probability estimation, in particular, can be improved. It would be possible to perform expert interviews and to calculate an average.

Decision Board

The decision board for the annual tactical planning can use the model. This means that the planning approach in general has to be changed to cover a longer period of time and that all of the company's resource consuming activities have to be included.

9.3 Software

Usability and Complexity

The open office software solution works well. There are only a few usability features, like the possibility to store the solver options, which should be improved.

The application of the model can be strengthened in the areas of result presentation and "what if" analysis views.

[54] Cf. Salo, Keisler and Morton, 2011, Chapter 4
[55] Cf. Gustafsson and Salo, Systems Analysis Laboratory Research Reports, 2005

10 Summary and Conclusion

The aim of this paper was to test whether the model described in "contingent portfolio programming for the management of risky projects"[56] is able to support project portfolio decision making process of an international funds management company.

The first step was to analyse and explain the theoretical model and its components.

Later, three points of view were used to elaborate how the portfolio decision model fits into a company's management processes. The chosen views were from a Research & Development Planning approach explained in Brockhoff[57], COBIT 4.1[58] and Val IT[59] as a framework, which helps to align business targets and (IT) investments with a Project Portfolio Office implementation guideline[60]. The three methods were analysed and the required parts for the implementation were explained.

As the next step, the company was introduced. The focus was on the existing processes and culture, which determine how to make decisions on the project portfolio.

Finally, the gaps between the frameworks analysed in Chapter 3 and the company's current situation were elaborated.

Based on the gaps, the missing factors were defined and the required parameters elaborated.

The biggest uncertainties in the strategic planning were driven by the current financial crisis, which does not support long term planning, and by new regulatory requirements, which result in projects consuming more resources.

As operational planning had to be derived from strategic planning, changing targets influenced and changed the assumptions, especially if targets were changed on the resource side, but also if they were changed on the revenue side.

In the tactical planning, enormous differences in bottom up requirements and available resources lead to several rounds of prioritisation.

In Chapter 6, the model was developed, the decision tree was built, and all the parameters, equations and functions were described.

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[56] Cf. Gustafsson and Salo, Operations Research, 2005

[57] Cf. Brockhoff, 1995

[58] Cf. COBIT, 2007

[59] Cf. Val IT, 2006

[60] Cf. Kendall and Rollins, 2003

At the next step, the practical application of the model was developed. The model was applied in Open Office 3.3.1.

Chapter 7 described the sensitivity analysis. By changing the input parameters, the sensitivity of the decision maker's project selection process to the changing parameter settings was analysed.

Preconditions to support the application are:

Continuously update the planning information. Ensure that all levels, strategic-, operational- and tactical planning are synchronised.

Implement a project portfolio management office, which manages all of the resource consuming activities within the company.

Because of the complexity of developing, and the effort required in maintaining, such applications, it is important that a dedicated line function is established within the company.

All projects from the sample must have the same life cycle in terms of initial development, external dependencies, reinvestment and project finalisation. This is quite unusual in a real environment. Stage 0 can be the point in time at which the annual budget is planned, usually in summer for the next year. At stage 1, a summer later, the process is repeated and the following year's budget is reviewed.

Decision makers typically start with limited information about each project and portfolio, and need guidance about which projects to analyse, and to what level of detail. Performing a very detailed project analysis, which might include applicability of the concept or a pilot implementation to find the estimated values of the potential cost and revenue for each project, is usually not feasible before the first decision to invest resources is made.

The result of the analysis showed that, in general, the model can support the decision making process within a funds- and asset management company. The standardisation of the decisions points, which lead to a standardisation of project decisions, project review and project finalisation points in time, is the element that differs most from practice. The rest of the findings, which support the application, are more general than model specific, when implementing a project portfolio within the company.

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Appendix 1: Curriculum Vitae

Personal data

Michael WILHELM
Birth date 4th of August 1972, Vienna
Married,
2 children

Education

1978 - 1982 Elementary school

1982 - 1986 Grammar school

1986 - 1991 Higher technical education institute for mechanical engineering

Since 1991 International business administration, University Vienna

2002 / 2003 Training "Organisation & Project Management"
(ÖVO / University of economics & business administration)

Since 2003 Czech language training

2006 / 2007 Erste Bank leadership training

Professional experience

Since 01/2010 Erste Asset Management CIO / Head of IT

- CIO in ESPA (Erste Sparinvest) und EAM (Erste Asset Management)
- Responsible for all Organisation and IT related activities in EAM
- Supporting of organizational development

09/2009 – 12/2009 Erste Bank – Project Review

- Responsible for review of core system implementation project and ESPA/ EAM IT line function

10/2005 – 09/2009 Erste Bank - Head of Group IT Planning & Controlling

- Implementing, improving and running Enterprise Portfolio Management Processes and support tool.
- Responsible for implementation and operation of an Erste Bank Group wide Project Management Office

- Operating Erste Bank Group IT Planning & Controlling

07/2003 – 10/2005 Erste Bank - Group IT Functions

- Implementing of group wide IT planning process and supporting tools.
- Supporting the IT strategy development and Organisation development (e.g. Portfolio Management Concept for Erste Bank Group, outsourcing studies, cooperation models, support strategy development (e.g. by mega trends CIO workshop)

09/2000 – 07/2003 Erste Bank - Project- & Program Management

- Responsible for IT integration in core banking system implementation projects in Ceska Sporitelna (15 months in CZ/Prague onsite) und Slovenska Sporitelna (15 months in SK/Bratislava onsite), Process coordinator for Group Selection Processes

Bank Austria / Creditanstalt – Data Service Informatik – other

12/1998 - 8/2000 BA-CA, Application manager for branch advisory service system

03/1998 - 11/1998 Military service - Aircraft defence

01/1998 - 03/1998 BA-CA. Project Manager (part time)

10/1994 - 12/1997 BA, Application Manager (private housing funding, car-Leasing, real estate market), freelancer

1987-1994 Work experience

Anna GOLD, Entsorgungsbetriebe Simmering, General Motors, PANGRAPHICA, MANNESMANN ZENTI, DIPL.ING. SZABO, DOLENZ, Fa. HUECK, VSM SIMON, Bank Austria

Appendix 2: Abstract in German Language

Die vorliegende Diplomarbeit prüft die praktische Anwendbarkeit des Modells „contingent portfolio programming for the management of risky projects“[61] von Gustavsson und Salo in einem Fonds- und Asset Management Unternehmen.

Im ersten Teil der Arbeit wird das Modell selbst beschrieben, im weiteren werden die Rahmenbedingungen, die für eine Einführung in einem Unternehmen erforderlich sind, näher beleuchtet. Diese Voraussetzungen werden dabei aus der Theorie „Planung und Kontrolle“ in der Forschung und Entwicklung[62] aus COBIT 4.1[63] und Val IT[64] und aus einer Anleitung zur Implementierung Portfolio Management[65] abgeleitet.

Anschließend wird das Unternehmen vorgestellt. Der Schwerpunkt liegt hierbei auf dem Reifegrad der Planungszyklen und der aktuellen Entscheidungsprozesse. Im Speziellen wird zwischen strategischen, operativen und taktischen Zyklen der Planung unterschieden.

Die notwendigen Änderungen im Unternehmen werden identifiziert und die Rahmenbedingungen für die Anwendung des Modells erarbeitet. Hierfür wird ein Investmentfokus definiert, Ressourcen werden zur Verfügung gestellt und es wird eine Liste von Projekten zur Bewertung erarbeitet. Diese Projekte werden kurz analysiert, um eine Kosten- und Ertragsschätzung zu erlangen.

Durch Management Interviews werden die notwendigen Input Parameter ausarbeitet.

Die tatsächliche Umsetzung des Modells erfolgt in Open Office. Es wird eine detaillierte Sensitivitätsanalyse durchgeführt in der die Auswirkungen von Änderungen der Input Parameter auf die Project Portfolio Entscheidungen evaluiert wird.

Des Weiteren werden die möglichen Erweiterungen des Modells, des Unternehmens und der Software besprochen.

Abschließend wird die praktische Anwendbarkeit und die Voraussetzungen dazu erörtert.

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[61] Cf. Gustafsson and Salo; Operations Reserch, 2005
[62] Cf. Brockhoff, 1995
[63] Cf. COBIT, 2007
[64] Cf. Val IT, 2006
[65] Cf. Kendall and Rollins, 2003

Appendix 3: Abstract in English Language

The working assumption for this paper was to prove the following thesis:
The model described in "contingent portfolio programming for the management of risky projects"[66] is able to support project portfolio decision making process of an international funds management company.

The first step was to analyse and explain the theoretical model and its components.

Later, three different approaches were used to elaborate how the portfolio decision model fits into a company's management processes. The chosen views were a Research & Development Planning approach explained in Brockhoff[67], COBIT 4.1[68] and Val IT[69] as a framework, which helps to align business targets and (IT) investments and a Project Portfolio Office implementation guideline[70]. The three methods were analysed and the required parts for the implementation were explained.

As the next step, the example company was introduced. The focus was on the existing processes and company culture, which determines how decisions on the project portfolio are taken.

Finally, the gaps between the frameworks analysed in Chapter 3 and the company's current situation were elaborated.

Based on the gaps, the missing factors were defined and the required parameters elaborated.

The biggest uncertainties in the strategic planning were driven by the current financial crisis, which does not support long term planning processes, and by new regulatory requirements, which result in projects consuming more resources.

As operational planning had to be derived from strategic planning, changing targets influenced and changed the assumptions, especially if targets were changed on the resource side, but also if they were changed on the revenue side.

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[66] Cf. Gustafsson and Salo, Operations Research, 2005
[67] Cf. Brockhoff, 1995
[68] Cf. COBIT, 2007
[69] Cf. Val IT, 2006
[70] Cf. Kendall and Rollins, 2003

In the tactical planning, enormous differences in bottom up requirements and available resources lead to several rounds of prioritisation.

In Chapter 6, the model was developed, the decision tree was built, and all the parameters, equations and functions were described.

At the next step, the practical application of the model was developed. The model was applied in open office 3.3.1.

Chapter 7 describes the sensitivity analysis. By changing the input parameters the sensitivity on the portfolio decisions was analysed and.

Preconditions to support the application of the model within a company are:

Continuously update the planning information. Ensure that all levels, strategic-, operational- and tactical planning are synchronised.

Implement a project portfolio management office, which controls all of the resource consuming activities within the company.

Because of the complexity of developing and the effort required in maintaining such applications, it is important that a dedicated line function is established within the company.

To ensure comparability between the projects all projects of the sample must have the same life cycle in terms of initial development, external dependencies, re-investment and project finalisation. This is quite unusual in a real environment.

The result of the analysis showed that, in general, the model can support the decision making process within a funds- and asset management company.

The standardisation of the decisions points, which leads to a standardisation of project decisions and project execution time frame, is the element that differs most from practice. The rest of the findings, which are mainly requirements needed to implement the application, are more general than model specific and derived during the implementation of a project portfolio management within the company.