„Anticipating Strategic Risks by Fuzzy-based Scenario Monitoring on the Example of Oil Price Developments“

Dissertation

of

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submitted at the

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at the
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Affidavit

I declare in lieu of oath, that I wrote this thesis and performed the associated research myself, using only literature cited in this volume.

Leoben, October 2009 Bernhard Frieß

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Abstract

The increasing dynamism in the business environment enlarges the gap between required and available response time to external changes. Therefore the anticipation of strategic risks at an early stage is essential especially in turbulent times.

The petroleum upstream industry faces an unstable environment which creates various strategic risks. Aside to the economic crisis the opportunistic behaviour concerning the access to reserves or the emerging national oil companies are key concerns of international oil companies. Internally cost controlling, the influence of changing fiscal terms and the operations in more and more marginal and mature fields represent other challenges. An even higher uncertainty is initiated by the unpredictability of the oil price, which is primarily responsible for the economic wealth of an oil company and determines their strategies and project decisions. Scenarios are adequate methods to deal with uncertainty at this extent and provide a basis for the preparation of the business for future developments of the oil price.

To take advantage of oil price scenarios it is necessary to monitor them by a comparison with actual developments. Instead of waiting until a certain limit for an influencing factor is achieved it is preferable to anticipate also moderate changes which indicate the development towards a specific scenario path. The application of fuzzy models for this purpose allow the representation of the underlying system and disclose the membership of the actual situation to the scenario paths even in the case of marginal changes. As a consequence the combination of the two methods represents an improvement of strategic early warning systems and transforms uncertainty to a determined risk.

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List of Abbreviations

ACE	Average Capital Employed
BP	British Petroleum
cf.	confer to
CFTC	Commodity Futures Trading Commission
cit.	Citation
E&P	Exploration and Production
EBIT	Earning Before Interests and Taxes
EC	European Commission
EIA	Energy Information Administration
et al.	et alteri or et alii
f.	and the following Page
ff.	and the following Pages
FSU	Former Soviet Union
GDP	Gross Domestic Product
GE	General Electric
GTL	Gas-to-Liquid
HWWI	Hamburgisches Weltwirtschaftsinstitut
ICE	Intercontinental Exchange
IEA	International Energy Agency
IMF	International Monetary Fund
IOC	International Oil Company
KPI	Key Performance Indicator
LNG	Liquefied Natural Gas
M	Thousand
MM	Million
MMM	Billion
NOC	National Oil Company
NOPAT	Net Operating Profit After Taxes
NYMEX	New York Mercantile Exchange
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
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PIMS	Profit Impact on Market Strategies
RDS	Royal Dutch Shell
ROACE	Return on Average Capital Employed
ROI	Return on Investment
ROS	Return on Sales
RoW	Rest of the World
RRR	Reserve Replacement Rate/Ratio
SMX	Singapore Mercantile Exchange
SRI	Stanford Research Institute
transl.	translated
TSR	Total Shareholder Return
US	United States
WEC	World Energy Council
WTI	Western Texas Intermediate

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1 Introduction

The introducing chapter gives an overview about the thesis including the initial situation, the research questions resulting from the situation respectively the specifications of the cooperating oil company as well as the description of the procedure to fulfil the given task.

1.1 Initial Situation

The developments in the last years created an exceptional turbulent environment for the petroleum exploration and production industry primarily triggered by the significant volatility of the crude oil prices (see fig. 1.1). Since 2002 the nominal oil price skyrocketed from 20 to 135 and dropped afterwards to 40 US-dollars per barrel again in 2008 on a monthly average.

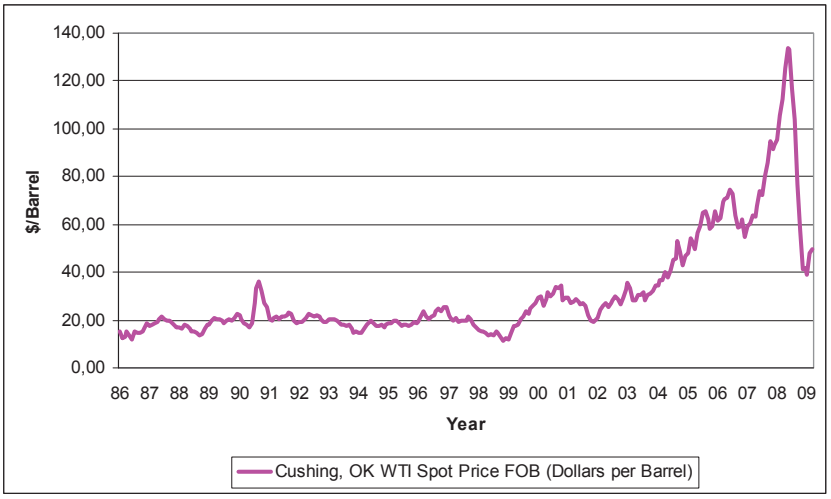

Fig. 1.1: Western Texas Intermediate Oil Price Development[1]

With the background of the years of the third oil price crisis in terms of a high price environment until 2008 international oil companies are facing partially dramatically changes with consequences for the competition for resources:

- Fiscal terms of the host countries are adapted to the oil prices.
- Capital and other costs increase nearly proportionally to the oil price.
- Sophisticated technology is in demand to explore marginal, deep water or unconventional fields.

[1] data: EIA (2009)

- The unfavourable age distribution of exploration and production professionals causes a war for talents.
- The rise of national oil companies and their internationalisation restricts the access to reserves as well as supports petro-nationalistic tendencies.

The consequence is an even higher uncertainty than in the history, in which the attempt to overcome the uncertainty was always of key interest in the industry. Since the beginning the oil economics and the market structure were the origin of the uncertainty, whereas the oil price has an outstanding significance for this circumstance.[2] The problem is reflected best by a quote of *Clô*[3], professor of industrial economics and former minister in Italy, in the context of the development of the futures markets:

"In the new competitive context, it is not so much the size of the company that counts but rather its capacity to interpret and anticipate market dynamics, to adopt the right decisions of sale/purchase rapidly, to make full use of the relative convenience of the prices of crude and products. Flexibility has become more important than dimension and speed of decision more important than completeness of information."

In the course of the attempt to overcome uncertainty various tools mainly working with probabilities were applied in the industry to reduce or even eliminate uncertainty. In a turbulent environment probabilities are not adequate to reflect the future meaningfully. The solution would be a process allowing the decider to anticipate and prepare for multiple futures. Only if the decider recognises that the uncertainty should only be reduced if it is meaningful for a certain decision but rather be managed at its original specification a competitive advantage can result from it.[4]

Using multiple planning by the help of scenarios has therefore a long tradition in the petroleum industry, whereas same major companies create their own scenarios and others rely on those of international organisations also publishing scenarios. Scenarios, introduced for the military field, were also transferred to business applications to the petroleum industry as the first business sector. The first use of scenarios in the sector by *Wack*[5] for Royal Dutch Shell in the seventies proved to be successful and was significantly responsible for outstanding competitive performance of the company in the course of the first oil crisis respectively the next decades.

Hardly any industrial sector is confronted with uncertainty at this extent as the petroleum industry. Dependent on the actual state of turbulence in the environment the extent of

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[2] cf. Clô (2000), p. XI f.

[3] cit. Clô (2000), p. 211

[4] cf. Bratvold et al. (2002), p. 1 ff.

[5] see Wack (1985a, 1985b)

uncertainty will change but will nevertheless in a long-term perspective be large enough that the conventional methods of risk management working with probabilities or single point prognosis are doomed to failure when anticipating future developments. This is dramatically evident regarding the oil price which is the most impacting factor for the industry in an economic view. To improve respectively complement existing methods to anticipate oil price changes as a source of strategic risk is the prime motivation for the cooperating petroleum company to support the thesis in hand.

1.2 Research Questions

Based on the situation described in the previous chapter the petroleum industry announced the demand for methods of strategic risk management able to anticipate strategic risks based on the oil price in time, which is the key research problem for the thesis. The method should be aligned with existing applications in the course of strategic risk management and correspond to the given state of uncertainty respectively be suitable for the environmental conditions of the industry. The results should represent an input for the strategy formulation, the premises control as well as for the evaluation of long-term projects.

To answer the key question some sub-questions are derived. First of all the environmental conditions should be investigated, at which the concepts of strategic management are adequate. It is put into question when the concepts are applicable since under certain external conditions the conventional planning approach is sufficient to cope with them.

Since the subject of strategic risk management is only of marginal interest in the scientific field, which is evident due to rather old concepts and methods described in the literature and missing enhancements, the rather small number of concepts and methods should be analysed. The focus is on their applicability, the scope of functions they cover and their overall suitability corresponding to the given task.

The subsequent target is to investigate how the petroleum upstream industry fit to the conditions investigated in the theory. It should be deduced that for the special sector the environmental turbulence and uncertainty is at a state which creates the demand for strategic risk management respectively its concepts. The three main subjects confronted with strategic risks are the success factors of the sector, the environmental trends and discontinuities as well as the oil price and its role as the most influencing factor for the economic performance.

After determining the conditions of the sector the most suitable method to manage the given uncertainty should be analysed in the context of oil price developments. The task is to investigate the chosen method in this context and to survey existing applications of the method corresponding to the oil price.

The last question concerns the enhancement of the chosen method to support the solution of the key problem – to anticipate oil price risks in time. Therefore the focus is on the monitoring of environmental changes that a real time information supply is given for strategic decisions. The output should be able to anticipate the risks in time for the purpose to gain a competitive advantage in a long-term view.

Consequently the key research question and the sub-questions are:

- Which methods are suitable in the strategic risk management to anticipate strategic risks based on oil price developments in time?
    - Which environmental conditions reason the demand for strategic risk management?
    - Which methods and instruments are applied within strategic early warning?
    - How the petroleum upstream industry can be characterised?
    - Which method of strategic risk management is suitable to overcome the uncertainty under the given conditions?
    - How scenarios can be monitored in time?

1.3 Procedure and Structure of the Thesis

Subsequently the procedure for answering the research questions respectively the structure of the thesis based on it should be described. In figure 1.2 the interrelationships are visualised including the numeration of the chapters.

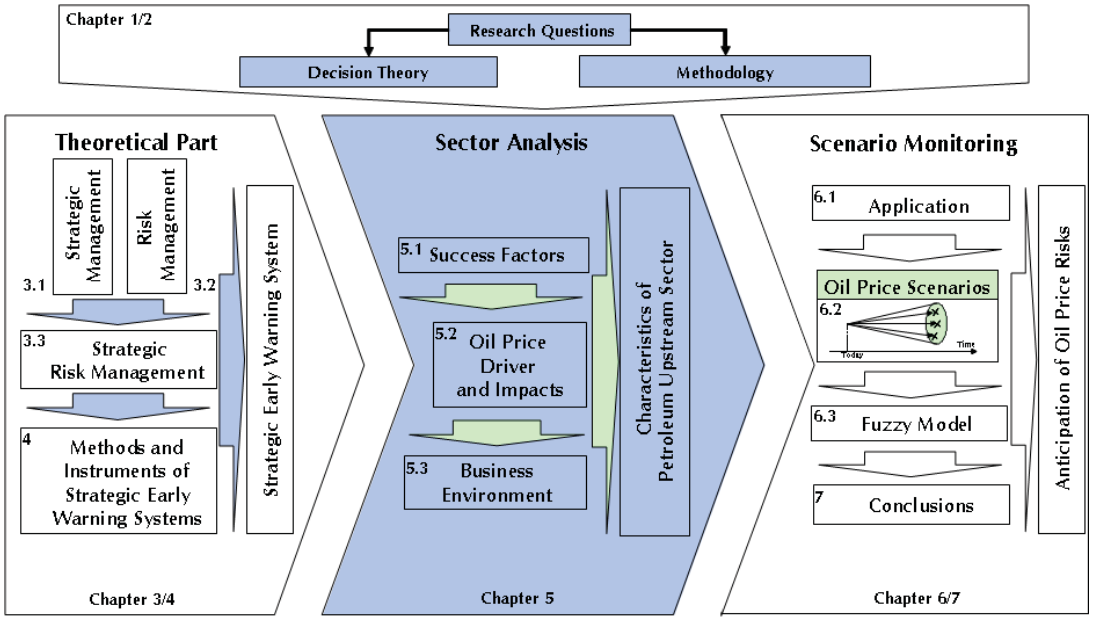

Fig. 1.2: Procedure Model of the Thesis

The introducing chapter including the research questions is the origin for the theoretical basis of the thesis. Nearly all research in the context of business management is based on the decision theory since the relevant aspects of a business are consequences of decisions. The epistemological methodology supports the scientific approach to answer the research questions, whereas the deductive and inductive approaches are chosen. The input of these chapters is stretched over all other ones.

In the theoretical part the strategic management and the risk management are combined to reason the contents of the strategic risk management and the environmental conditions for its application. Complemented by the methods and instruments used in this context a complete strategic early warning system is described.

Subsequently the characteristics of the petroleum upstream industry are reflected on the theory. The necessity of strategic early warning should be deduced from the environmental conditions of the industry besides the identification of the success factors and the representation of the key impact factor oil price and its drivers and impacts on the business performance. By disclosing the success factors of the business the issues which should not be endangered by risks are mentioned. Further on the oil price developments and their influence on a macro- and microeconomic level is investigated to justify the focus on this parameter. Concluding the environmental conditions are represented to disclose the existing turbulence in the sector and to justify the application of strategic early warning systems.

In the next chapter the use of the scenario technique as an adequate method for the given case is explained and for the purpose to enhance the benefits of scenarios complemented with a new monitoring method. In this context available oil price scenarios are investigated by content and their transfer to a fuzzy-based model is shown exemplary. Based on the example the general suitability of fuzzy-based scenario monitoring is induced. Finally in the last chapter conclusions are drawn in regard of the results, their utilisation in the strategic risk management as well as prospects for further research.

2 Theoretical Basics

In this chapter the underlying scientific area and the epistemology relevant for the scientific procedure in the thesis are represented. In business sciences all actions in the context of the management of a business are based on decisions. Since the study addresses uncertain and risky states of environmental information the decision theory is the first subject-matter of this chapter. Furthermore the decision theory is considered as the fundamental theory for the explication of the problems in business management.

In the epistemological context the deductive and inductive approaches are applied for answering the key research questions. They build the basis for the derivation of conclusions for the purpose to reflect existing theories in a new context and to extent the existing knowledge by the application of a new method. These procedures are also described in the chapter and their implications for the thesis are discussed subsequently.

2.1 Decision Theory

Heinen[6], as a representative of the decision-oriented industrial management, states that the fulfilment of the tasks of an enterprise, which are the creation and the utilisation of outputs as well as the realisation of revenues, is dependent on decisions on the combination of the production factors man, material and machines. Therefore there are no activities in a business which are not the consequence of decisions, whereas the decision process consists of the recognition of the problem, the search for and selection of alternatives and their implementation and controlling.[7]

The tasks of the decision-oriented industrial management are according to *Heinen* the systematisation, the explanation and the design. The systematisation approach deals with the ascertainment of the problem and its criteria-based segmentation into elements to reduce complexity and to find starting points for advanced analysis. The demand on the explanation task concerns the derivation and validation of universal statements about the investigated area of reality. The cumulated statements are parts of theories or models and their universal validity is checked by the confrontation with reality. The design task should provide models for decision-making, where different alternatives originate from the explanation models. The recommended modules of the design should include assumptions about

[6] see Heinen (1978)

[7] cf. Heinen (1978), p. 25

the objectives of the business, explanation models and algorithms to find the best solutions. Finally the design approach should offer instruments and methods to solve decision problems in business management by approximation to reality.[8]

2.1.1 Descriptive and Prescriptive Decision Theory

The decision theory covers different basic approaches which are shown in figure 2.1. Descriptive theories originate from empirical investigations attempting to verify issues in reality. Prescriptive theories don't try to create an image of reality, their task is to deduce tools for processing of information to cope with different decision problems.[9]

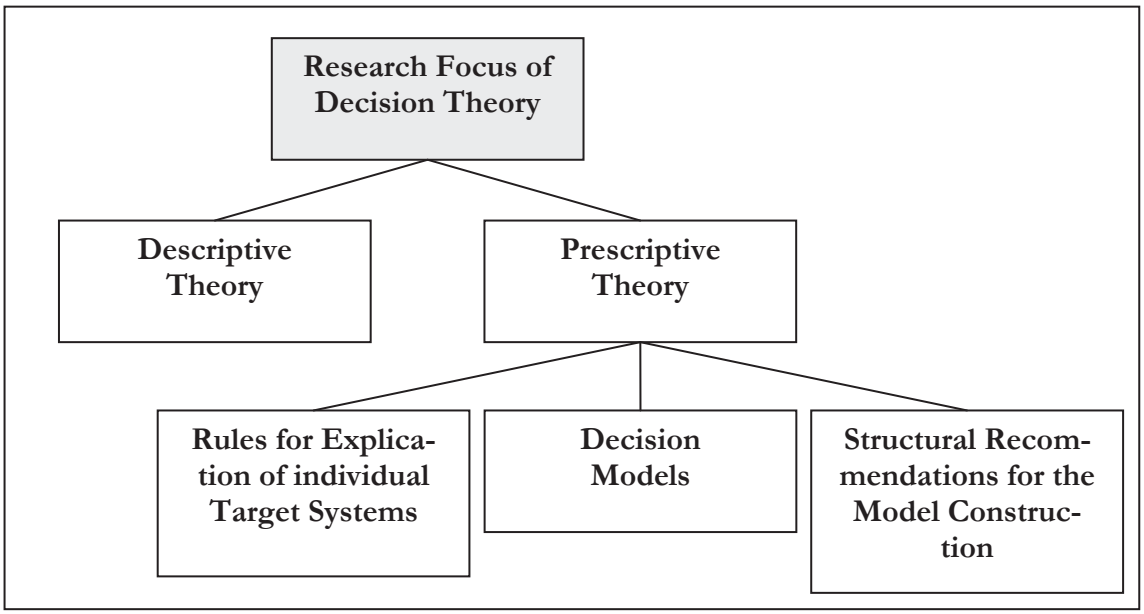

Fig. 2.1: Possibilities of Decision Theory to create Aids for Decision Making[10]

The descriptive decision theory focuses on the prediction of decisions under a known initial situation based on the empirical investigated behaviour of individuals and groups in the decision process. The theory considers for example the way of probability estimation and the creation and change of targets of the participant in the process. If decisions are made in groups the influence of group structure, of the group discussion in general or of the group composition on the collaboration of the individuals may be of key interest of the descriptive decision theory. By the investigation of the way how individuals and groups decide the resulting improved ability to predict decisions allow better and therefore more rational de-

[8] cf. Heinen (1978), p. 28 ff.

[9] cf. Laux (2003), p. 13 f.

[10] Source: Laux (2003), p. 13, transl.

cisions as a secondary effect. Also the prescriptive decision theory uses the findings of the descriptive one, for example to specify the requirements a decision maker is able to fulfil.[11]

The prescriptive decision theory investigates the decision behaviour in the dependence of targets, which requires possibilities to evaluate the different alternatives in the context of the target system and to take rational acting as a basis. The decider acts on the assumption of rationality in association of his own target system. In this context a kind of formal rationality is in the focus since not the contents of the targets but the form of the target system is in the centre of attention. The rationality can further be divided in an objective rationality, where the decision maker's view of reality is aligned with that of an objective observer, and in a subjective rationality, where the decider's subjective cognition of information complies with the requirements. Notwithstanding the advantages of the objective rationality the decisions in practice will be dominated by the subjective rationality.[12]

The prescriptive decision theory offers three possibilities for the generation of aids for the decision process (see fig. 2.1): the explication of individual target systems, the decision models and the structural recommendations for the construction of these models. Concepts for the explication of individual target systems try to explore the target system of the decider since in the case of complex situations this system may be not even conscious to the decision maker himself. One possibility is to derive the target system from the previous behaviour of the decision maker, but in practice the considered alternatives, the considered consequences of the alternatives or the change of the target system over time are unknown for the observer. Therefore in the prescriptive decision theory the concept to explore the target system of a decider uses simple, hypothetic decision problems. Those are representative for complex problems and by the analysis of the decisions the relevant elements of the target system should be explored and deduced to the real respectively complex problem.[13]

As a part of the research by deduction are decision models a formulation of the elements and relationships according to a problem as an aid to solve problems by logical implications or solution algorithms. Thereby the models are divided in generic and specific ones. Generic models should be available to an adequate extent and their assumptions and solutions algorithms should be determined exactly. If a specific solution problem occurs, based on selected generic model a specific model for the given situation with specific parameters is deduced.[14]

The structural recommendations for the model construction specify how a generic model can be transformed to a specific model, which represents per se a problem of the decision

[11] cf. Laux (2003), p. 14 f.

[12] cf. Rommelfanger/Eickemeier (2002), p. 2 f.

[13] cf. Laux (2003), p. 15 f.

[14] cf. Laux (2003), p. 16 ff., see also Bretzke (1980), p. 8 ff.

theory regarding the rules and criteria of the model design in alternative decision situations.[15]

2.1.2 Decisions in Industrial Firms

Decisions in the industrial management are determined by a decision field, which contains the variables in the field of action and the environmental data restricting the decision field. The field of action is composed of the persons and issues, which can be influenced by a decision and the environmental data describes economic, social, technical, cultural or political aspects. Based on these components of the decision field the decision maker is choosing the best alternative from his point-of-view. The types of decisions to take are listed in table 1.1.[16]

Tab. 2.1: Types of Decisions in Business Management[17]

Decision Maker	Decision Object	Decision Consequences	Decision Process
Individual and collective Decisions Centralised and decentralised Decisions Leadership and Department Decisions	Meta and Object Decisions Occasional and continual Decisions Constitutive and situational Decisions Total or partial Decisions	Decisions in Case of Certainty, Risk or Uncertainty Long-, short- and medium-term decisions Decisions in case of mono-variable and multi-variable targets	Simultaneous and successive Decisions Programmable or non-programmable Decisions

A categorisation of decisions by the decision maker differentiates place and person of decision-making. Thereby decisions can be taken in groups or by individuals, where individuals are confronted with their limitations of information processing. The level of centralisation of decisions indicates to which extent the decision authority is delegated to lower hierarchical levels. Leadership and department decisions differ mainly by their content, leadership decisions focus mainly on a long-term view and on more relevant topics like corporate property or profitability in contrast to contents of decisions delegated to departments.

Meta-decisions are taken in advance to object decisions and regard more generic aspects like corporate targets or organisational structures and represent in succession a basis for object decisions concerning procurement or financing for example. The frequency of decisions is a criterion to differentiate between occasional and continual decisions. This distinc-

[15] cf. Laux (2003), p. 18

[16] cf. Heinen (1978), p. 41 f.

[17] Heinen (1978), p. 42, transl.

tion is associated with the life-cycle of a business, decisions in the foundation or liquidation phase are rather occasional than those in the turnover phase. Constitutive decisions have a long-term significance for the business and build the framework for situational decisions, which are taken to adapt the business to environmental developments. Total and partial decisions can be differentiated by the range of their field of application.

The level of information of the decision maker is another important criterion for categorising decisions. If the consequences of a decision are known, it is taken under a situation of certainty, if probabilities of the consequences are known, the situation is risky, if even this information is not available the decisions are taken under uncertainty (see also chapter 3.2.1). Referring to the temporal horizon of the effects of the decisions they are classified as short-, medium- or long-term. Mono- and multi-variable decisions differ by the number of targets they focus on.

If several decisions are taken at the same point of time they are denoted as simultaneous ones in contrast to successive decisions, where decisions affecting different parts of the business are made one after another and the results of previous decisions can be used for forthcoming ones. Lastly decisions are distinguished regarding their programmability, whereby recurring decisions with comparable structures can be standardised by criteria or methods and in succession be delegated and processed electronically.[18]

The decision-oriented business management is not restricted to the selection of a decision alternative, a process covering three main steps is in the focus of the theory (see fig. 1.2) offering a helpful segmentation to explain the process and analyse the relationships. In the first phase of the decision process the recognition of a present problem as a deviation of the actual from the ideal state acts as stimulation for the process. If the subsequent acquisition of further information demands a decision about the issue the stimulation phase proceed to the search phase. In this alternatives for actions are explored and the consequences regarding their contribution to the target achievement and their fit within internal and external limitations are determined. The optimisation phase completes the decision-making process by selecting with the help of certain criteria the best possible alternative to achieve the target.

The decision process continues after reaching the decision with the realisation phase, where the chosen alternative is put into action by the decider's provision of instructions and in most cases a room to manoeuvre, which is aligned with the decision, for the executing person. The controlling phase accompanies the decision process and causes in the case of deviations from the planned values adaptations respectively new decisions. All phases have in common, that the acquisition, processing and transfer of information play a major role

[18] cf. Heinen (1978), p. 41 ff.

which makes high demands on the communication if more persons are involved in the process.[19]

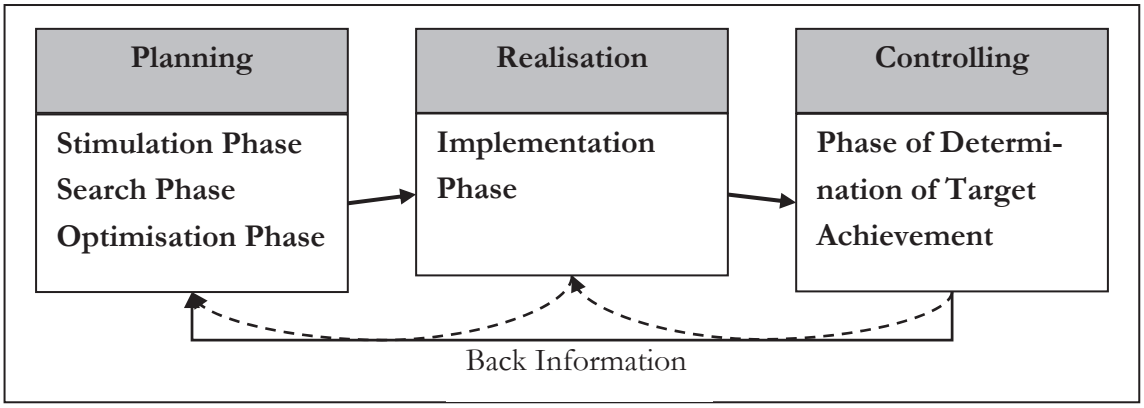

Fig. 2.2: Phases of the Decision Process[20]

2.2 Inductive and Deductive Methodology

For the acquisition of scientific knowledge different methodologies are applied, whereas the deductive and inductive methodologies are described subsequently since they are applied to answer the key research questions. They are used to gain knowledge by research logics (methodologies) respectively to extent the existing knowledge base.[21] In this context the gain of scientific knowledge is the construction of theories based on observed facts. The derivation of theories is the result of logical conclusions whereas the theory should be the consequence of the given facts which can not be verified to its full extent.[22]

Deductive reasoning draws conclusions from the general to the special case.[23] The statement gained from the general theory has to be checked empirically, whereas the quality of the conclusion is dependent on the extent of the empirical validation of the underlying theories.[24] The deduction uses logical arguments to draw a conclusion from two conditions, if there is no contradiction then a logically valid deduction is given. In this case the conclusion must be true if the conditions are true like in the following example:

[19] cf. Heinen (1978), p. 53 ff.

[20] Heinen (1978), p. 54, transl.

[21] cf. Weber (2004), p. 48

[22] cf. Chalmers (2001), p. 35

[23] cf. Weber (2004), p. 52

[24] cf. Bortz/Döring (1995), p. 18

Condition 1: All chapters about the epistemology are boring.

Condition 2: This is a chapter about epistemology.

Conclusion: This chapter is boring.

Even if the conclusion is logically valid the conclusion must not be true since its validity is reasoned by the validity of the conditions. Concerning the example the deduction would be true even if this would be a chapter about scenarios and it would not represent the truth. The deduction is per se not a source of new knowledge, but it discloses a new context of already existing contents and is therefore preserving the truth.[25]

The induction is based on a special, concrete case and results in a general, abstract statement. The induction principle is widespread in the empirical research and was the only way to gain knowledge for a long period.[26] Based on a limited number of observations general conclusions are formulated. The characteristics of inductive arguments are that the knowledge is gained by extending the content of the premises so that based on single events statements about all events in a certain context are derived. An example is the expansion of metal when it is heated:

Premise 1: Metal 1 is expanding when it is heated at time 1.

Premise 2: Metal 2 is expanding when it is heated at time 2.

Premise 3: Metal 3 is expanding when it is heated at time 3.

Conclusion: All metals are expanding when they are heated.

Since it is not necessary that the conclusion is true if the premises are true the induction is no logically valid argument. Independent on the number of observations it is possible that not all metals are expanding when they are heated.[27]

Regarding induction the observations have to fulfil some conditions that theories can be based on them:[28]

- Repeatability/Reproducibility: To have an evidence for the science the observations have to be repeatable by other persons.

[25] cf. Chalmers (2001), p. 36 f.

[26] cf. Bortz/Döring (1995), p. 275

[27] cf. Chalmers (2001), p. 38 f.

[28] cf. Weber (2004), p. 49

- Inter-subjectivity: The observations have to be described that they are traceable and that two observers recognising the same event would describe it in the same way.
- Controllability: All aspects of an experiment should be controlled by the acting persons that the causal relationship between the factors and the results is obvious.
- Completeness: All aspects of the observation situation should be documented completely if they are meaningful for the event.

Inductive conclusions may lead to new ideas but involve a high uncertainty about the validity of the result since they are extending the content of the observations and are outside the borders of logic. The induction problem describes the inability of a certain conclusion to unobserved or future events. The rather pragmatically reasoning of the induction principle is that many inductive conclusions proved to be true in reality but to conclude that the induction is generally valid is an induction problem itself. One solution of the problem is the development of the critical rationalism which aims at falsifying hypothesis deduced from theories.[29]

2.3 Implications for the Thesis

The outcome of this study and therefore the answers to the research questions should result in processed information for decisions, in this context decisions in the strategic management process of a corporation. The support of the decision making process in the phase of problem recognition and the attempt of this study to transform uncertainty to risk respectively to minimize risk are reasons to discuss the decision theory in this study.

In the context of the prescriptive decision theory the results of the thesis offer the possibility to process information for the purpose to evaluate alternatives. This contributes to the theory by providing a method processing information combined with the analysis of the elements and relationships related to the problem which can be directly used in decision models respectively the method can be a part of decision models itself. Concretely by the application of the fuzzy logic to model scenarios a fundament for decisions is made available which represents the use of generic theories transformed to a specific model adapted to the considered scenario. The structural recommendations to create the model are also a substantial part of the thesis. The decisions in firms are supported by considering the most significant environmental aspects to determine the field of action for the company. In general the result of fuzzy monitoring is an aid for choosing the best alternatives in the decision making process.

[29] cf. Bortz/Döring (1995), p. 276

The deductive and inductive approaches are used in the first instance to deduce the need for strategic early warning systems in the given situation respectively the considered industrial sector and to apply a monitoring method in the special case which can further on be applied generally. Adapted to the theory the approaches are primarily helpful for the following problems:

Deductive approach:

Condition 1: The use of strategic early warning systems is essential in a turbulent environment.

Condition 2: The petroleum upstream sector is in a turbulent environment.

Conclusion: The use of strategic early warning systems is essential in the petroleum upstream sector.

Inductive approach:

Premise 1: Fuzzy-based monitoring is adequate for a scenario with the parameters A, B, C.

Premise 2: Fuzzy-based monitoring is adequate for a scenario with the parameters D, E, F.

Premise 3: Fuzzy-based monitoring is adequate for a scenario with the parameters G, H, I.

Conclusion: Fuzzy-based monitoring is adequate for all scenarios.

In spite of the deduction problem the advancement of the approach to the critical rationalism is not recommendable since it focuses on the falsification the hypothesis. The adequateness of the fuzzy-based scenario monitoring is dependent on the quality of the underlying scenarios which reflect potential developments over a time period of decades. Since there is no fundamental demand on scenarios to reflect reality, there would only be the possibility to falsify the ability of the monitoring method to represent the scenario, whereas the results can not be reflected on reality consequently. Not considered influencing factors as well as discontinuities may limit the significance of the scenario in certain time periods and therefore a falsification is not possible due to diverging trends of the monitoring results and real results.

3 Strategic Risk Management

The subsequent chapter derives the definitions, necessity and contents of strategic risk management from its original management systems, the strategic management and the risk management. The target is to introduce the reader to the complexity of the poorly structured, uncertain but high impacting strategic level and to create an understanding for the necessity and difficulties to manage risks in this context.

3.1 Introduction to Strategic Management

The strategic management approach is an advancement of planning approaches and characterised by various views on definitions, process descriptions or contents for the purpose to preserve the success potential of an enterprise. The dependence on environmental developments puts even the involved planning approach into question if the environment is not stable which corresponds with actual developments.

3.1.1 Definitions and Classification of Terms

To discuss strategic management more concretely the terms involved have to be defined. For the purpose of explanation the strategic level is compared with other organisational levels before different definitions of strategy and strategic management are analysed.

Strategic Level

The strategic level as an abstract field can be described by its distinction from and relation to the other existing levels in a corporation. The strategic level should create conditions to meet the requirements of the normative level for long-term development of the organisation. For this purpose strategies have to be formulated and structures and systems have to be provided to implement them. That involves the determination of the external positioning in the market as well as the internal alignment of the resources. In this way a long-term valid frame of action is made available, in which the precise activities of the operative level are placed.[30]

On a normative level norms for the understanding of the purpose of the organisation are provided in the form of vision and mission statement by the top management or the own-

[30] cf. Hungenberg (2004), p. 24

ers of the business. Additionally to formulating the fundamental objectives of the organisation an adequate culture should be created on this level. The operative management define objectives and activities in the frame of action given by the strategic level for individual units of the business, whereas the focus is rather short-term oriented.[31] The distinction between the strategic and the operational level is explained best by considering the different characteristics of decisions on the two levels (see tab. 3.1).

Tab. 3.1: Characteristics of Strategic and Operative Decisions[32]

Characteristics	Strategic Decisions	Operative Decisions
Decision Maker		
Hierarchical Level	Top Management	Middle and Lower Level
Delegable	Low	Strong
Object of Decision		
Area of Validity	Enterprise as a Whole	Parts of the Enterprise
Repetitiveness	Low	Repetitive
Validity	General	Occasionally
Time Horizon	Rather Long-term	Rather Short-term
Reversibility	Low, with high Costs	Middle, with Lower Costs
Structure of Decision		
Complexity	High	Low
Certainty	Uncertainty	Risk
Structuring	Poorly Structured	Better Structured
Level of Detail	Low, Global	High, Specified
Decision Process		
Programmability	No	Partially
Input of Individual Value Premises	High	Low
Way of Thinking	Holistic, Intuitional	Strong Analytical
Way of Decision Behaviour	Innovative, Creative	Routines

The most relevant differences concern the decision maker himself as well as the object, the structure and the process of decisions. In general strategic decisions are made at a higher hierarchical level and should not be delegated, because knowing the overall picture of the enterprise and its environment is essential. These decisions are not repetitive, generally

[31] cf. Hungenberg (2004), p. 23 ff.

[32] Lange (1981), p. 7. transl.

valid, long-term orientated and only reversible combined with high costs. The structure of decisions on the strategic level is dominated by complexity and uncertainty, therefore they are not well structured and details are missing. The process is not programmable since it is innovative and the attitude of the deciders respectively the policy play an important role.

Strategy

"People should not be unfamiliar with strategy,
Those who understand it will survive,
Those who do not understand it will perish"[33]

As already indicated in the citation of Sun Tzu, the term strategy originates from the military. His European pendant *Carl von Clausewitz* (1780-1831), a Prussian general, defined strategy as the "teachings of the usage of combats for the purpose of war" in contrast to tactic, which is the "teachings of the usage of the armed forces in the combat".[34]

Transferring the initial definitions of strategy in the military speech to the context of business management, a wide range of different quotes can be found in the literature. According to *Chandler* [35] strategy is the "determination of the basic long-term goals and objectives of an enterprise and the adoption of courses of action and the allocation of resources necessary for carrying out those goals". This classical understanding of strategy describes the entrepreneurial activities, which are necessary to achieve the long-term goals. Characteristically for the definition are the bundles of combined individual decisions, the hierarchical character of the strategy as a result of philosophy and politics as well as the determination of the position of the enterprise and its allocation of resources.[36]

Years later *Mintzberg*[37] stated a very generic definition of strategy as a "pattern in a stream of decisions". He expressed his discontent with the classical definition as a result of a formal and rational planning process by formulating an alternative and more general description of strategy. The term strategy covers the 5 Ps plan, ploy, pattern, position and perspective. Strategies as a plan respectively as intended approach are congruent with the classical definition. Strategies as a ploy aim at the surprise of the competitors by short-term threats or actions. Strategies as pattern are regarded as the consequences of the behaviour, whereas this may be intended or not. They appear as a conscious or unconscious pattern of decisions in an enterprise and are called emergent strategies due to mostly missing intentions. The position of an enterprise in his environment is indicated as a strategy too, independent

[33] cit. Sun Tzu's "The Art of War"

[34] cit. Clausewitz (1832-1834), p. 104, transl.

[35] cit. Chandler (1962), p. 13

[36] cf. Welge/Al-Laham (2001), p. 13 f.

[37] cit. Mintzberg (1978), p. 935

if the positioning is a result of a plan or a random consequence of decision patterns. This last definition considers the collective attitude of the strategists and is based on their cognition of the environment, in a broader sense it is influenced by the culture or ideology of the deciders.[38] Later on *Mintzberg* concretised the term strategy together with *Quinn*[39] and defined strategy as "the pattern or plan that integrates an organisation's major goals, policies and action sequences into a cohesive whole". *Porter*[40] integrated his well-known market-based view in his strategy formulation which describes strategy as "an internally coherent arrangement of activities, which distinguishes an organisation from its competitors".

Considering the similarities of the definitions, the aspects goals, actions and resources should be highlighted. *Chandler* already integrated all of the mentioned aspects in his comprehensive formulation, focussing on the long-term validity of the goals respectively objectives, on the implementation of the strategy by adequate procedures and the consideration of the needed resources. *Mintzberg* points out the patterns in the decision making processes and conditioned the patterns later on by the organisational goals and the required procedures for putting them into action again. Also *Porter* highlights the activities which can also be associated with the use of resources and implicates the goal-orientation in the differentiation from the competitors in the market. Concluding, strategy in a business context can be summarised by balancing internal resources (personnel, finances, material, etc.) and determined goals[41] and the realisation of the involved activities.

Strategic Management

Based on the strategy definition the term strategic management can be understood as a "process, in whose focus is the formulation and implementation of strategies in an enterprise".[42] This basic description shows the context between the strategy itself and its management in a process-orientated way, which will be content of chapter 3.1.4. The definitions of the field are rather differentiated as can be seen in the listing of selected statements shown in table 3.2.

[38] cf. Mintzberg (1987), p. 11 ff.

[39] cit. Mintzberg/Quinn (1996), p. 3

[40] cit. Porter (1999), p. 15, transl.

[41] cf. Hinterhuber (1984), p. 30

[42] cit. Welge/Al-Laham (2001), p. 19, transl.

Tab. 3.2: Selected Definitions of Strategic Management[43]

Author	Definition
Schendel/Hofer (1979)	Strategic management is a process that deals with the entrepreneurial work of the organisation, with organisational renewal and growth, and, more particularly, with developing and utilising the strategy which is to guide the organization's operations.
Bracker (1980)	Strategic management entails the analysis of internal and external environments of firms to maximise the utilisation of resources in relation to objectives.
Jemison (1981)	Strategic management is the process by which general managers of complex organisations develop and use a strategy to co-align their organisation's competencies and the opportunities and constraints in the environment.
Van Cauwenbergh/Cool (1982)	Strategic management deals with the formulation aspects (policy) and the implementation aspects (organisation) of calculated behaviour in new situations and is the basis for future administration when repetition of circumstances occurs.
Smircich/Stubbart (1985)	Strategic management is organisation making – to create and maintain systems of shared meanings that facilitate organised action.
Schendel/Cool (1988)	Strategic management is essentially work associated with the term entrepreneur and his function of starting (and given the infinite life of corporations) renewing organisations.
Fredrickson (1990)	Strategic management is concerned with those issues faced by managers who run entire organisations, or their multifunctional units.
Teece (1990)	Strategic management can be defined as the formulation, implementation, and evaluation of managerial actions that enhance the value of a business enterprise.
Rumelt et al. (1994)	Strategic management is about the direction of organisations, most often, business firms. It includes those subjects of primary concern to senior management, or to anyone seeking reasons for success and failure among organisations.
Bowman et al. (2002)	The strategic management field can be conceptualised as one centred on problems relating to the creation and sustainability of competitive advantage, or the pursuit of rents.

The term "management" itself is seen in two different ways in the literature, on the one hand as an institution and on the other hand as a function. The managerial functions approach describes functions and processes like planning, organisation, leadership and controlling, which are essential in organisations, in which labour has to be shared. In an institutional sense respectively in a managerial roles approach management stands for the description of (groups of) persons involved in management including their activities and roles.[44] In the definitions below, both perspectives are concerned whereby especially the formulation of *Fredrickson*[45] focuses on the managerial roles approach by explaining the strategic management with the contents of the top management's work respectively their units. In gen-

[43] Nag et al. (2007), p. 954 f.

[44] cf. Staehle (1991), p. 65

[45] see Fredrickson (1990)

eral considering all citations of strategic management in the list it can be summarised as a process involving goal formulation and implementation, in the hand of the senior management, that should promote organisational change by aligning the internal resources with the external environment pursuing the objective to succeed in the competition. It becomes obvious that the knowledge of the internal competencies is as essential as the analysis of the business environment to fulfil the mentioned requirements.

3.1.2 Development of Strategic Thinking

The strategic management process and the requirements, which come along with it, can be made more understandable if the development of the strategic thinking and the changing environmental conditions influencing the management are discussed. The development process is therefore a continuous reaction to the changing environment, especially to the rising dynamics. The phases of the strategic thinking over the time are visualised in figure 3.1.

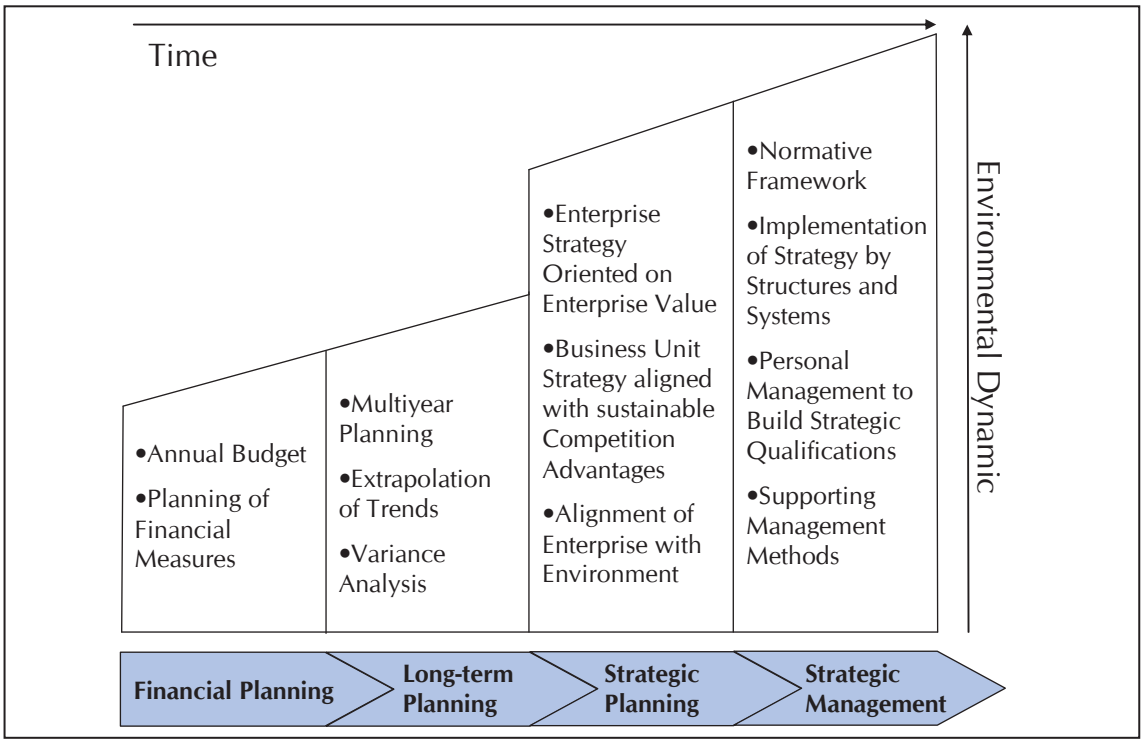

Fig. 3.1: Development of Strategic Thinking in Enterprises[46]

Beginning after the Second World War and the strong and stabile economic growth of this time the challenge of the management was restricted to pursue the path of growth with

[46] cf. Henzler (1988), p. 1298

their business. The focus was to plan financial measures to analyse the profits and costs as well as the budget for a rather short period, in most cases only for one year. The aim was to detect restrictions for the development and deviations from the plan. The approach was adequate for the existing conditions but had to be revised as the environmental dynamic was rising.[47]

The new conditions demand a more long-term orientated approach, as a consequence the long-term planning is based on prognosis of the environment. The results are used to adjust the objectives, activities and budgets. The weakness of the long-term planning was the concentration on the prognosis which extrapolate the past and are therefore of limited suitability in a dynamic environment. New tools like trend analysis or regression models represented an improvement by imaging the present but were also not capable to forecast the future. Also the allocation of resources took place considering long-term aspects. The targets were defined for several years and are based on the question of survival of the business. The targets undergo a deviation analysis and determine the strategy and in succession the structures in the organisation.[48]

With the appearance of the first discontinuities, especially triggered by the oil price shock in 1973, updating trends which are generated from past data became superfluous. The requirement to understand the environment and to concentrate on the markets activated the development of the strategic planning. The consideration of external threats and opportunities is characteristically for the approach and represented a viable way under the given circumstances. Another supporting fact for new developments at this time is the growth and diversification of the enterprises, so that one task of the new approach was to align the strategies of the business units with those of the entire enterprise. New tools are introduced to assist the strategic orientation like the portfolio analysis or industry analysis. The strategic planning involved an enterprise-wide planning of targets and actions instead of only considering financial measures.[49]

The most considerable difference between strategic planning and strategic management is the process orientation. Based on the cognition that the sole planning of strategies is not sufficient, the implementation of them takes the centre. Therefore the internal fundamentals like structures and systems have to be created, that strategies can be realised, but the entrepreneurial culture as a component of the normative level and the personal management got a strategic meaning too. All the mentioned steps are built on and complement

[47] cf. Hungenberg (2004), p. 49 ff.

[48] cf. Kreilkamp (1987), p. 15 f.

[49] cf. Hungenberg (2004), p. 51 f.

each other. New changes in the business environment will demand higher sophisticated approaches of strategic thinking and will continue the development process.[50]

3.1.3 Theories of Strategic Management

The development of the strategic thinking is strongly linked to the empirical research in this field. In this area the strategy content research and strategy process research are distinguished. Strategy content research analysis the best strategic positions ensuring success in different environmental conditions whereas the process research focus on the role of the design of decision processes.[51] The discussion of the procedure of strategy formulation and implementation in the process view resulted in a so called planning model of *Ansoff*.[52] This model was of prescriptive nature and recommended the most efficient sequence of partial steps in the decision process, which was a task of the corporate management. Based on empirical investigations of strategic decision processes *Mintzberg*[53] and *Quinn*[54] criticised the planning model and introduced the descriptive incremental model, which dissociates from the determined sequence of different process phases. Their research in the corporations disclosed that strategies are created sporadically and decentralised instead of following strict patterns. The corporate management only formulates global targets as a frame for the actions of the subordinate units. The strategy content research addresses the precise contents of strategic decision processes and their drivers and consequences, especially studies on success factors take a major role.[55]

Strategy Process Research

The activities in strategy process research lead to an extensive academic discussion about the formation of strategies in a business, whereas up to ten different schools can be distinguished (see tab. 3.3). The first three listed schools are prescriptive and focus on the ideal way strategies should be formulated and the other descriptive ones put into question how strategies emerge (too[56]). Subsequently the most widespread school concerning practical

[50] cf. Hungenberg (2004), p. 52 ff.

[51] cf. Rühli/Schmidt (2001), p. 534 f.

[52] see Ansoff (1965)

[53] see Mintzberg (1978)

[54] see Quinn (1980)

[55] cf. Hungenberg (2004), p. 58 f.

[56] An exception from this categorisation is the configuration school since it represents a combination of all other schools in one.

application, the prescriptive planning model of *Ansoff*[57], and the later developed, descriptive incremental model of *Mintzberg* and *Quinn* are introduced.[58]

Tab. 3.3: Ten Schools of Thought[59]

School	Main Representatives	Process Understanding
Design School	Learned et al. (1965)	Strategy formation as a conceptual process
Planning School	Ansoff (1965)	Strategy formation as a formal process
Positioning School	Porter (1980)	Strategy formation as an analytical process
Entrepreneurial School	Schumpeter (1934)	Strategy formation as a visionary process
Cognitive School	March/Simon (1958)	Strategy formation as a mental process
Learning School	Lindblom (1959)	Strategy formation as an emergent process
Political School	Pfeffer/Salancik (1978)	Strategy formation as a power process
Cultural School	Unspecified	Strategy formation as an ideological process
Environmental School	Hannan/Freeman (1977)	Strategy formation as a passive process
Configurational School	Miles/Snow (1978)	Strategy formation as an episodic process

The planning model represents an orientation on rational decisions, composed of a sequence of factually connected decisions in a structured process. At least the two phases of strategy formulation and strategy implementation are part of the process resulting in the determination of targets based on the analysis of the business as well as its external environment and the activities realising the given strategic targets.[60] The planning model of *Ansoff*[61] is based on the capital theory, which he extended with a view on the opportunities of the business environment for product-market decisions. The new approach have the prerequisites to consider a sequence of steps for solving the problem of strategy formulation including the search for market opportunities, to allocate internal resources aligned with the actual and future opportunities, to assess synergy effects, to select the most advantageous opportunities, to handle target conflicts and to assess the long-term potential of projects. The iterative method starts with the determination of decision rules, which should be more and more precise along the process. The first decision concerns the question if a business should be diversified or not (expansion would be an alternative). Secondly the overall product-market scope (which product in which market) must be chosen, before in

[57] see Ansoff (1965)

[58] cf. Hungenberg/Wulf (2005), p. 212 f.

[59] on the basis of Welge/Al-Laham (2001), p. 22; Mintzberg (1990), p. 111 ff.

[60] cf. Welge/Al-Laham (2001), p. 23

[61] cf. Ansoff (1965), p. 12 ff.

the subsequent step the scope is refined regarding the characteristics of the market (e. g. analysis of the firm in comparison to competitive characteristics). Once the characteristics are identified opportunities must be identified and evaluated and a feedback has to be done to challenge them. In each step targets are determined, the gap between the actual state and the targets has to be assessed, a strategy to close the gap is formulated and finally the capability of the strategy to close the gap is tested. In the centre of the method is the sequence of decisions in an adaptive process, finding an adequate strategy to close the gap to the objectives of a business.

Critics of the planning model questioned if a strategy can be planed and at that in a formal process since plans are in practise doomed to failure. Another point is how planning, with its characteristic to fix a direction and therefore a source of inflexibility, is able to be aligned with change and environmental turbulence. Besides planning is often considering the existing plans and rely on the existing categories instead of initiating strategic change. In detail the major pitfalls of the planning model are the inability to predict discontinuities, the separation from the strategic and operative level and the formalisation preventing novelties.[62]

Based on the planning model of *Ansoff* quite a number of different process models for strategic management were developed. In figure 3.2 the model of *Welge* and *Al-Laham*[63] is shown, containing a clear visualisation of the different process steps and their interrelationships and the iterative character of the approach.

The target planning starts with determining a vision, which focuses on the development and the change of an enterprise and presents a future dream. The vision should express the direction of the business, combine the cultural and factual level and be a tool to implement certain values in the company. The primary purpose of the vision is to motivate employees by giving them a superior target and to avoid a concentration on secondary problems.[64] The next step is to create a mission statement concretising the vision. These policies should help to orientate the behaviour of the employees on the stakeholders of the enterprise. They formulate the principles for the realisation of the vision.[65] Based on the vision and the mission statement the planning of strategic targets is of great importance since without formulated targets the long-term strategic perspectives would be neglected.[66]

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[62] cf. Mintzberg (1990), p. 119 ff.

[63] see Welge/Al-Laham (2001)

[64] cf. Herbek (2000), p. 51 ff.

[65] cf. Bea/Haas (1995), p. 64 ff.

[66] cf. Welge/Al-Laham (2001), p. 109

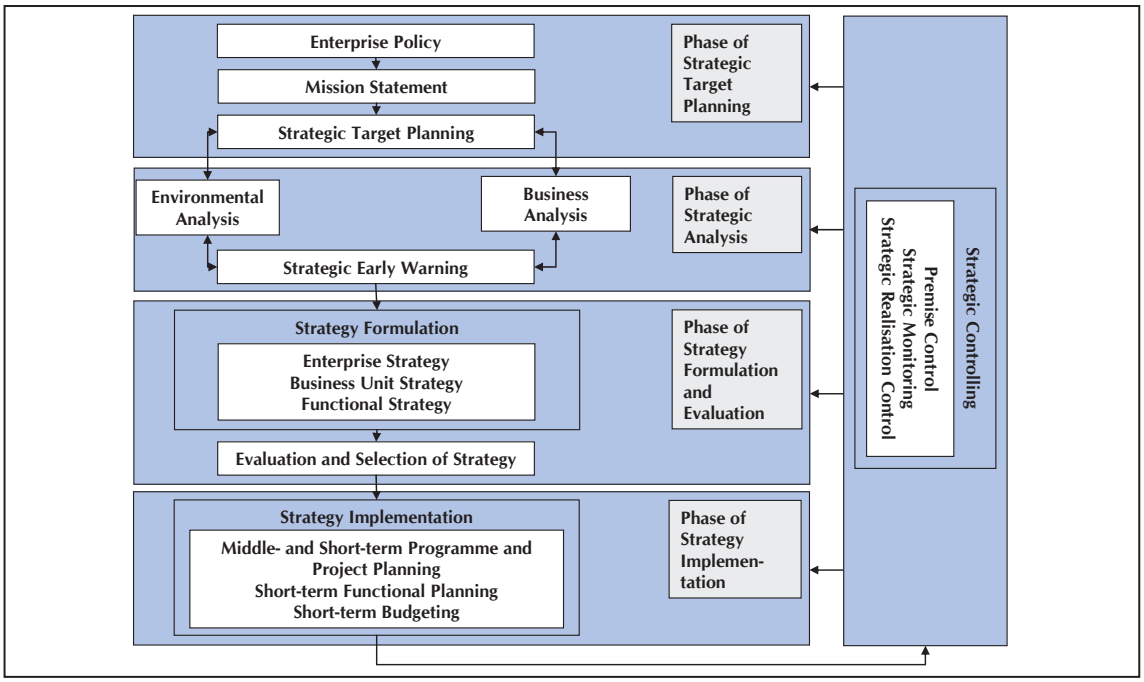

Fig. 3.2: Process Model of Strategic Management[67]

The strategic analysis deals with opportunities and threats in the future, with the indication of new or terminable fields of activity and with the identification of possibilities to gain a strategic competitive advantage.[68] Analysis can be performed either for the whole company or for certain strategic business units. These units are characterised by their appearance as a separate competitor in an external market, by their independence on decision-making and by their independent contribution to the increase of the success potential, which is associated with independent targets and activities.[69] There are three external aspects, the global environment, the structure of the branch and the competition, with an impact on the success of an enterprise. Defining a strategy should start with an intensive investigation of environmental influences.[70] The goal of performing an internal analysis of the enterprise respectively of the strategic business unit is to discover internal potentials and the own strengths and weaknesses too.[71] The strategic analysis consisting of an external as well as an internal analysis presents basically a combination of the market-based and resource-based view. Finally the factors of the business environment and the company related factors are put together to perform an analysis of the strengths, weaknesses, opportunities and

[67] on the basis of Welge/Al-Laham (2001), p. 96

[68] cf. Karst (1998), p. 26

[69] cf. Welge/Al-Laham (2001), p. 328

[70] cf. Hinterhuber (1983) , p. 47 ff.

[71] cf. Karst (1998), p. 47 ff.

threats.[72] The rise of the environmental dynamics in the last decades reasons the recommendation to use strategic early warning systems in the strategic analysis too.[73]

The primary task of the corporate level is to formulate a value creating strategy for the entirety of business units for the purpose to balance cash consuming and cash generating units. All units have to be monitored continuously if they contribute to the value creation of the entire corporation, therefore tools are available to make the single business units comparable. For a company offering several products in several markets and countries, the strategic management faces more complex problems. Products with different market shares or profit margins in growing or saturated markets in countries with different market barriers make it difficult to distribute the resources in a way that the best possible corporate results can be achieved. To reduce these problems companies created decentralised units, a result of these segmentations are the strategic business units.[74] The strategies of these units should determine the borders of the target market and by which means the unit should compete.[75] Since the strategies of the business units are not precise enough, functional strategies have to be formulated. With the development of the strategic thinking also the strategic potential of the former short-term dominated planning of the functional units has been detected. Based on the strategies of the business unit a more detailed strategy for the functional units should be derived, which should serve as input for the short-term planning, as a coordinating function and as an interface between strategy and operative implementation.[76] The subsequent evaluation of the possible strategies concerns the quantitative and qualitative impacts of the individual strategies. Therefore existing strategies are evaluated regarding the goal realisation level and new strategy alternatives regarding economic criteria and consistency or feasibility.[77]

The strategy implementation focuses on one hand on a factual level and on the other hand on activities to motivate all employees for the implementation. The factual related implementation of the strategic planning regards the consideration of the strategy in operative and anticipated planning as well as in the daily business activities. To avoid the neglect of the strategic ideas, specific strategic programs should be formulated. The personnel related implementation is at risk to fall victim to the concentration of the strategy creation process on factual problems. Without considering the personnel level the strategic implementation

[72] cf. Welge/Al-Laham (2001), p. 183

[73] cf. Kreilkamp (1987), p. 26

[74] cf. Welge/Al-Laham (2001), p. 324 ff.

[75] cf. Bea/Haas (1995), p. 164

[76] cf. Welge/Al-Laham (2001), p. 403 f.

[77] cf. Welge/Al-Laham (2001), p. 487 f.

is in the most cases doomed to failure. To succeed in business demands to formulate specific programs.[78]

The strategic controlling has to meet the requirement to restrict the uncertainties of planning by controlling the assumed premises continuously in terms of their validity. Each deviation from reality has to be analysed to identify possible modifications of the strategy. Another task is the splitting of the long-term implementation process into milestones. Thereby a permanent controlling of deviations is given, which can be analysed and give reason to modify the strategy or strategy implementation programs.[79]

Three different types of strategic controlling can be distinguished: the premise control and strategic monitoring, both already starting during the strategy formulation phase, followed by a realisation control starting together with the strategy implementation phase and paralleling the two other processes. The purpose of the premise control is to check the alignment of the strategic assumptions to reality. The premises focus on conditions and developments of the external environment (including the market and competition situation), on the assumptions about the internal situation (resources and competences) as well as on the organisational culture (readiness to take risk, economical and ethical attitude). The process starts with the acquisition of the premises and the identification of the critical ones. Subsequently indicators are determined which are able to signalise deviations. Based on these indicators the premise control can be applied.

The strategic realisation control checks out if there is a discrepancy between the defined milestones and the actual partial results of the realisation. Milestones are measurable and manageable objectives, which should be achieved aligned with a predetermined schedule. The strategic monitoring should audit the environment and the situation of the organisation permanently to recognise emerging threats and opportunities. The premise and realisation control are systematically and based on predefined assumptions. The strategic monitoring should detect unpredictable events and developments for the purpose to compensate the weaknesses of the systematic controlling types.[80]

The definition of targets, the strategic analysis and the strategy formulation can be summarised as strategic planning, which is an exclusive task for the strategic leadership. Considering the strategy realisation, consisting of the implementation and the controlling of the strategy, the operational leadership is in charge too. Planning, implementation and controlling are representing parts of the process. The strategic planning defines the input for a long-term business development and provides a basis for the strategy implementation. The strategic controlling monitors the strategy implementation as well as the deviation of the

[78] cf. Kühn/Grünig (2000), p. 63 ff.

[79] cf. Kühn/Grünig (2000), p. 66

[80] cf. Steinmann/Schreyögg (1990), p. 221 ff.

planning premises to reality. If significant differences between actual and target values are identified, the process starts again by modifying the planning.[81]

Based on the critics on the planning model a complementary approach, the incremental model, has been developed, which is primarily associated with the research of *Mintzberg*[82]. The validation of the model is based on results of empirical investigations of strategy decision processes in firms but also of governments and therefore a descriptive approach. The strategy formation is affected by the three aspects environment, bureaucracy and leadership. Strategic change is in this view a reaction on environmental changes, retarded by the operational systems respectively the bureaucracy and its speed is influenced by the leadership. The mentioned factors build a link between intended and realised strategies, which are combinable in three ways. First, the intended strategies get realised as so called deliberate strategies. Secondly, the intensions to not face realisation and result in unrealised strategies and finally, the realised strategies are never intended and therefore emergent ones. Due to the dependence on the environment, which may be stable for years or become turbulent abruptly, a regular and sequenced strategy formation process is not adequate. Nevertheless different patterns of strategy formation are identified, which are dependent on the human cognition too and therefore reactions to environmental change correspond to discreet steps respectively are incremental.

In the literature there are several studies concerning the characteristics of strategic planning and its impact on the company performance, two of them should be exemplified in the thesis in hand. The study of *Falshaw et al.* [83] investigated 113 companies in the United Kingdom regarding the formality of the planning process and their financial performance by questionnaire. Their hypothesis stated, that there is a strong relationship between the level of formal planning and the subjective cognition of performance, that larger companies use more formal approaches, that there is a difference between industrial sectors concerning formality and a more turbulent environment causes a more formal planning. While the results show no correlation between formality of planning and perceived performance, a positive relationship between company size respectively environmental turbulence and the level of formal planning is recognised. Especially the results concerning turbulence is a contradiction to other studies, where an increasing change rate demands less formality and rather informal methods like scenario planning.

The study of *Hopkins* and *Hopkins*[84] analyses the influence of the strategic planning intensity and the financial performance of 112 banks by a mail survey. For this purpose the impact

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[81] cf. Hümmer/Hess (1990), p. 4 ff.

[82] cf. Mintzberg (1978), 941 ff.

[83] cf. Falshaw et al. (2006), p. 16 ff.

[84] cf. Hopkins/Hopkins (1997), p. 637 ff.

of managerial factors (strategic planning expertise, planning-performance beliefs), environmental factors (complexity and change, interactive effects of environment) and organisational factors on the strategic planning intensity, which is expressed as the level of involvement in each planning process phase, is investigated. Subsequently the influence of the planning intensity on the financial performance (net income, return on equity and deposit growth) is questioned. The results highlighted a strong relationship of planning intensity and financial performance in the bank sector, whereas the intensity a bank use is primarily caused by managerial factors and, contrary to other studies, is negatively correlated with increasing organisational factors (structural complexity and organisation size). The two studies discussed are representative for the research in this field and also disclose the often appearing contradiction of the results of different empirical studies in the strategic management theory.

Considering the contribution of the strategy process research in the practice there is a high interest of corporations in the way how the process should take place. The planning model of *Ansoff* is very popular in the practice as well as in the academic teachings. One reason for that are the clearly defined instructions to use the model. It serves as a reference point, in the most cases it is adapted for the specific decisions processes in the concerned enterprise. The controversial discussion between the planning and the incremental model is not resumed by the users. The shortcomings of the incremental model are in the view of the practitioners the missing practical interest in the theoretical developed approach and consequently the missing applicability.[85]

Strategy Content Research

Strategy content research takes the contents of the strategic decision processes into consideration, especially the relationship of a strategy and success as well as the sources of success in single business units, which is a task of success factor research. Another focus of the content research is the investigation of the success contribution of different diversification strategies on the corporate level, whereas the market-based view as well as the resource-based view play a prominent role. In a third bias the impact of structures and systems in the strategy implementation are put into question.[86]

Success Factor Research

The term "success factor" was introduced by *Daniel* [87] in 1961, who recommended determining critical success factors to evaluate the relevance of strategic leadership information.

[85] cf. Hungenberg/Wulf (2005), p. 212 f.

[86] cf. Hungenberg/Wulf (2005), p. 213 ff.

[87] cf. Daniel (1961), p. 111 ff.

Decades later, *Antony* and *Dearden*[88] rediscovered his proposal and established success factors as central parameters for the explanation of long-term success differences. The impact of the success factors on competition and strategy is shown in the definition of *Hofer* and *Schendel*[89]:

"Key success factors are these variables, which can be influenced by the decisions of the management and which are able to determine the competition position of different enterprises in a specific industrial branch in a significant manner. These factors vary from branch to branch."

To identify general success factors empirical studies are performed, two examples are the PIMS-program (Profit Impact of Market Strategies) and the study of *Peters* and *Waterman*[90].

The PIMS–program[91], developed with General Electrics and introduced in 1972, is an empirical study of the relationship between strategic parameters and success. The program is based on a database of strategic business units of all branches and observes their performance for several years. By correlation of data the provider is able to identify factors that are critical to success. The provision of information is done by questionnaire. In the course of the years hundreds of companies have been contributing to this study by more than 2600 strategic business units. To evaluate the performance of the units it is necessary to quantify success. According to the PIMS–study success is defined by the return on sales (ROS) and the return on investment (ROI), so it is mainly focused on shareholder interests. The program is based on the assumption that three main factors are influencing success: competition, strategy and the market conditions. For this purpose the strategic business units have to specify independent key factors describing their current position and the changes since the last evaluation. To identify success factors, the influence of the profitability measures ROI and ROS is examined by finding regularities. Strategic business units can use the correlated data to estimate the negative or positive impact of their activities on profitability. Analysis has shown that in some cases it is necessary to categorise the results by branches or geographically. Nevertheless the study confirmed some basic theories for the relationship between strategy and success:[92]

- Quality of products and services: Quality influences the ROI in a positive way and is of great importance in the long-term view. An increase of quality enables a company to raise prices and to gain market share.

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[88] cf. Leidecker/Bruno (1984), p. 23

[89] cit. Hofer/Schendel (1978), p. 77, transl.

[90] see Peters/Waterman (1984)

[91] see Springer (1973), p. 1177 ff.

[92] cf. Buzzel/Gale (1989), p. 7 ff.

- Market share: There is a positive and nearly linear relation between market share and profitability. The effects of economies of scale explain this proportionality. The growth of the company or strategic business unit in comparison to the competitors leads to lower producing costs and a larger profit margin.
- Investment strategy: Companies with high investment rates have to expect a decreasing ROI because investments do not affect returns.
- Life-cycle stage: Concerning life cycle stages the findings of the PIMS–study were unexpected and contrary to the theory of the Boston Consulting Group portfolio. The study shows that even more than 50% of strategic business units classified as "question marks" or "poor dogs" achieve a positive cash flow. On the other side, more than a fourth of units in the "stars" or "cash cows" stage are facing losses. This impairment is a consequence of the fact that the ROI is not only dependent on market share and market growth, which are the two determinants of the portfolio.
- Vertical integration: Considering the level of vertical integration it is remarkable that a low or a high level of integration cause a high profitability. The v-shaped behaviour is explained by increasing integration investments on one hand and the reduction of costs by a very high level of integration on the other hand.

The study of *Peters* and *Waterman* investigated a series of successful companies to discover differences. As a result they found eight soft factors that represent the basic requirements for management. These factors were well known, but the essence of their findings was that only companies that give them priority are able to transform them into success factors.[93] The success factors according to *Peters* and *Waterman* are:[94]

- Primacy of action: Although successful companies make their decisions in an analytical way too, they show more courage to try.
- Contact to the customer: Excellent firms learn from their customers.
- Freedom for entrepreneurship: Positive effects can be achieved by supporting management talents and innovators.
- Productivity by human beings: The best companies care about their employees to increase quality and productivity.

[93] cf. Kühn/Grünig (2000), p. 115 ff.

[94] cf. Peters/Waterman (1984), p. 32 ff.

- Exposed value system: A conscious experienced culture makes work meaningful und creates a commitment - as a consequence it influences the performance in a positive way.
- Keep up the business area: Successful, innovative companies concentrate on their business area and profit from their developed competences.
- Simple, flexible organisation: Only less complex structures promise good results and are able to react on a changing environment.
- Tight and slack leadership: It is advantageous for a firm to be managed centralised and decentralised at once if only the few fundamentals are centralised in contrast to the operative parts. The mission should be to lead as much as necessary and to control as less as possible.

While different tools can control hard factors, developing soft factors is associated with intellectual competences and is the result of long-term observation of social influences.[95] The mention of this study should give a complementary point of view and show that also soft factors have to be considered as success factors, although it represents difficulties to measure them.

In the last years research on success factors met with criticism concerning methodical weaknesses, content and the trade-off between rigour and relevance. *Ahlert et al.*[96] summarised the methodical impairments specified in the left column of table 3.4 based on the publications of *March* and *Sutton*[97], *Woywode*[98] and *Nicolai* and *Kieser*[99].

Besides the mentioned methodical weaknesses of the investigation of success factors impairments as regards content face criticism too. *March* and *Sutton*[100] cited that the diffusion of knowledge about a certain success factor invalidates it, imitation causes a reduction in the variations of independent as well as dependent variables. According to this statement a sustainable superior position is not achievable by the detection of a success factor and therefore the term "success factor" loses its significance. Another shortcoming concerns the simplifications of the scientific approach necessary to identify success factors - they are based on different theories. Researchers use these theories to assume causal relationships in their empirical studies and are not able to control the adequateness of the theory empirically in the same study. The third weakness in this context is the requirement of numerous

[95] cf. Kühn/Grünig (2000), p. 117

[96] cf. Ahlert et al. (2005), p. 362 ff.

[97] cf. March/Sutton (1997)

[98] cf. Woywode (2002)

[99] cf. Nicolai/Kieser (2002)

[100] cf. March/Sutton (1997), p. 698 ff.

decisions while identifying and constructing success factors which are not established in a scientific way. The research processes use only these methods which result in the validation or rejection of the investigated hypothesis with an inerrant certainty.[101]

Tab. 3.4: Methodical Impairments of Success Factor Research[102]

Problem	Description
Sample is not representative	Formal and methodical errors
Inadequate methods are applied	
Inadequate scales are created for the measurement of constructs	
Insufficient content of theory	Absence of a quantitative confirmatory method based on a hypothesis (Fritz, 1990)
Invalid operationalisation of success factors	Invalid operationalisation of constructs or distortion of measurement may cause wrong conclusions (Hildebrandt, 1983; Kube, 1991; Backhaus et al., 2003)
Causal interpretation of cross-sectional data	Dynamic influences on success factors are not considered
Key informant bias	Information is acquired by the subjective assessment of one informant per firm (Ernst, 2001)
Non response bias	Distortion of the results due to not participating firms (Armstrong and Overton, 1977)
Endogeneity	Independent variables are influenced by disturbance variables not considered
Survival bias	Only surviving companies are targeted by the investigation

Another fundamental problem in research generally and consequently in research on success factors is the supposed trade-off between "rigour" and "relevance".[103] The assumption that scientific rigour in the exploration of success factors and their relevance for practitioners can not be combined leads to a lively discussion between researchers.

Shrivastava[104] formulated the following prerequisites for rigour in research:

- Conceptual adequacy: the research program should be based on theories and conceptual framework should be consistent with existing theories

[101] cf. Nicolai/Kieser (2002), p. 579 ff.

[102] on the basis of Ahlert et al. (2005), p. 362 ff.

[103] cf. Nicolai (2004), p. 99 ff.; Varajadaran (2003), p. 368 ff.

[104] cf. Shrivastava (1987), p. 79 ff.

- Methodological rigour: the use of analytical methods and objectively quantifiable data to investigate research questions empirically
- Accumulated empirical evidence: research programs should be able to produce a high amount of empirical evidence to support it

On the other hand the demand for practical relevance should be considered simultaneously. *Thomas* and *Tymon*[105] defined the following criteria to meet the demands of practitioners:

- Descriptive relevance: theory should incorporate phenomena encountered by practitioners
- Goal relevance: correspondence of outcome variables with goals of the practitioners
- Operational validity: ability of practitioners to translate the implications of a theory into action by controlling the causal variables
- Non-obviousness: theory should meet or exceed the complexity of common-sense theory already used by practitioners
- Timeliness: availability of research findings to practitioners in time to deal with current problems

Nicolai and *Kieser*[106] state reasons why it is impossible to fulfil both in equal measure, the expectations of rigour and relevance. First of all researchers are dependent on their reputation which can primarily be raised by publications. The probability of being published in a reviewed journal is associated with articles containing further developments of existing concepts respectively the application of sophisticated quantitative methods, both not consistent with the demands of practitioners. Concerning the second reason for the contradiction between rigour and relevance the two mentioned authors subscribe to the view of *March* and *Sutton*[107] that the conflict between the two perspectives has caused the separation of the context. As a consequence academic departments have on one hand practice-/consulting-orientated members and science-orientated members on the other hand. Due to the demand for third-party funds from the industry this separation is already institutionalised and contributes to the further divergence between scientific rigour and practical relevance. *Nicolai* and *Kieser* conclude that the overcoming of the trade-off between rigour and relevance in success factor research is only pretended.

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[105] cf. Thomas/Tymon (1982), p. 345 ff.

[106] cf. Nicolai/Kieser (2002), p. 579 ff.

[107] cf. March/Sutton (1997), p. 698 ff.

Varadarajan[108] is another author participating in the debate on relevance and rigour in the field of marketing research. He is of the opinion that it is counterproductive and erroneous per se to characterise journals as either high on rigour or high on managerial relevance. If potential relevance is defined as the extent to which research findings are put into practice, then relevant research have to change the beliefs and behaviours of at least one segment of journal readership.[109] Therefore a research article is only qualified to succeed in doing so if the rigour of research is reported too. In conclusion to create relevance for practitioners is in this view closely linked to rigour, which makes the two perspectives inseparable.

Market-based View

The basic idea behind the market-based view is the structure-conduct-performance paradigm originating from the industrial economics. It states that the performance is a consequence from the attractiveness of the industrial sector (structure) and the positioning of the business in the sector (conduct).[110] The paradigm was taken up by *Porter*[111] and introduced in the business management by creating a five-forces-model for analysing the market structure and a recommendation of systematised competitive strategies representing the conduct-part. Since the strategy formulation is dependent on the business environment, it is essential to analyse the relevant environment, primarily the sector a company compete in. For this purpose Porter created the five-forces-model (see fig. 3.3) highlighting the forces determining the intensity of competition. The differences in the magnitudes of the forces dictate the profitability potential in the individual sectors and one target of the selected corporate strategy is to protect the business against the forces. Generally, in a market of perfect competition the rate of return of the invested capital is reduced to a minimum. A rate of return above this minimum rate will cause additional investments into the sector respectively will attract new entries of competitors. The profitability in turn is a function of the five forces, which will be discussed subsequently.

The threat of the entry of new competitors is coming along with the theory of the perfect market particularly high in case of high return rates and if new competitors enter the market the prices are brought down. The magnitude of market entries is controlled by the entry barriers like economies of scale, product differentiation, capital requirement, switching costs or access to distribution channels. Besides other size-independent barriers the governmental policy may also create barriers. The level of rivalry between existing competitors is an interactive taking of actions and counteractions, in several cases occurring as price wars. Factors for an intensive rivalry are for example a great number of equally equipped

[108] cf. Varajadaran (2003), p. 368 ff.

[109] cf. Zaltman et al. (1982)

[110] cf. Hungenberg/Wulf (2005), p. 215

[111] cf. Porter (1988), p. 25 ff.

companies, a slow market growth, high fixed costs and strong exit barriers. The threat of substituting products emerges with supply of substitutes by another sector and creates an upper price limit dependent on the price performance relationship. The bargaining power of the purchaser may have a decisive influence on the profitability of a business and in advance of the whole sector. The influence of the customers is rising if the business is dependent on few, but large buyers, if the products are rather standardised, if the switching costs are low or if there is a threat of backward integration. Also suppliers have an impact on the sector's profitability by establishing prices or quality in relation to their market power. The determinants of their power is comparable with those of the purchasers, only the views are changing and a threat of backward integration will become a threat of forward integration for example. All five forces are subject to a continuous change and therefore not only a static view should be part of the analysis.[112]

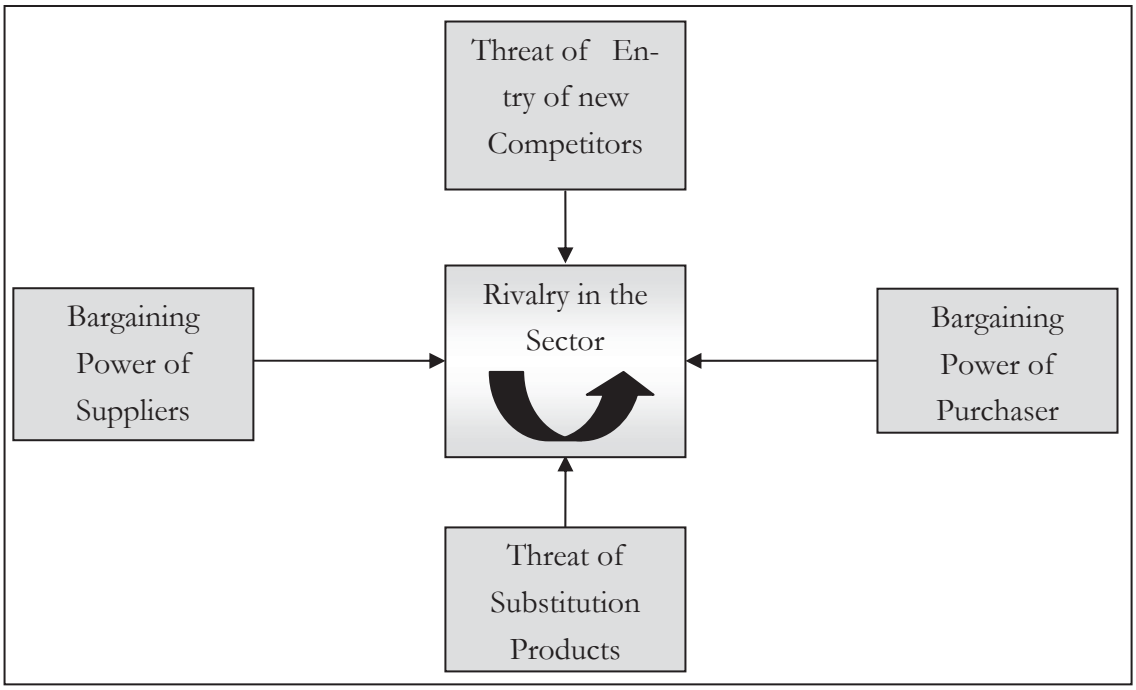

Fig. 3.3: Five-Forces-Model of Porter[113]

Based on the structural analysis of the sector competition strategies have to be formulated, which position the corporation in a way, that its capabilities are used to defend it from the market forces, that the balance of forces is influenced to improve the position and that changes of the forces are anticipated in time to use it for the advantage of the corporation. To succeed in the given environment *Porter* recommends three basic strategies: cost leadership, differentiation or a focussed strategy. A cost leadership strategy is aimed at the utilisa-

[112] cf. Porter (1988), p. 29 ff.

[113] on the basis of Porter (1988), p. 26

tion of economies of scale and therefore to maximise the production capacity to lower costs below of those of the competition. Cost leadership protects the business against all forces, especially the price can only be brought down until it is equal to the costs of the second efficient competitor. The differentiation strategy focuses on the supply of unique products or services on the market and can be related to design, brand, technology, marketing, after-sales services and others. Although costs are not in the centre of this strategy type it can be very profitable and defends from the five forces by the uniqueness of the output.

The focussed strategy is a concentration on market niches like a segment of buyers, a special segment of products or a specific geographical market. The supply of the chosen niche can be implemented by a cost leadership or a differentiation strategy, whereas the market and the profit potential are limited when following a focussed strategy. The three strategies are possibilities to cope with the five market forces. It is necessary to chose between the strategies, enterprises choosing a combination of cost leadership and differentiation will "stuck in the middle" respectively will face losses in profitability, which is represented by the U-curve (see fig. 3.4).[114]

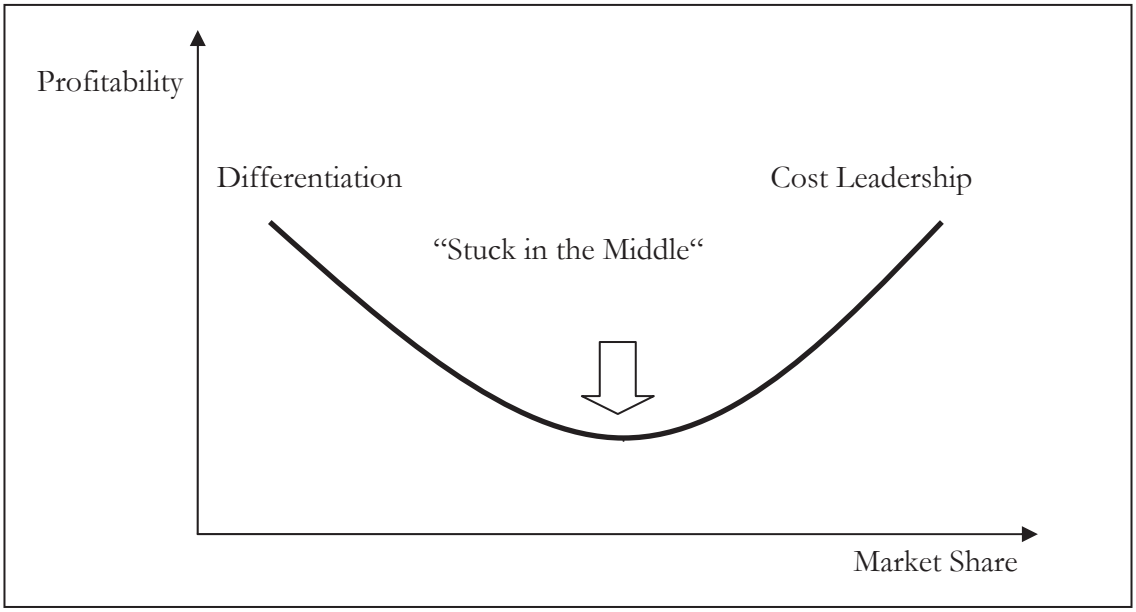

Fig. 3.4: U-Curve[115]

Resource-based View

In the search of competitive advantage in the academic discussion the market-based view met with criticism. As weak points the assumptions are identified, that strategic resources

[114] cf. Porter (1988), p. 57 ff.

[115] on the basis of Porter (1988), p. 73

of companies in a specific sector are heterogeneous, that these heterogeneities if occurring are neglected due to their very short appearance and that resources needed for the strategy implementation are highly mobile respectively marketable. The resource-based view disagrees with these assumptions and analysis the mentioned resources instead of the environmental forces to find sources for sustainable success. The mentioned resources can be categorised in three groups:

- Physical resources: technology, plants, equipment, geographic location, access to raw materials,…
- Human capital resources: training, experience, judgment, intelligence, relationships,…
- Organisational capital resources: reporting structure, planning, controlling, coordinating systems,…

The new assumptions, that resources of a business are strongly heterogeneous and immobile for a long time account for new characteristics, which are able to establish sustained competitive advantages. The first condition is that the resource must be of value for the implementation of strategies, which improve the performance of the firm. If a great number of competitors possess the same valuable resources, then the advantage would be neutralised. Therefore the rareness is another precondition for success based on a specific resource. The first two characteristics represent a rather static view since although resources are rare and valuable they can be imitated in a short-term view by other companies. Consequently they have to be imperfectly imitable, which can have three reasons. The state of an enterprise is always dependent on its historical path, so that the development of a specific research progress or an existing organisational culture cannot be imitated and create a unique historical condition. Another reason for the protection from imitation is the causal ambiguity, which means that the causal relationship between the use of a resource and the competitive advantage is not even understood by the enterprise itself and hence not imitable. The last reason is the social complexity standing for the interactions and relationships of the individuals in an enterprise, which cannot be transferred to a competitor. The final condition for a sustainable competitive advantage is that the resource, even it fulfils all previous conditions, is not substitutable. In other words no other resource should exist enabling the same effect in implementing the same strategy.[116] Based on the theoretical background the approach of core competencies was developed and found recognition with its practical application known as core competence analysis (see fig. 3.5).[117] Several empirical studies highlights the advantageous competition position of companies using resources

[116] cf. Barney (1991), p. 100 ff.

[117] see Prahalad/Hamel (1990)

with the mentioned characteristics, however the strength of the resource-based view are rather the contrary assumptions and the view beyond tangible assets than its differences in the application of the concept.[118]

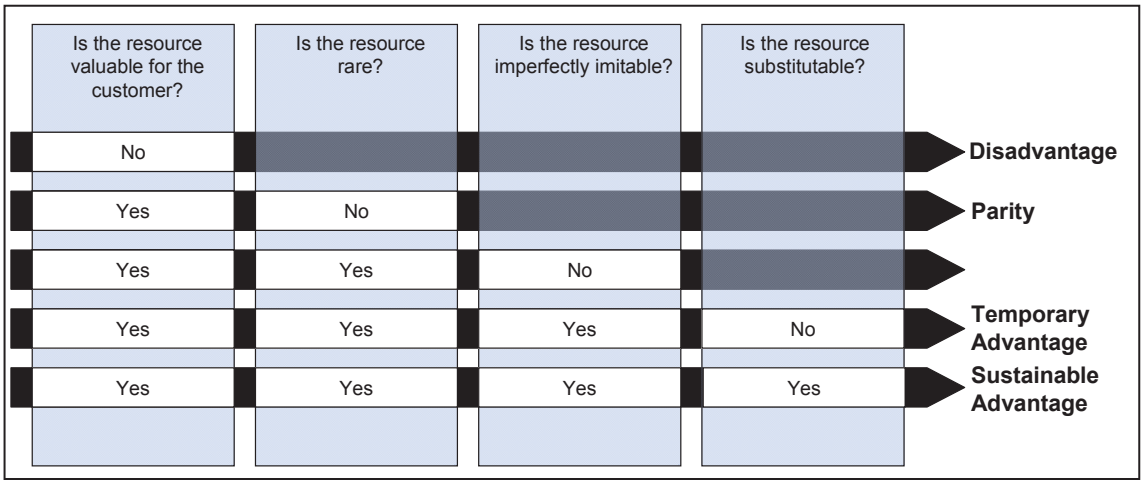

Fig. 3.5: Core Competence Analysis[119]

In the perspective of the practitioners especially the results of the success factor research attracted attention. This is reasoned by the practical meaning of the empirical studies, since they disclosed contemporary success factors for the relevant time. Especially in unsuccessful times of the businesses knowing these factors was significant and it was rather easy to transform the clear and simple conclusions of the studies into actions. The market-based view as a concept with a well-defined practical orientation became therefore accepted in the business. The resource-based view as a more theoretical founded approach became an influence not until it was combined with the core competencies analysis. By introducing the analysis the practitioners got a tool for understanding and implementing the approach and consequently make use of the view. The newer developments like game theory in the market-based view and the analysis of causal relationships or the dynamic perspective in the resource-based view are neglected in practice so far.[120]

Complementary Views

Although the two traditional views cover the analysis of the resources in the firm and the business environment, some gaps were left providing room for additional views. The relational view, originating from *Dyer* and *Singh*[121], makes the relationship of a business with its stakeholders responsible for success respectively competitive advantage. The relationships

[118] cf. Barney (2001), p. 648 ff.

[119] on the basis of Barney (1991), p. 106 ff.

[120] cf. Hungenberg/Wulf (2005), p. 214 ff.

[121] cf. Dyer/Singh (1998), p. 660 ff.

to suppliers, customers, partners and competitors build a network for generating so called relational rents as a property of the whole network. These rents arise from relation-specific assets (synergies from physical and human assets), knowledge-sharing routines, complementary resources and capabilities as well as effective governance (common advantages from goodwill trust or reputation). The basic idea behind the relational view is, that the assumptions of the resource-based view concerning resource heterogeneity and immobility can be corroborated, but sharing these capabilities would even result in higher rents.

Tab. 3.5: Comparison of Strategic Views[122]

Dimensions	**Market-based View**	**Resource-based View**	**Relational View**	**Dynamic Capability View**
Unit of analysis	Industry	Firm	Pair or network of firms	Firm
Primary Sources of supernormal profit returns	-Relative bargaining power -Collusion	-Scarce physical resources -Human resources -Technological resources -Financial resources -Intangible resources	-Relation-specific investments -Interfirm knowledge-sharing routines -Complementary resource endowments -Effective governance	Strategic and organisational processes -Product development -Strategic decision making -Building of alliances -Knowledge transfer
Mechanism that preserve profits	Entry barriers -Government regulations -Production economics/sunk costs	Barriers to imitation -Resource scarcity/property rights -Causal ambiguity -Time compression diseconomies -Asset stock interconnectedness	Network barriers to imitation -Causal ambiguity -Time compression diseconomies -Interorganisational asset stock interconnectedness -Partner scarcity -Resource indivisibility -Institutional environment	Resource… -Integration -Recombination -Allocation -Acquisition and Release
Ownership/control of rent-generating processes/resources	Collective (with competitors)	Individual firm	Collective (with trading partners)	Individual firm

[122] on the basis of Dyer/Singh (1998); Eisenhardt/Martin (2000)

The dynamic capability view is based on the argument, that the resource-based view cannot withstand dynamic markets due to the fast diffusion of information. Therefore dynamic capabilities are not subject to the conditions of being not substitutable and not imitable. The view focuses on the processes embedded in the organisation and strategy of a business and aims at the manipulation of the existing resources to create value creating strategies under dynamic conditions. To gain a competitive advantage, which is regarding the conditions not sustainable, organisational and strategic processes configure (acquire, shed, integrate, recombine,…) the resources in a way, that market changes can be anticipated or affected. The view centres the processes generating the outperformance of the competition repetitively instead of the used resources themselves.[123] Table 3.5 summarises and compares the four views in terms of the analysed unit, the sources of success, the mechanism preserving the profits and ownership of processes respectively the resources.

3.1.4 Strategic Management in Different Environments

Since the strategic management approach incorporating the processes and contents are changing if the environmental conditions are altering the link between the management approach and the business environment is discussed subsequently. Before the literature regarding concepts for the classification and operationalisation of environments is analysed to explain the terms used which are not uniquely defined.

Description and Conceptualisation of the Business Environment

In the literature the terms turbulence, dynamics and uncertainty are often used to describe business environments and sometimes equalised in their meaning. The classification respectively the conceptualisation of the terms and partially the underlying constructs are covered by this chapter in a chronological order.

The first attempts to classify organisational environments are in the literature often attributed to *Emery* and *Trist*[124]. They introduce four types of causal textures, which are based on the system theory and represent the environmental interdependencies acting on organisations seen as open systems. The least complex type of environmental texture is described as a placid, randomized one related to the changing rate respectively the distribution of goals and so called noxiants ("goods" and "bads"). The second type can be described by imperfect competition, the environment is still placid, but relationships between the goals and noxiants of different organisations exist and therefore it is defined as a placid, clustered one. The disturbed-reactive environment type equates to an oligopoly and is characterised

[123] cf. Eisenhardt/Martin (2000), p. 1105 ff.

[124] cf. Emery/Trist (1965), p. 24 ff.

by numerous similar organisations with a relative symmetric information distribution, which results in attempts to hinder others for the own advantage in an equal way as competitors try. The most complex type are the turbulent fields, where dynamic processes dominate based on large clusters of organisations able to act persistent and influence the environment, on the interdependence between economic and societal aspects resulting in changes of legislation or public regulation and on the intensification of research and development. In the sequence the types are described the uncertainty is increasing. This classification is based on the system interdependencies in a market, which lead to increasing complexity in case of a higher magnitude of relationships between the market participants. The third and fourth type, the disturbed-reactive environment and the turbulent fields, are described as dynamic states. The terms complexity, dynamics, turbulence and uncertainty are not differentiated in detail in this early work.

The second significant attempt to characterise business environments was made by *Duncan*[125]. Unlike other authors he included the external and internal environment in his considerations and clustered both into components (e. g. external environment components: customer, supplier, competitor, socio-political, technological). To describe the environments two dimensions are conceptualised, the simple-complex and the static-dynamic one. The first dimension is a measure for how many factors are considered in a decision and to how many different components they belong. The second dimension is determined by the rate of change of the factors included in a decision and how often they are replaced by others in the decision making process. The study then investigates empirically how the different values of the two dimensions influence the perceived uncertainty of the management in decision making. To question the perceived uncertainty a definition was derived consisting of three components: lack of information regarding the environmental factors, missing knowledge concerning the outcome of a decision and the in ability to assign probabilities for the effect of the factors with any degree of confidence. Based on the two dimensions and the perceived uncertainty the interrelationships are conceptualised by a matrix (see tab. 3.6) and tested by hypothesis. The results highlight the increased perception of uncertainty in case of a dynamic and complex environment, whereas the static-dynamic dimension has a higher impact on the uncertainty. Here the classification of the environment is based on the operationalisation of complexity and dynamic as well as uncertainty, where the complexity dimension of the attempt of *Emery* and *Twist* is extended by the dynamic dimension.

[125] cf. Duncan (1972), p. 314 ff.

Tab. 3.6: Environmental State Dimensions and Perceived Uncertainty[126]

	Simple	**Complex**
Static	Cell 1: low perceived uncertainty Small number of factors and components in the environment Factors and components are somewhat similar to one another Factors and components remain basically the same and are not changing	Cell 2: moderately low perceived uncertainty Large number of factors and components in the environment Factors and components are not similar to one another Factors and components remain basically the same and
Dynamic	Cell 3: moderately high perceived uncertainty Small number of factors and components in the environment Factors and components are somewhat similar to one another Factors and components of the environment are in a continual process of change	Cell 4: high perceived uncertainty Large number of factors and components in the environment Factors and components are not similar to one another Factors and components of the environment are in a continual process of change

A very detailed typology of organisational environments was created by *Jurkovich*[127]. He organised 64 types of environments in a matrix with the two main dimensions general characteristics and environmental change. The general characteristics are categorised hierarchical by complexity, routineness of problems/opportunities, organisation of sectors and the relatedness of the sectors to the organisation. Concerning complexity no definition is proposed for the empirical study, only the perception of complexity is queried. The routineness of problems and opportunities to handle is determined by the uncertainty respectively the availability of information, less information cause a non-routine problem-opportunity state. The organisation of sectors, defined as organisational sets and categories of unorganised individuals and organised groups, is dependent on the fact, if the group or clusters are handling according to a set of formal rules or not (e. g. customers). Finally the sectors can be directly of indirectly related to the organisation, which can be differentiated by presence of intermediaries in case of exchanges (e. g. government agencies, which contract organisations to contract other ones). The second dimension of the matrix, the environmental change, is determined by the change rate and the stability of the change. *Jurkovich's* definition of the change rate transfers the environmental change to processes of internal change. So he operationalise the rate as number of major goal alterations of an organisation in a specific period, assuming that a higher environmental change rate will cause

[126] Duncan (1972), p. 320

[127] cf. Jurkovich (1974), p. 381 ff.

more internal goal alterations. The stability of change is explained by the predictability respectively the erratic behaviour of the changes. This typology combines the environmental and the organisational characteristics (routineness, level of organisation) to a greater extent than the other attempts and results in a very precise classification in a matrix with numerous fields. The environmental change rate is also supplemented with a characterisation of the change by measuring the stability of the developments.

Miller and *Friesen*[128] investigated the link between environmental conditions and strategy making, and considered dynamism, hostility and heterogeneity (respectively complexity) in the description of the business environment. To assess the environment a questionnaire is formulated sampling the changes of the defined contents over the past five years with the help of a seven point scale. Dynamism is defined by questions regarding the magnitude and unpredictability of change in customer preferences, production or service technologies and the activities of the competitors. Hostility is covering the extent of price, product, technological and distribution competition, regulatory restrictions, shortages of labour or raw materials as well as unfavourable demographic developments. Heterogeneity or complexity is explained by differences in competitive tactics, customer preferences, product lines, distribution channels and others causing the requirement for diversity in production and marketing. Compared to the former characterisations the hostility is introduced as a third environmental component, which represents the multiplexity and intensity of competition as well as the state in the industry cycle (up- or downswings).

A further study of *Koberg*[129] was conducted to analyse the impact of the environment on organisational structures on the example of the school system. She uses two components to describe the environment, the already mentioned environmental uncertainty perceived by managers and the scarcity of critical resources. The uncertainty was questioned by a 9-item, 5-point Likert measure and is related to the perception of unpredictable changes concerning supply, funding, regulations, policy, relationships and other developments. Additionally to the mentioned concepts she also considers the resource scarcity, in the given case the availability of new students, queried by the indication of the enrolment trends. In this study another important aspect, independent of uncertainty, was regarded to determine the environmental conditions. The resource scarcity is declared to a separate determinant, which is partially also comparable to other characterisations, in contrast to conceptualisations where the resource availability is a trigger for turbulence or uncertainty.

[128] cf. Miller/Friesen (1983), p. 222 ff.

[129] cf. Koberg (1987), p. 798 ff.

Tab. 3.7.: Selected Typologies of Business Environment

Author(s)	Typology of Environment	Operationalisation
Emery/Trist (1965)	Placid randomised Placid clustered Disturbed-reactive Turbulent fields	Changing rate Distribution of/relationships between goals/noxiants Information distribution
Duncan (1972)	Simple/complex	# of factors included in decisions # of environmental components concerned
	Static/dynamic	Rate of change of considered factors Replacement of factors in the decision process
Jurkovich (1974)	General characteristics Complexity	 Perception of complexity
	Routineness	Availability of routines for problems/opportunities
	Organisation of sectors	Existence of formal rules for sectors
	Relatedness of sectors	(In)direct relationship of sector to organisation
	Environmental change Change rate	 # of major goal alterations in a specific period
	Stability	Predictability/erratic behaviour of changes
Miller/Friesen (1983)	Dynamism	Extent and predictability of change
	Hostility	Competition, regulations, availability of raw material/workforce, demography
	Heterogeneity	Requirement of diversity in production/marketing
Koberg (1987)	Uncertainty	Predictability of changes
	Resource scarcity	Availability of resources
Sutcliffe/Zaheer (1998)	Primary uncertainty	Uncertainty regarding exogenous sources
	Competitive uncertainty	Activities of potential/actual competitors
	Supplier uncertainty	Opportunism of exchange partners

Sutcliffe and *Zaheer*[130] conceptualised environmental uncertainty with the categories primary, competitive and supplier. The primary uncertainty originates from external sources like natural events, changes in preferences or regulatory changes. It comprises the uncertainty due to technological changes as well as the so called state uncertainty, which covers the information deficit about the states of the nature. The competitive uncertainty is closely

[130] cf. Sutcliffe/Zaheer (1998), p. 2 ff.

related to *Porter's* market-based view (see fig. 3.3) and is resulting from the activities of potential and actual competitors. The supplier uncertainty is caused by the actions of the exchange partners, positioned backwards or forwards in the value chain, and their possible opportunism. This concept of uncertainty is based on one hand on the lack of information regarding exogenous sources, but on the other hand also includes the magnitude of competition and the power of suppliers as a separate area of origin.

To get an overview table 3.7 summarises the mentioned typologies of a business environment and their operationalisation of the different authors in a chronological order.

The Link between Environment and Strategy

In this chapter the different states of business environment should be analysed in the context of strategic management. New developments require the availability of an adequate strategic response, which can be ensured by procedural and content-related aspects of the strategic management process aligned with environmental conditions.

Already *Ansoff*[131] makes the application of his strategic issue analysis (see chapter 3.3) dependent on the environmental characteristics. He opposed the conventional strategic planning to the issue analysis, whereby the most relevant difference is the information acquisition. He described strategic planning as a periodically, organisation-focussed process, in which the required information is derived from the strategic decision. In contrast, in the problem-focussed, continuous process of strategic issue analysis the decisions are based on the available information. In a stable environment the usage of the strategic planning approach is recommended, if the strategic future seems to be unsatisfying or a future improvement is desired. In turbulent environments, a business with optimistic strategic trends should rely on the strategic issue analysis. The concept of issue analysis is based on the proposition that firms in an environment, which is not surprise-free, have to adapt their strategic approach.

As already mentioned in the previous chapter, *Miller* and *Friesen*[132] performed a study to analyse the link between environmental issues and strategy making. Additionally to the determinants describing the environment, they take two dimensions for strategy making in consideration, which are called analysis and innovation. An analysis orientated planning approach means to consider more factors in the decision process systematically and methodically, to integrate different decisions by focussing in their complementarities and synergies and to plan for future contingencies. In the questionnaire designed for the study, they investigated the analysis part of the strategy by asking for the time horizon of the an-

[131] cf. Ansoff (1976), p. 150 f.

[132] cf. Miller/Friesen (1983), p. 222 ff.

ticipation of market-related developments, the alignment of decisions with actual strategies, the time expenditure for decision analysis, the development of the understanding of the market by the senior management and the number of factors incurred in decisions. The innovation dimension covers the introductions of new technologies, the search for problem solutions, the implementation of leader or follower strategy and the risk attitude. Based on the operationalisation of the constructs three hypotheses are formulated:

- More successful firms will show more positive correlations between increases in environmental dynamism and increases in (a) analysis and (b) innovation.
- More successful firms will show (a) more positive correlations between increases in hostility and increases in analysis, and (b) more negative correlations between increases in hostility and increases in innovation.
- More successful firms will show more positive correlations between increases in environmental heterogeneity and increases in (a) analysis and (b) innovation.

The results of the correlations give evidence, that there is a positive relationship between dynamism and analysis as well as innovation, but only significant for the group of high performers. Regarding the second hypothesis, the link between hostility and an increase of analysis in more successful firms can be demonstrated for the given sample, but no relation between hostility and innovation has been detected. The third hypothesis is also only partially confirmed by the results, whereby to few significant correlations indicate the missing relationship between heterogeneity and analysis, on the other hand the positive correlation between heterogeneity and innovation in more successful companies is supported. Recapitulating, there is a requirement for more analysis in case of increased dynamism or hostility and for more innovation in case of increased dynamism or heterogeneity.

Lozada and *Calantone*[133] attended to the investigation of the relationship between uncertainty respectively environmental dynamism and the information acquisition behaviour for strategic decisions. Their hypotheses state, that an increased perception of uncertainty will cause the decision makers to intensify their information scanning activities (undirected viewing of the environment), to rely more on personal/less on written sources of information and to make more use of external sources. Another hypothesis asserts that environmental dynamism results in an increase of the information acquisition activities too. The intensity of scanning needed for the study is measured by two dimensions: the environmental traits managers focus at in their scanning activities and the extent they scan the different traits. Concerning traits a classification in entrepreneurial (external product/market trends/events), engineering (external trends/events impacting manufacturing), administrative (external trends/events impacting administration) and regulatory sectors (e. g. govern-

[133] cf. Lozada/Calantone (1996), p. 24 ff.

mental regulations) is recommended. The scanning intensity is measured by the frequency method, asking for the learning frequency of events in a number of predefined sectors, and the interest method, representing the interest of the managers in information originating from the sectors. The results expose a more frequent scanning behaviour in case of a higher uncertainty, all other hypotheses are rejected in their study.

Parnell et al.[134] were also engaged in the question of the influence of environmental uncertainty on patterns of strategic behaviour. For the alignment of the organisation with the environment four patterns are defined: prospectors face the perceived uncertainty with flexibility to deal with environmental change, defenders see the environment as stable and focus on stability and control to maximise efficiency, analysers alternate between stability and flexibility case by case and reactors are described as underperformer without a consistency in their strategies.[135] In recent literature a combination of generic strategies is recommended as a guarantee for high performance, which adds the "balancer" to the mentioned patterns, which can be described by acting separately as defender, analyser and prospector in the product market. In the study three propositions are analysed. The first one assumes, that balancer are far more successful (in terms of return on assets), and that reactors are far less successful than the others. The second one presumes that uncertainty about competitors, customers and environment is perceived differently regarding the classification of generic strategies. The last proposition is based on the second one, and put into question, if the magnitude and type of uncertainty is a predictor for the chosen generic strategy. After conducting an empirical study based on these constructs, the first two propositions can be strongly supported. Concerning the third one, the uncertainty about customers and environment are identified as predictors for the generic strategy, whereas the uncertainty about competitors is not decisive for the chosen strategy.

Another study is based on the complexity theory and tries to describe the relationship between success in a complex/turbulent respectively a simple/stable environment and the traditionalism of the management. Therefore *Mason*[136] investigates different companies by interviews and document analysis to review four different propositions:

- In a more complex/turbulent environment the better performer would rely on self-organising management and emergent strategy making processes.
- In a more complex/turbulent environment the weaker performer would rely on traditional management and strategy making processes.

[134] cf. Parnell et al. (2000), p. 520 ff.

[135] cf. Miles/Snow (1978), in Parnell et al. (2000), p. 520

[136] cf. Mason (2007), p. 16 ff.

- In a more simple/stable environment the better performer would rely on traditional management and strategy making processes.
- In a more simple/stable environment the weaker performer would rely on self-organising management and emergent strategy making processes.

Tab 3.8: Selected Studies on the Relationship between Environment and Strategic Management

Author(s)	Hypothesis/Proposition	Support/Rejection
Miller/Friesen (1983)	More successful firms will show more positive correlations between increases in environmental dynamism and increases in (a) analysis and (b) innovation.	Supported
	More successful firms will show (a) more positive correlations between increases in hostility and increases in analysis, and (b) more negative correlations between increases in hostility and increases in innovation.	(a) Supported (b) Rejected
	More successful firms will show more positive correlations between increases in environmental heterogeneity and increases in (a) analysis and (b) innovation.	(a) Rejected (b) Supported
Lozada/Calantone (1996)	Increased perception of uncertainty will cause an intensification of information scanning activities	Only scanning frequency supported
	to rely more on personal/less on written sources of information	Rejected
	to make more use of external sources	Rejected
Parnell et al. (2000)	Balancers are more successful and reactors are less successful than the others.	Supported
	Uncertainty about competitors, customers and environment is perceived differently regarding the classification of generic strategies.	Supported
	The magnitude and type of uncertainty about competitors, customers and environment is a predictor for the chosen generic strategy.	Supported for customers/environment Rejected for competitors
Mason (2007)	In a more complex/turbulent environment the better performer would rely on self-organising management and emergent strategy making processes.	Supported
	In a more complex/turbulent environment the weaker performer would rely on traditional management and strategy making processes.	Supported
	In a more simple/stable environment the better performer would rely on traditional management and strategy making processes.	Rejected
	In a more simple/stable environment the weaker performer would rely on self-organising management and emergent strategy making processes.	Rejected

The outcome makes evident, that consistent with other literature the assumptions for the complex respectively turbulent environment can be confirmed. On the other hand the analysed companies showed not the expected behaviour for the case of a simple and stable environment, the less successful company uses a more traditional approach than the better performer. The results of the studies are summarised in table 3.8.

Recapitulating, the empirical studies disclose the link between the business environment and the strategic behaviour of firms. Better performer answer with more analysis-oriented approach to dynamism and hostility and an innovation focus to dynamism and heterogeneity. Uncertainty increases the scanning frequency and is partially a predictor for the chosen strategic patterns. Additionally in complex and turbulent environments emergent strategies seem to be more successful than traditional strategy making, which corresponds with *Ansoff's* position concerning the application of strategic issue management. The studies of *Miller/Friesen* and *Lozada/Calantone* demonstrate an intensification of the efforts to analyse the environment in uncertain times. *Parnell et al.* as well as *Mason* point out the need for strategic flexibility (respectively balance) under uncertain conditions.

3.2 Introduction to Risk Management

This chapter is dedicated to the general risk management approach starting with the definition of the terms risk and risk management. Thereafter the necessity of risk management due to legal frameworks and foremost the changing business environment is justified. Finally the systematically process of risk management is described as wells as the implementation of the single steps.

3.2.1 Definitions and Classification: Risk and Risk Management

The well known quote: "Risk varies inversely with knowledge"[137] already discloses that risk is related to a state of processed information. Thereafter the term risk is defined in the view of two theories, differentiated from uncertainty and different types of risks are introduced. Afterwards the management process is defined considering various definitions from several sources.

Risk

The term risk is described in various ways in the literature. Etymologically the term originates from the Arabic "risc" standing for something which is godly given, the Latin "risco"

[137] cit. Fisher (1930), p. 221

associated with the sailing around a cliff and the Italian "risicare" which can be equated with a peril. In contrast to the definition as a godly fortune the sailing manoeuvre also includes the aspect of human behaviour.[138]

In the context of business management *Brühwiler*[139] categorises the different risk definitions and lists the determination of risk as a variation of the result distribution, as threat of loss, as state of information, as threat of wrong decisions and finally as a negative deviation from targets, which he uses as definition for his work too. His chosen definition is closely connected with the symmetric risk term, which also considers the chance of a positive deviation. Since his work covers accidental risks he only alludes to chance management, but uses the asymmetric risk term as an adequate definition in this context. It becomes obvious that dependent on the risk object different definitions are used.

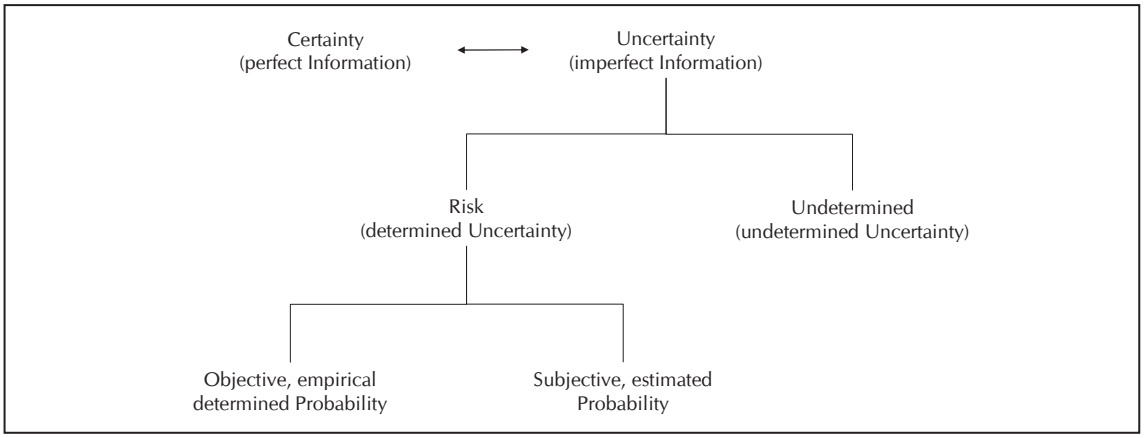

Fig. 3.6: Risk in the View of the Decision Theory[140]

The risk categories of *Brühwiler* give evidence, that the definitions consider the cause or the effect side of a potential event. Basically the definitions can be distinguished concerning their derivation from the decision theory (cause related) or their orientation on the target system (effect related). Decisions in a business are made for the future, which inheres in uncertain developments. The variety of potential future paths represents a risk at the time of decision, where the state of information is consequently imperfect. The cause related risk definition regards the uncertain state of information and the threat of wrong decisions as a risk source.[141] In the decision theory (see fig. 3.6) the state of information regarding a potential event is decisive. Certainty is given, if an activity leads to exactly one event and the complete information for that relationship is available. All other cases are referred to

[138] cf. Bieta et al. (2002), p. 104 f.

[139] cf. Brühwiler (1980), p. 40 f.

[140] cf. Rabitsch (2006), p. 22; on the basis of Hildenbrand (1988), p. 9

[141] cf. Kremers (2002), p. 36

uncertainty, which can be divided depended on the determinacy in risk and an undetermined state. In the first case it is possible to evaluate potential events in a subjective or objective way for example with the help of probabilities, which is not possible in case of indeterminacy.[142]

A more detailed gradation of uncertainty in dependence on the available information state is summarised in table 3.9. In the first case objective probabilities are determinable since an adequate amount of statistical data is available. In case of missing data probabilities can only be estimated from qualified and experienced persons. Uncertainty of 3rd order is based on a lack of experience concerning the intensity of the potential consequences, only the types of possible outcomes are known. In the case of the lowest state of information disposability even the potential paths of development are unknown or only partially known.[143] Only the first two orders of uncertainty are endued with probabilities respectively determined and consequently according to the classification in figure 3.6 assigned to the risk term.

Tab. 3.9: Categorisation of Uncertainty[144]

Uncertainty Category	Characteristics	Examples
1st Order	Objective probabilities of occurrence for all future states of environment are available	Volatilities of exchange rate, number of staff away sick
2nd Order	Subjective probabilities of occurrence for all future states of environment are available	Expected sales revenues, starting losses of market expansion
3rd Order	No probabilities of occurrence of future states of environment are available, the type of states is known	Fundamental research in new products
4th Order	No probabilities of occurrence of future states of environment are available, the type of states are only partially known	Effects of new products in the area of biotechnology

A definition referred to effects focuses on the deviation from determined targets, whereas in a symmetric view ("speculative risks") also chances (positive deviations) are included in the term risk, in an asymmetric view only negative deviations. The risk is seen as a threat of consequences of a potentially occurring event and therefore the expected target of decision is not achieved.[145]

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[142] cf. Saliger (2003), p. 16 f.

[143] cf. Kremsers (2002), p. 42 ff.

[144] Kremers (2002), p. 43; on the basis of Weber et al. (1999), p. 13

[145] cf. Hölscher (2002), p. 5 f.

Up to now risks are differentiated concerning their symmetry, their subjective respectively objective evaluation and their cause respectively effect related definition. Additionally risks can be distinguished regarding their insurability, their financial management or output oriented context, their internal or external origin, their concerned categories, their reference to different management levels and their single or aggregate consideration.[146] Selected differentiation characteristics are discussed subsequently since it is essential for the classification of risks considered in the thesis.

In an enterprise next to the production processes of goods and services also financial processes exists. Both are affected by different risks, where the real output oriented production processes and the financial management must be differentiated regarding the risk management measures too.[147] The risks covered by each process are summarised in table 3.10.

Tab. 3.10: Output oriented and Financial Management Risks[148]

Output oriented Risks	**Financial Management Risks**
Fixed asset risks	Payment default risk
Personnel risks	Risk of change in interest rate
Legal risks	Share price risks
Market risks	Exchange rate risks
Political risks	Liquidity risks

Risks can also be categorised concerning their internal or external reference and further subdivided in areas. Internal risks and their specification are dependent on management decisions and therefore controllable in contrast to external risks. Risks originating from the external environment arise for example from political or legal decisions and are therefore not manipulable from a business. Since corporate risks are often resulting from a combination of internal and external sources, a classification is a difficult process.[149] The internal and external risk areas are described by their categories in table 3.11 respectively table 3.12.

[146] cf. Kremers (20002), p. 45 ff.

[147] cf. Hölscher (2002), p. 6

[148] cf. Hölscher (2002), p. 6

[149] cf. Kremers (2002), p. 47

Tab. 3.11: Internal Risk Areas (Examples)[150]

Product Mix	Employees	Operating Income/ Financial Situation	Research & Development
Development of Product Portfolio Product Mix (Depth and Breadth in Comparison to Competitors)	Fluctuation, Illness and Accident Rates Age Structure Salary and Wage Increase in Comparison to Competitors	Liquidity Development Capital Development	Patent Applications/Validity Periods Development Costs in Comparison to Competitors Customer Structure Price Development

Tab. 3.12: External Risk Areas (Examples)[151]

Economic Development	Structural Development	Technological Area	Socio-political Area
Sales Markets Orders received Demand Development Price/Product Development of Competitors Supply Markets Availability of Raw Material (Resources) Price Development of Raw Material (Resources)	Labour Markets Number of Vacancies Unemployment Rate Expected Wage Increase Capital Markets Interest Rate Development Exchange Rate Development	Research & Development of relevant Competitors Innovations in Process and Product Engineering Development of Industry Patents	Demographical Development Legislative Initiatives/Legal Developments (e. g. Fiscal Policy) Social/Political Environment at own Production Location

Another key differentiation of risks for this thesis concerns the different management levels respectively the distinction between operative and strategic risks. Above all the time horizon and the potential impact are the decisive differentiating factors between the two types of risks. The strategic risks and their definition will be discussed in detail in chapter 3.3. Operative risks concern short-term disturbances of the ordinary business operations, but may have consequences for the corporate level if their aggregation has a major impact.[152] Since risks are oriented on decisions, a comprehensible distinction of the two types is possible by considering the characteristics of strategic respectively operative decisions in table 3.1.

[150] cf. Elfgen (2002), p. 218

[151] cf. Elfgen (2002), p. 217

[152] cf. Kremers (2002), p. 46 f.

In a holistic way, where the cause and the effect related definitions can be combined, risk can be defined as „… decision situation in uncertainty about the future development of decision relevant data, which can be described in the subjective or objective probability distributions of future data constellation, whereas the possibility of a deviation of the really achieved results from the planned respectively expected results is given".[153] In this definition the determination of uncertainty is limited to probability distributions, which will be in the focus of discussion later on in the thesis, since determinacy is not only restricted to probability. The risk definition for the thesis will be derived in chapter 3.3, where the perspective of the strategic level will be included in the determination.

Risk Management

As already explained in chapter 3.1.1 the term management corresponds to a functional respectively an institutional perspective. On the one hand functions and processes like planning, organisation, leadership and controlling are associated with the role of the manager and on the other hand management describes the activities and roles of persons involved in management seen as an institution.[154] The general definition of management is adapted for different management systems, in this chapter in the context of risk management.

In general, three different risk management approaches can be distinguished: risk management for handling special risks, risk management to support the leadership and risk management by hedging. The first group covers approaches, which focus on the operative handling of risks in selected categories instead of a holistic management of all classifiable risks affecting an enterprise. The specific risks are identified, assessed, treated and controlled by the risk management process and aligned with the objectives of the risk policy. The second approach focuses on a holistic consideration of all risks relevant for an enterprise. The aggregation of the risks originates from the system theory and should provide a support for the top management level to ensure their superior goal of long-term existence in the market. In other words the accumulation of single risks to a corporate risk position aims at the creation of transparency and the reduction of the resulting risk to a level, where its occurrence will not endanger the existence of the enterprise by balancing, reducing or diversifying risks. Risk management as hedging is primary the view of banks and insurances and aims at stabilising cash-flows by trading risks on the capital market. This perspective of risk management excludes the handling of risks not tradable at the mentioned markets and is therefore not adequate for a holistic approach.[155]

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[153] cit. Rabitsch (2006), p. 24, transl.

[154] cf. Staehle (1991), p. 65

[155] cf. Liekweg (2003), p. 7 ff.

Those authors concentrating on specific risks centre the operative process in their definition of risk management. They define it as a process including the steps identification, evaluation, treatment and controlling of risks with a bias on the risk objectives.[156] The process of risk management is described in detail in chapter 3.2.3.

The requirement of a holistic corporate risk management plays a major role in other definitions. They refer rather to normative respectively strategic levels and focus on the overall risk position of the corporation. *Brühwiler*[157] defines risk management in relation to the total corporate policy and the associated risks and chances. Another definition in this group also focus on aggregated view of risks by defining risk management as "…the systematically, active, future and objective oriented management of the overall risk position of the corporation".[158]

Elsewhere integrative risk management is seen as "… continuous, proactive and systematically process for the understanding, management and communication of risks in an organisation-wide perspective."[159] The integration of the management system is characterised by the extension of the process by the tasks to create a common understanding and to ensure a communication of the risks enterprise-wide.

Considering the contents and processes of risk management *Strohmeier*[160] derived a holistic definition of risk management:

"Risk management as an immanent component of business management covering all decision and implementation actions and the preceding, following and parallel positioned planning, organisation, leadership, information, coordination and controlling functions, which are aimed at a systematically and continuous analysis, treatment and controlling of the corporate risk potentials to enable the realisation of risk management objectives under consideration of the chance aspects on the basis of the underlying the value system of the corporation."

This definition describing risk management as an integrative approach too is exemplary for the combination of the functional definition of the management term with the process of risk management and integrates the normative level, represented by the objectives and values of a corporation.

Based on the definitions, risk management pursues different targets dependent on the sector the system is implemented. For instance, in the insurance sector, the risks threatening monetary factors are dominating. The task of risk management in this context is the long-

[156] cf. Kremers (2002), p. 76 ff.; Dörner/Doleczik (2000), p. 201

[157] cf. Brühwiler (1994), p. 6

[158] cit. Denk/Exner-Merkelt (2005), p. 30, transl.; on the basis of Guserl (1998), p. 165

[159] cit. Zech (2002), p. 39, transl.

[160] cit. Strohmeier (2007), p. 47, transl.

term protection and the creation of new success potentials by the early detection of risks for the financial, asset or profit situation of an enterprise. By the consideration of the total risk position and balancing of risks over the time or across more risk categories by insurance products results should be stabilised to achieve the mentioned goals in this sector.[161] In a mining and technology group the expectations on risk management are the balance between security and creation of value, the support of leadership to achieve the corporate objectives, the limitation of financial losses, economic or image impairments as well as the insurance of the long-term existence of the business.[162] In an mechanical and plant engineering group the goals of risk management cover the securing of continuity, the creation of shareholder value and profitability, the continuance of the social programs and in a holistic view the increase of the potential to achieve the corporate goals but also the protection of humans, assets and environment.[163] All expectations on the management system focus commonly on the long-term survival of the business. Whereas in the insurance sector the financial concerns play a major role, in industrial sectors also try to support the achievement of their goals and try, as demonstrated in the last example, to protect their human and physical resources.

3.2.2 Historical Development and Necessity

The historical development of risk management is associated with the environmental changes, which should be a key message subsequently. Nowadays the legislation and especially the existing business environment are the key drivers which explain the necessity of risk management.

Development of Risk Management

In the view of business practice risk management was understood as insurance decision in the middle of the 20th century. The main task for a risk manager was to assess, if an insurance should be accepted for the risk or if it is economically advantageous to implement internal measures against the risk instead. Caused by the changes in the economic environment like stagnation and oil crises in the sixties and seventies the risk management view was extended by the procedural approach and the consideration of a broader range of risk aspects in the strategic and operational planning. In the nineties the bias was, supported by the application of derivative financial instruments, shifted to financial risks. In the nearer

[161] cf. Zech (2002), p. 42

[162] cf. Heinze/Kullmann (2002), p. 129

[163] cf. Graf (2002), p. 145

past the development was influenced by the banking sector, impacting business management and legal specifications.[164]

The risk management originating from the US-insurance business was primarily focused on the protection of assets from unexpected impairments. It concerns in the first instance the differentiation of insurable and not insurable risks and the determination of the premium. The concentration on insurable risks excluded the consideration of speculative risks, only negative deviations from the objectives are regarded.[165]

With the development of the relevance of the financial management, especially in medium and large-sized enterprises, also the risk concentration was focused on this aspect. The disengagement from the conventional bank financing and investment is a consequence of the availability of financial derivates, which are used also by non-financial sectors independently besides the purpose of risks for speculative reasons too. Primarily the risk management is centred on the quantification and treatment of interest and exchange rate risks in this context.[166] The risks in the financial market gained importance due to developments in communication and data processing since both challenge the stability of the market and accelerate changes. The equity position of the enterprises is more and more linked to volatile stock markets representing a main source of risk. Additionally globalisation created an interdependence of risks on the international market, a relevant event may impact the world-wide market immediately.[167]

Business Environment and Legislation as Driver for Risk Management

The demand for risk management issues in the business management area is predominantly driven by two influences. The primary drivers are the discontinuities and turbulences in the environment, which already caused renowned insolvencies in the last years (Barings Bank, Swiss Air, Enron,…). The actual risk situation is determined by various factors (see tab. 3.13), which disclose significant chances, but massive risks too. A secondary driver for the integration of risk management into the existing management systems are institutional frameworks. Dependent on the country an enterprise is operating in different binding and non-binding standards and guidelines have to be regarded.[168]

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[164] cf. Liekweg (2003), p. 4 f.

[165] cf. Mikus (2001), p. 10

[166] cf. Holst (2001), p. 131

[167] cf. Gramlich (2001), p. 161 f.

[168] cf. Denk/Exner-Merkelt (2005), p. 39 ff.

Tab. 3.13: Environmental Developments Enhancing Business Risks[169]

Globalisation and intensified Competition	• Country risks caused by cross-border activities • Due to the close international interconnectedness economic shocks may cause world-wide chain reactions • Due to the attempt of industrial and trading firms to cover all segments of the sector the competition is intensified • For the build-up of a world-wide presence high investments are required, which may result in high amounts of loss in case of failure • The shortening of product life-cycles and the individualisation of demand necessitate increasing investments in research and development • Due to mergers and acquisitions the size and market power of competitors, customers and suppliers are increasing • Due to deregulation and liberalisation market entry barriers are weakened • The intensified competition forces to accept contracts with an disadvantageous risk structure
Modern Production and Inventory Management Technologies	• Potential damages are higher with more expensive facilities • High fractions of fixed costs decrease the assimilation capability and speed of changed environmental conditions • Costs for shutdowns are especially very high for linked production systems • Increased complexity of production systems results in higher susceptibility to failure • Higher sensitisation of publicity for the consequences of production to humans and environment (image damages)
Inter-organisational Cooperation	• High dependency between cooperation partner respectively customers and suppliers • A fair distribution of risks between the partners is nearly impossible • Risks token by partners have to be carried together without intentions • Partners may show an opportunistic behaviour
Offer of System Solutions	• Industrial firms offer services beyond their original core competences • By offering extensive system solution and the trend to single sourcing higher and higher order values are concentrated on a smaller number of orders

The second group of drivers are institutional frameworks, which demand or support risk management. Concerning the binding character and the operationalisation they can be categorised in binding standards, international standards and non-binding guidelines (see fig. 3.7).[170] The most relevant standards from Germany and Austria valid for all sectors and with a high risk management nexus are explained subsequently.

[169] cf. Erben/Romeike (2003), p. 44

[170] cf. Denk/Exner-Merkelt (2005), p. 42

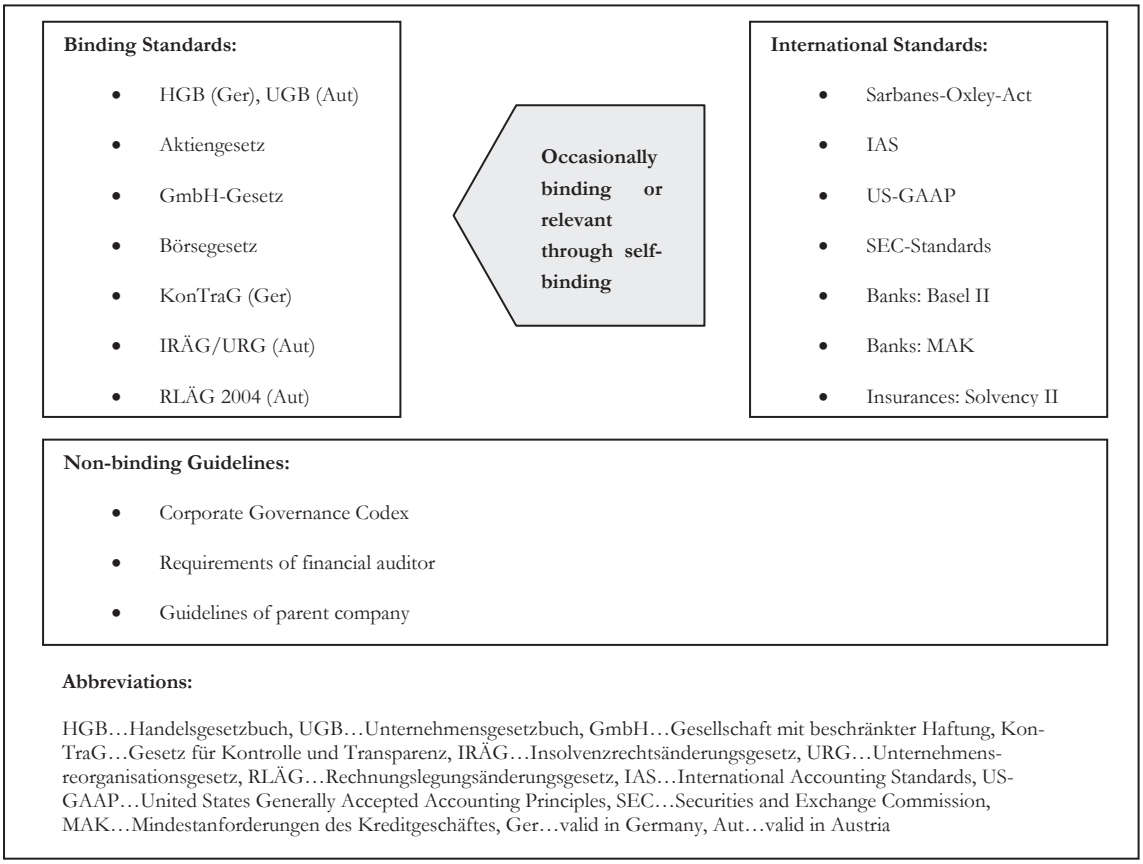

Fig. 3.7: Abstract of Institutional Frameworks[171]

The "Gesetz für Kontrolle und Transparenz (KonTraG)" is integrating other standards in terms of risk management and is mentioned as most relevant institutional driver, especially in Germany and in other German-speaking countries, where it is implemented voluntarily. It was introduced in 1998 and binding for stock-quoted corporations in Germany. The motivation for the new law was founded by the increased occurrence of enterprise crises. KonTraG is based on other laws (Aktiengesetz, Handelsgesetz,…) and explicates modifications regarding the implementation of a risk management system. It forces the board of an enterprise to install a monitoring system capable to anticipate risks endangering the survival of the firm and the implementation is dependent on the size of the firm as well as the volume, complexity and risk content of the operations. It has a major impact on the audit of financial statements, where the gap between the normative specifications for the auditing professionals and the expectations of the publicity should be closed by improving the quality, extending the audit and widening the information supply. As a consequence the KonTraG defines some particularities, whereas especially the risk situation in the status report of the annual report is concerned. The standard does not recommend the operationalisation of the risk management system in detail, but supports the development of tools for the

[171] on the basis of Denk/Exner-Merkelt (2005), p. 42

risk management in firms.[172] According to the specifications the board has to demonstrate in the case of crises, that all requirements have been met formulated in the paper. Recapitulating, three essential points are concerned by the introduction of the KonTraG:[173]

- Installation of an early warning and a monitoring system by the board
- Publication of future risks in the status report
- Audit and control of the early warning system and the risk report by the supervisory board and the annual auditor

The first point originates from the Aktiengesetz and the others from the Handelsgesetzbuch in Germany respectively the Unternehmensgesetzbuch in Austria. The mentioned points are substantially representing the risk management requirements of these two laws. The Aktiengesetz rules the requirements on the risk management system as a monitoring system. It dictates measures like determination of the risk categories, the risk identification, analysis and communication as well as attribution of responsibilities and the documentation of the measures. The Handels-/Unternehmensgesetzbuch contains the rules the reporting obligations in the annual report and regards risks in the status report by publishing the risks of future development, the events occurred after the end of the accounting year and the prospective development of the business.[174]

A non-binding guideline gaining major importance is the corporate governance codex, which rules the cooperation between the owner of an enterprise and the board of directors working in their behalf. It is aimed at the insurance of a responsible and long-term value creating leadership and control. The problems to solve are caused by potential information asymmetries between the supervisory board and the directors. Therefore, as regards content, the main focus is on the information obligations and qualifications of the people involved. Concerning risk management, the major point is the requirement of a proactive risk management process as an integrated part of the business management.[175]

The other mentioned standards and guidelines concern only partial aspects of the risk management process respectively regard single risks. The Insolvenzrechtsänderungsgesetz (IRÄG) was revised resulting in the Unternehmensreorganisationsgesetz (URG), which rules the laws of reorganisation in case of insolvencies to improve the financial situation to facilitate the survival. The Rechnunglegungsänderungsgesetz (RLÄG) obligates a firm to report risks in the status report including information about the used financial tools. In the Sarbanes-Oxley-Act primarily the rules for the financial reporting and its auditing are de-

[172] cf. Wolf/Runzheimer (2003), p. 20 ff.

[173] cf. Romeike (2003b), p. 69

[174] cf. Denk/Exner-Merkelt (2005), p. 43 ff.

[175] cf. Romeike (2003b), p. 72 f.

fined to prevent from accounting scandals. The International Accounting Standards (IAS), the United States Generally Accepted Accounting Principles (US-GAAP), and the Security and Exchange Commission (SEC)-Standards regulate substantially the accounting requirements and the evaluation of assets. The Mindestanforderungen an das Kreditgeschäft (MAK) and Basel II are binding for banks and concern the risk management associated with credit approval processes, whereas Basel II also considers the minimum requirements on equity. Solvency II is a pendant to Basel II and aims at the security of insurances. Firms also have to consider the guidelines of the financial auditor or the parent company.[176]

Based on the developments of the last decades associated with bankruptcies of large groups firms are subject to continuous changes in the institutional environment too. Since the crises provoked by discontinuities in the business environment are in the most cases occurring in advance and the trigger for new standards it is occasionally essential for companies to anticipate changes long before standards are formulated. The explained standards partially prescribe the introduction of a risk management system or determine minimum requirements to avoid risky situations.

3.2.3 Process Perspective of Risk Management

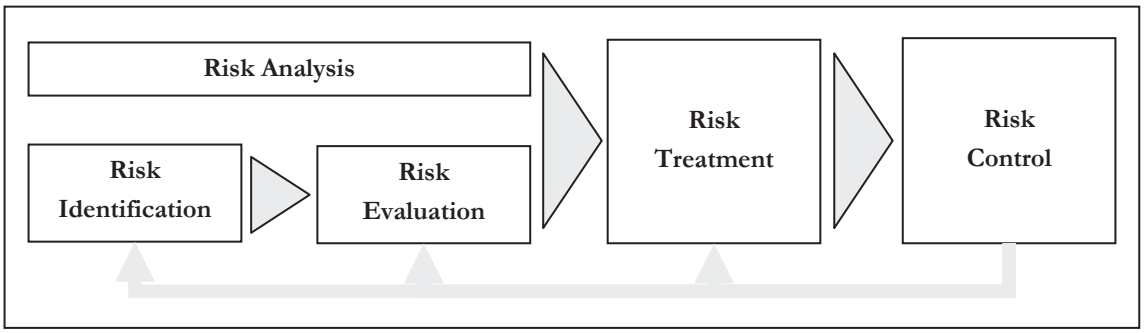

Fig. 3.8: Process Structure of Risk Management[177]

In a procedural view risk management is described by its process steps identification, evaluation, treatment and control (see fig. 3.8). The risk analysis covers the first two steps, in which risks are identified and evaluated to assess the actual risk situation. The risk treatment is based on the results analysis and defines the measures necessary to handle the inacceptable risks. The risk control monitors the change of the risk situation due to the realised measures. The process has an iterative character and unintended deviations from the objec-

[176] cf. Denk/Exner-Merkelt (2005), p. 46 ff.

[177] on the basis of Kremers (2002), p. 78

tives detected by the control phase may cause modifications of the other phases.[178] The four process phases are described more precisely subsequently.

Risk Identification

The risk identification delivers the information basis and is therefore a critical step in the process since only risks can be managed which are recognised. The identification also considers causal relationships and analysis cause and effect chains of potential events in divers risk categories to extent the number of risks identified. Some risk can occur only, if more than one event become effective and on the other hand one event may influence several risks. As a consequence the consideration of the relationships is essential since a risk perceived as irrelevant may have a fatal impact due to chain effects.[179]

The adequate application of the risk identification needs to meet some basic requirements. First of all the identification should be complete, so that all actual and potential future risks should be disclosed. The second condition is the availability of up-to-date information since a reaction in time should be possible and the risk treatment in an earlier stage is less extensive. Another point is the cost-effectiveness, whereas the costs of prevention should not exceed the potential damage costs. The last point is the psychological and organisational resistance to risk management, so the risk identification is dependent on the risk culture of an organisation.[180]

In many cases the identification of risks is based on intuition relying on the experience of the decider. To capture risks systematically the step should be supported by adequate methods and tools whose application is dependent on the type of risks to identify. No single method is able to disclose all potential risks, so the use of several methods is recommended to get a more complete picture. Nevertheless the completeness of the risk acquisition cannot be checked. Additionally the contribution of as much as possible employees of an enterprise is advantageous, since they know the different risks in their working environment better.[181]

Concerning the implementation of the risk identification process the top-down and the bottom-up approaches can be distinguished. In the first approach is based on the expectation that the top management knows the occurred and potential risks. This method is more efficient and less costly, but by not considering the lower level risks may be ignored, evaluated in an insufficient manner and no risk awareness is created in the company. The bottom-up approach integrates the lower levels and uses the experiences, information and

[178] cf. Kremers (2002), p. 77 f.

[179] cf. Romeike (2003 c), p. 153 ff.

[180] cf. Wolf/Runzheimer (2003), p. 41 f.

[181] cf. Kremers (2002), p. 78 f.

analysis of the involved employees. The potential disadvantages are the higher costs, a to excessive consideration of details or a missing great view. As a consequence it is recommendable to combine the two approaches to make use of all advantages. The bottom-up-top-down approach collects the results of the risk identification conducted by the lower management for the top management. Thereafter the identified risks are checked and discussed top-down and occasionally modified.[182]

Risk Evaluation

The risk evaluation as the second step of the risk analysis aims at the quantification of the impact of a risk on the business. The objective is the ranking and selection of the most relevant risks for subsequent measures.[183] The risk evaluation can be performed associated with two motives: the assessment of the actual risk potential or the risk assessment in the context of a decision. In the first case the initiation of necessary measures comes to the fore since only quantified risks are manageable. When a decision is met, the risk assessment fulfils the task to evaluate the change of the risk position due to the decision. The outcome of the decision is therefore dependent on the extent of the total risks involved.[184]

Conventionally risk is assessed by the use of two determinants: the probability of occurrence and the potential magnitude of impact. The probability measure stands for the cause related perspective and excludes values of 0% and 100%, since these are impossible respectively certain events. The effect related measure of the extent of the impact quantifies the consequences of the occurrence of the risk on the monetary or non-monetary targets. To evaluate a risk it is necessary to consider both dimensions, which can be represented in the three ways described subsequently.[185]

The first possibility for a combined representation of occurrence probability and impact is the risk expected value, a multiplicative linkage resulting in a single value:

Risk expected value = Probability of risk occurrence x Risk impact

The output of a single value for the risk simplifies the comparison with other risks, nevertheless the aggregation of two input values to one output is accompanied with a loss of information. Therefore the application of the risk expected value is restricted since a high probability of occurrence and a low impact would lead to the same result as a low probability and a high impact. In other words a catastrophically impact on the business may be underestimated in the case of a low probability.

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[182] cf. Denk/Exner-Merkelt (2005), p. 76 f.

[183] cf. Hölscher (2002), p. 13

[184] cf. Kremers (2002), p. 82

[185] cf. Kremers (2002), p. 41

To avoid some restrictions of the expected value calculation, the risk map is used, a graphical visualisation of risk in a two-dimensional portfolio. On the abscissa the impact and on the ordinate the probability are determined in the graph (see fig. 3.9). By the consideration of both dimensions the relevant information is preserved and ranges can be indicated as well, demonstrating the areas of negligible respectively not acceptable risks for a business dependent on its risk culture. Advantages of the risk map are, beside the simultaneous consideration of both dimensions, the descriptive and comprehensible visualisation of risks, not only understandable for experts, and the possibilities to reproduce the changes due to determined activities to handle the key risks.[186]

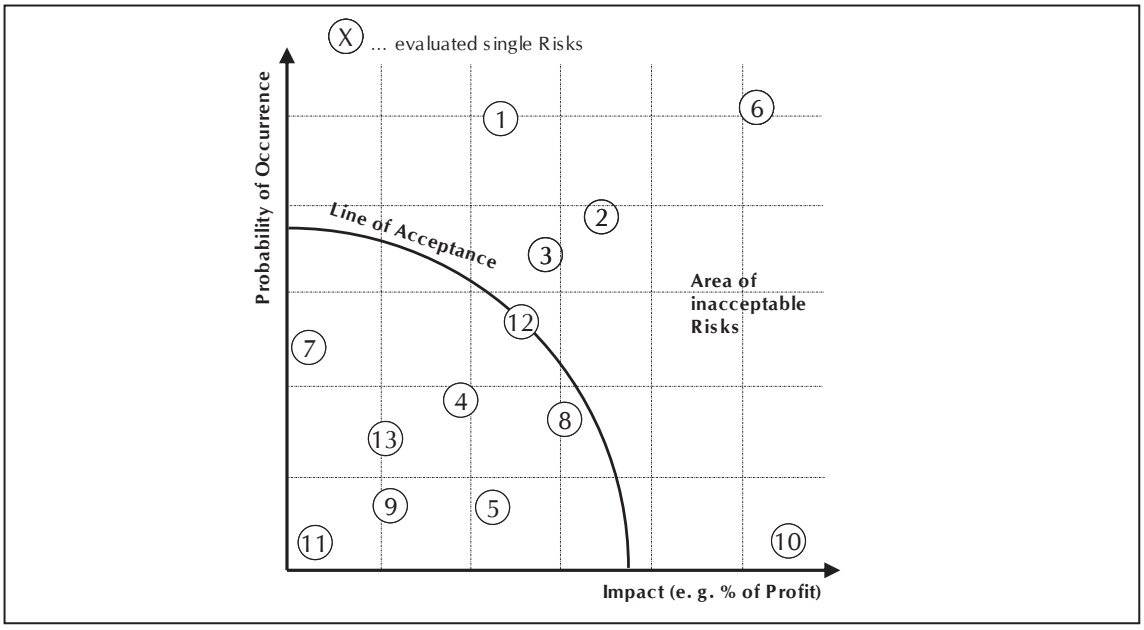

Fig. 3.9: Visualisation of Risk in the Risk Map[187]

In the risk map single values for the probability and the impact are applied. In reality one event can have different magnitudes of impact, which is disregarded in the risk map. To reconstruct reality as close as possible the magnitude of the impact of an event should be represented as a probability distribution (see fig. 3.10). Based on the probability distribution it is put into question, which value for the risk impact should be taken for the risk expected value respectively the risk map. One alternative is to consider the maximum possible loss indicating the worst case. Since this value indicates very high impacts at a very low probability it is not purposeful and would lead to an extreme demand for risk avoidance. Another alternative is the probable maximum loss, which is more realistic than the maximum

[186] cf. Kremers (2002), p. 109 ff.

[187] cf. Romeike (2003a), p. 237

possible loss value. The value indicates the impact, which will not be exceeded at a determined probability (95% in fig. 3.10) if a risk occurs.[188]

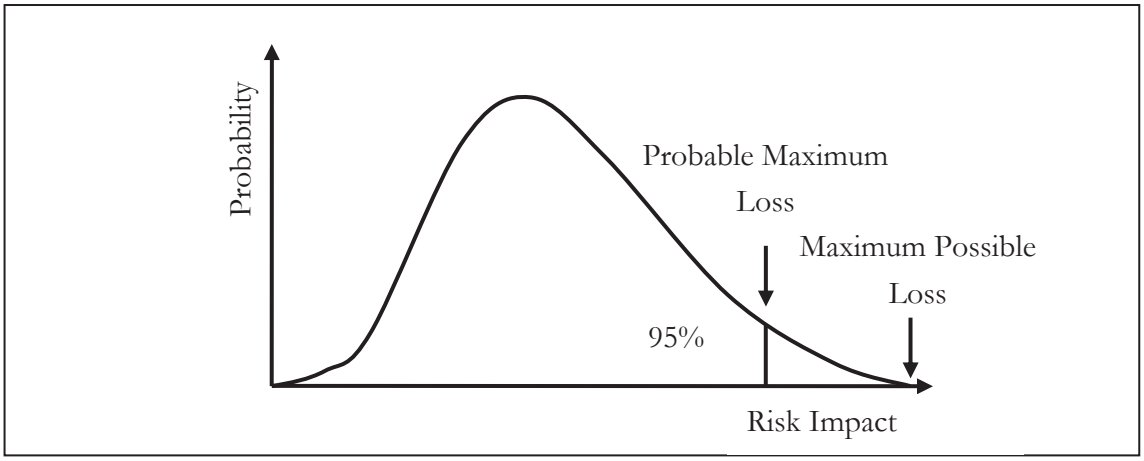

Fig. 3.10: Probability Distribution of Risk Impact

In concretising risk by the mentioned alternatives the rational aspect is in the centre. The distinction between subjective and objective probabilities is neglected and the broad range of uncertainty too (see tab. 3.9), which may lead to a discussion of the meaning of quantified risks. A more objective picture can be created by analysing and discussing risks in team work, whereas the application of the risk map as a generally accepted and comprehensible tool is recommended to create a common picture of the risk situation in a business. It is essential to have the limitations of risk quantification in mind to prevent risks from the risk management process itself.[189]

Risk Treatment

Based on the two steps of the risk analysis measures for the risk treatment are determined. Therefore a concept has to be created for determining the accepted risks to optimise the risk-return-relationship and the limits of risk acceptance. The concept is influenced by the risk strategy assigning the risk policy (risk-taking, risk-neutral, risk-averse), the optimal risk management structure and the marginal utility of the risk measures.[190] Different strategies for risk treatment are classified in table 3.14.

[188] cf. Kremers (2002), p. 114 f.

[189] cf. Strohmeier (2007), p. 38 f.

[190] cf. Denk/Exner-Merkelt (2005), p. 117

Tab. 3.14: Risk Treatment Strategies[191]

Preventive Risk Management Measures	Corrective Risk Management Measures	No Risk Management Measures
Active risk treatment by • Risk avoidance • Risk reduction • Risk diversification	Passive risk treatment by • Risk transfer • Risk provision	Risk is taken by oneself
Risk structures will be created	Risk structures remain unchanged	Risk structures remain unchanged
No or reduced risk effects by reduction of probability of occurrence and/or risk impact	No or reduced risk effects due to provision or shifting of consequences	Occasionally intelligent risk-taking

In the case that only passive or even no risk measures are taken the risk structures remain unchanged, so that neither the probability of occurrence nor the impact are altered. The risk transfer is characterised by shifting the risks to an external market, either to the insurance or the capital market (hedging), but also along the value chain to suppliers or customers. Regarding the risk provision, financial reserves are built by withholding profits and increasing the reserves in the balance sheet to cover potential risks. After exhausting all risk measures some risks may remain, which have to be taken by the business itself. These risks have to be balanced with the risk-bearing capacity of the business and occasionally other measures have to be taken. The risk management in a narrower sense is focussing on a preventive respectively active risk treatment, which will be discussed in detail subsequently.[192]

Preventive risk management measures cover the avoidance, reduction and diversification of risks. The risk avoidance is the most radical method of risk treatment and only applied if other measures are not effective enough since the avoidance of a risk is associated with the relinquishment of the chances too. Thereby the risk cause must be able to influence, that the probability of occurrence or the impact can be diminished (see fig. 3.11).[193] For instance, environmental risks of a production process can be avoided by substituting it by another production method or even by discontinuing the production of the relevant product.[194] As a consequence the risk avoidance is only an adequate measure if the risk is not acceptable and no alternative measure is applicable.[195]

[191] on the basis of Romeike (2003a), p. 236

[192] cf. Denk/Exner-Merkelt (2005), p. 118 ff.

[193] cf. Romeike (2003a), p. 236

[194] cf. Kremers (2002), p. 85

[195] cf. Hölscher (2002), p. 14

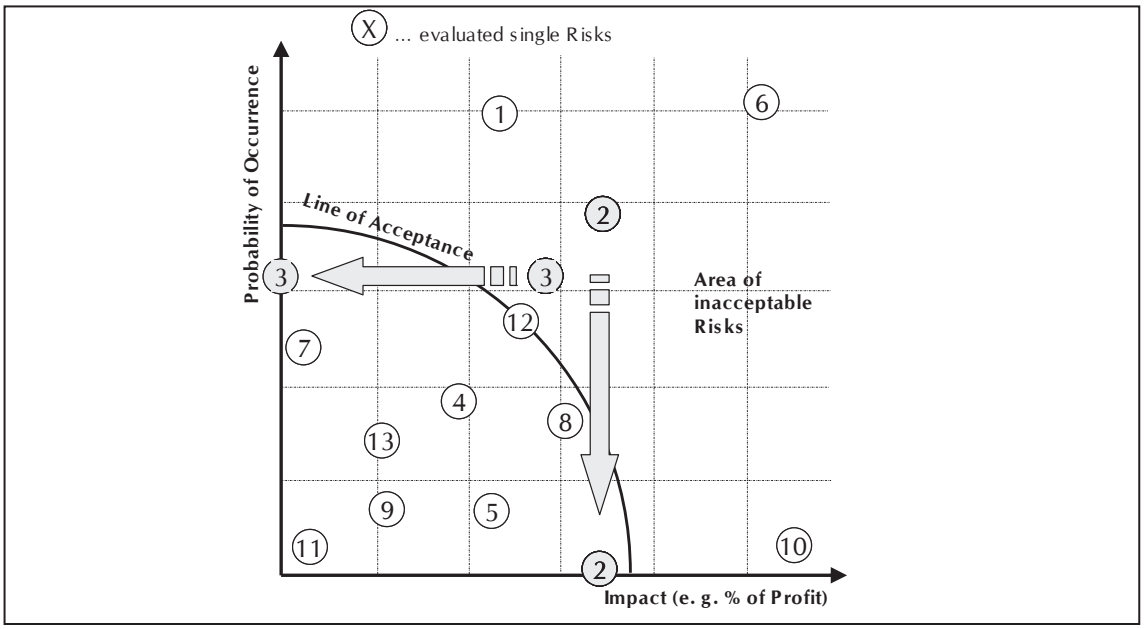

Fig. 3.11: Risk Treatment by Risk Avoidance[196]

The risk reduction (see fig. 3.12) focuses on the decrease of the occurrence probability and/or the impact to an acceptable level (below the line of acceptance). The reduction can be realised by personal (training, employee selection,…), technical (CO_2-extinguishing system, firewall, derivates,…) or organisational measures (process optimisation, introduction of quality management,…).[197] The measures influence either the probability component (e. g. the installation of a protective device at a machine) or the impact (e. g. the installation of a sprinkler system), the realisation of several measures may affect both. The risk reduction is adequate if the considered risks are threatening the profits instead and not the existence of an enterprise[198] and is preferable in comparison with the avoidance since the chances are conserved.[199]

[196] on the basis of Romeike (2003a), p. 237

[197] cf. Romeike (2003a), p. 237

[198] cf. Denk/Exner-Merkelt (2005), p. 120

[199] cf. Wolf/Runzheimer (2003), p. 90

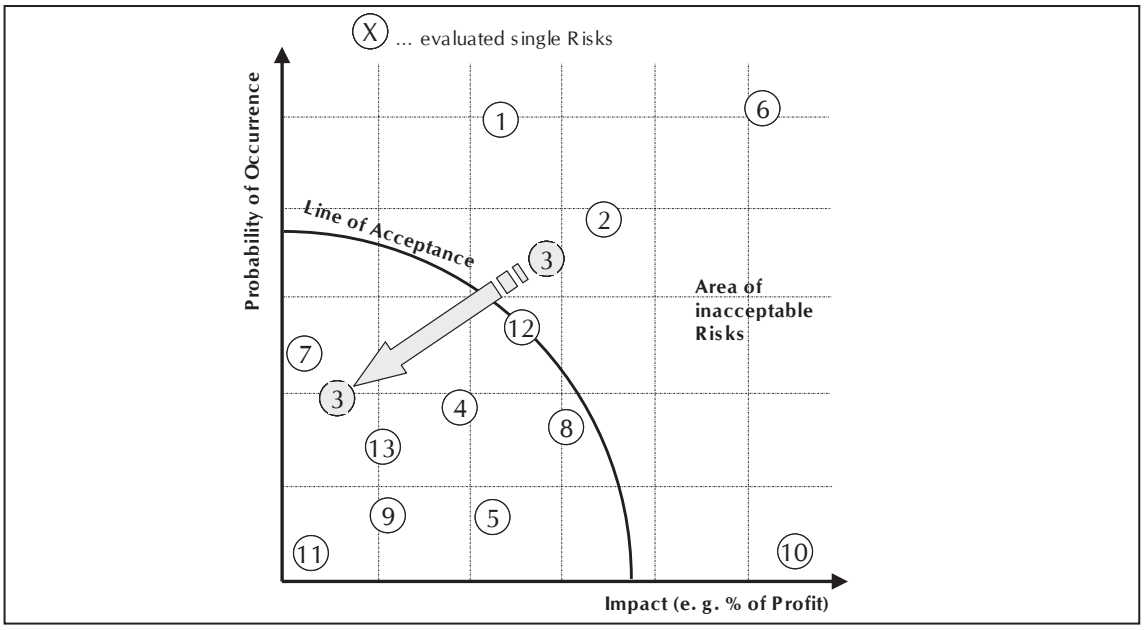

Fig. 3.12: Risk Treatment by Risk Reduction[200]

Especially in large-scale enterprises the risk diversification is an adequate measure to treat risks, which are independent from each other. Diversification represents the geographical, object or person oriented distribution of an inacceptable risk to split it in smaller parts (see fig. 3.13).[201] Thereby a risk collective is created in which the occurrence probability remains unchanged, but the impact is clearly reduced.[202] A geographical diversification is achieved by producing the same product at different locations for example. An object oriented diversification may mean to operate several of the same production lines. The person oriented diversification tries to avoid the loss of whole groups of persons, for instance by separately travelling board members.[203]

[200] on the basis of Romeike (2003a), p. 238

[201] cf. Denk/Exner-Merkelt (2005), p. 120

[202] cf. Hölscher (2002), p. 15

[203] cf. Hölscher (1999), p. 328 f.

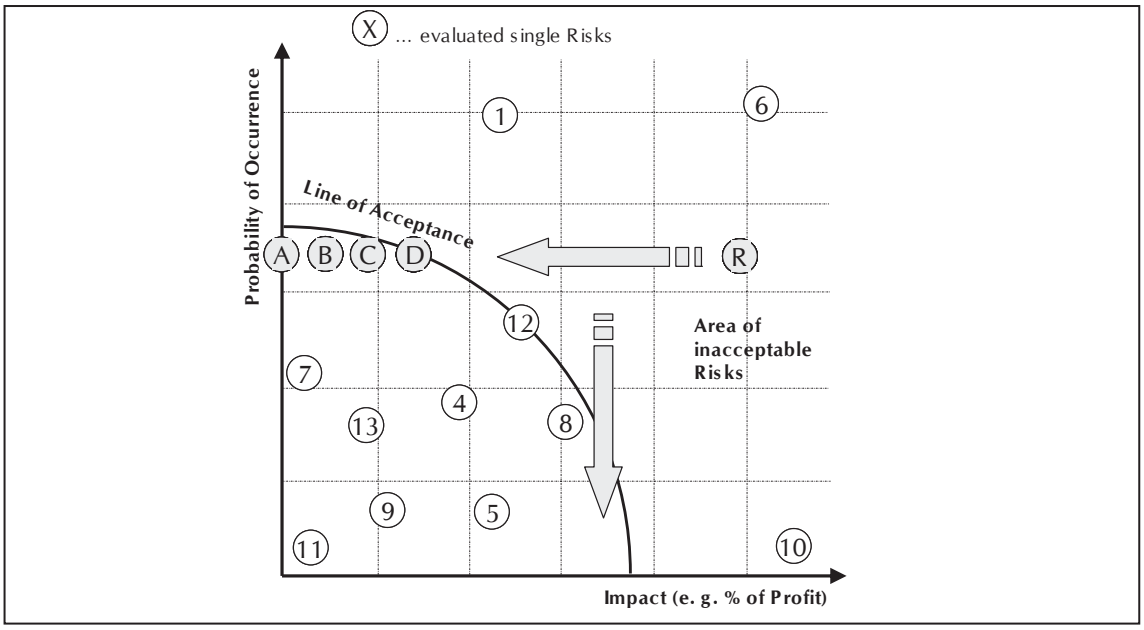

Fig. 3.13: Risk Treatment by Risk Diversification[204]

Risk Control

To ensure the efficiency of the risk management process the risk owner is responsible for the process accompanying control and the risk post processing in the risk control step. The control of the process should reduce mistakes and includes the following tasks:[205]

- To review if all occurred risks were known respectively if the risk identification was complete
- To reassess the risk evaluation by comparing the probability and impact of the occurred risks with the prognosis
- To control if the implemented measures for the risk treatment bring out the intended impact

Supportively the risk control can be conducted by the use of key risk indicators, which have an early warning effect regarding the development of the risk may indicate new measures for the risk treatment before a risk becomes effective. A set of key risk indicators represents a early warning system, which is primarily applicable for homogeneous risks. If the system is not applicable for special risks, where the risk sources are not measurable with indicators, then the risk management cycle including the identification and evaluation should be performed more frequently. For the key risk indicators (e. g. customer satisfaction, employee attitude, capacity utilisation, raw material price,…) tolerance limits are de-

[204] on the basis of Romeike (2003a), p. 239

[205] cf. Kremers (2002), p. 93

termined, which indicate a tighter risk situation if exceeded.[206] Since risk management does not aim at the complete avoidance of risks the occurrence of a risk is not automatically a deficiency of the risk management system. Only deviations from the planned risk situation may disclose a malfunction of the process and provide useful information for the improvement of the risk analysis. Also the planned occurrence of risks can deliver important information about the causal relationships of risks within the scope of post processing.[207]

3.3 Risk Consideration in the Strategic Management

By combining the introducing chapters about strategic management and risk management the definitions for strategic risks and the corresponding management term are derived. Afterwards the benefits of strategic risk management are contrasted with a generic management system to identify points of contact. Finally the basic concepts for strategic risk management are introduced. The meaning of strategic risks should be represented by the following quote: „You're insured and hedged against many risks – but not the greatest ones, the strategic risks, that can disrupt or even destroy your business."[208]

3.3.1 Definitions: Strategic Risk and Strategic Risk Management

Subsequently different definitions of strategic risks and their management are analysed and consolidated. Thereby the link between the contents of the introducing chapters of strategic management and risk management should become obvious.

Strategic Risk

Based on the general definition of risks the strategic component is integrated by considering the characteristics of the strategic levels. In the literature different definitions are published focussing on similar criteria. *Hinterhuber*[209] defines strategic risks besides insurable ones as risks, which may have an effect on the long-term and sustainable value creation of an enterprise. Next to the indication that not all strategic risks are insurable, the classification focuses on the success potentials and their endangering, but avoids mentioning potential impacts on the existence of the business.

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[206] cf. Denk/Exner-Merkelt (2005), p. 124

[207] cf. Kremers (2002), p. 93 f.

[208] cit. Slywotzky/Drzik (2005), p. 78

[209] cf. Hinterhuber (1998), p. 13

Schierenbeck and *Lister*[210] differentiate strategic risks from other ones in respect of their impact and the uncertainty of their evaluation. They point out the relevance of strategic risks for the long-term existence of a business and the inhered uncertainty due to the longer time horizon of strategic decisions and the associated environmental developments. Strategic risks are less clearly structured and it is more difficult to evaluate the probability of occurrence than for operative risks. Their classification of strategic risks is strongly related to uncertainty, so that the differentiation between uncertainty and risk as determined uncertainty is a little fuzzy.

Elfgen[211] describes strategic risks as those, which may weaken the market position and therefore the success potentials of an enterprise as well as its resources, which will endanger the future development of the business. The classification establishes a stronger context to the survival of a business and incorporates the market-based and resource-based view of the strategic management, but integrates the long-term view too.

In the view of *Denk* and *Exner-Merkelt*[212] strategic risks may influence the complete future cash-flow potential of a strategic asset, which already exists or the investment decision for it is in progress, respectively a whole strategy. Besides the extent of the risks, they can be distinguished as regards content too, since they focus on the strategy or structure of a business rather than on the objectives of a single accounting year or on single business transactions. Their definition considers symmetric risks and brings the contents into focus, nevertheless the risk impact and allusively the time horizon are criteria too.

Recapitulating, all definitions differentiate strategic risks by their long-term perspective respectively their impact on the business from operative risks. The potential impact ranges from the loss of the success potentials to the loss of the existence. The selected descriptions also indicate the different views of risks concerning their symmetry respectively their inhered chances.

Strategic Risk Management

The definition of strategic risk management is based on the adaption of the strategic level in the process of risk management. According to different scientific sources no common understanding of strategic risk management has been developed so far. The majority of definitions have at least the same focus, although some divergent definitions can be found. For instance *Romeike*[213] defines strategic risk management as integrative link and fundament of the risk management process. He sees its task in formulating the risk management objec-

[210] cf. Schierenbeck/Lister (2002), p. 184

[211] cf. Elfgen (2002), p. 207

[212] cf. Denk/Exner-Merkelt (2005), p. 145

[213] cf. Romeike (2003c), p. 147 f.

tives (risk policy) and determining the organisation (functions, responsibilities and information flow). The formulation of objectives is primarily based on the desired risk appetite respectively the ratio between risks and chances. The particularity of this definition is that strategic risk management is not understand as a risk consideration in the strategic management process but the strategic and partially normative level of the risk management system. The mention of this definition should demonstrate the varying views on this context, but it is not suitable for the purpose of the thesis in hand.

Hinterhuber[214] describes strategic risk management as "totality of tools for decisions and activities, with which an enterprise in a turbulent environment may protect itself from a risk or a crises". He highlights the management interventions in the decision process respectively by activities and premises a turbulent environment for the justification of a strategic risk management. The context to the strategic level is ensured by defining the risks to be analysed in this process as it is explained in the first paragraph of the last chapter.

Denk and *Exner-Merkelt*[215] circumscribe strategic risk management as an offensive supporting function of a value-creating leadership approach, which is anchored in strategy and structure creating and implementing processes and provided with instruments. Comparable with their definition of strategic risk the inhered chances are considered too and thereby the value-creating contribution is highlighted. The integration in processes, basically covered by the strategic management, is also an essential component of their discussion of the strategic risk management.

The most extensive and precise one of the selected definitions is that of *Elfgen*[216]. Basically the focus is on the integration of specific risk considerations into the strategic management process, where the risk management process is based on a different orientation and longer planning horizons. It should complement the strategic management by the obligatory application of specific instruments like multiple planning, scenario techniques and especially early warning systems. This description corresponds best to the conception, that strategic risk management is an adaption of the risk management for the complementation of strategic management by using other tools and extent the search for potentials respectively chances with the reflection of risks in certain steps of the strategic management process.

Recapitulating, excepting those of *Romeike*, in essence all definitions aim at the early recognition of strategic risks by complementing the strategic management process with specific tools of the risk management process in specific phases.

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[214] cit. Hinterhuber (1998), p. 13, transl.

[215] cf. Denk/Exner-Merkelt (2005), p. 143 ff.

[216] cf. Elfgen (2002), p. 207 f.

3.3.2 Necessity of Strategic Risk Management

Basically the drivers for strategic management are similar to those of the risk management already described in chapter 3.2.2, the changes in the business environment and legislation. Besides also the flexibility demanded in generic management systems respectively by the fast-paced developments requiring faster reaction times from the businesses are triggers for risk considerations in strategic thinking.

Representative for various holistic management concepts the generic management philosophy, developed at the Department of Economics and Business Management of the University of Leoben, is selected to derive the necessity of strategic risk management. The most relevant elements of the philosophy are the consideration of …

- a business as social system, requiring a cybernetic and self-reflexive leadership
- an organisation able to adapt and influence dynamic environmental conditions
- all stakeholders
- the organisational environment including the natural environment

The approach can be characterised by complexity treatment, adaption capability, anticipation capability, stakeholder orientation and the increase of enterprise value aligned with the vision of the enterprise. The primary goals can be visualised in a triangle (see fig. 3.14), representing the three essential aspects of a holistic management approach.[217]

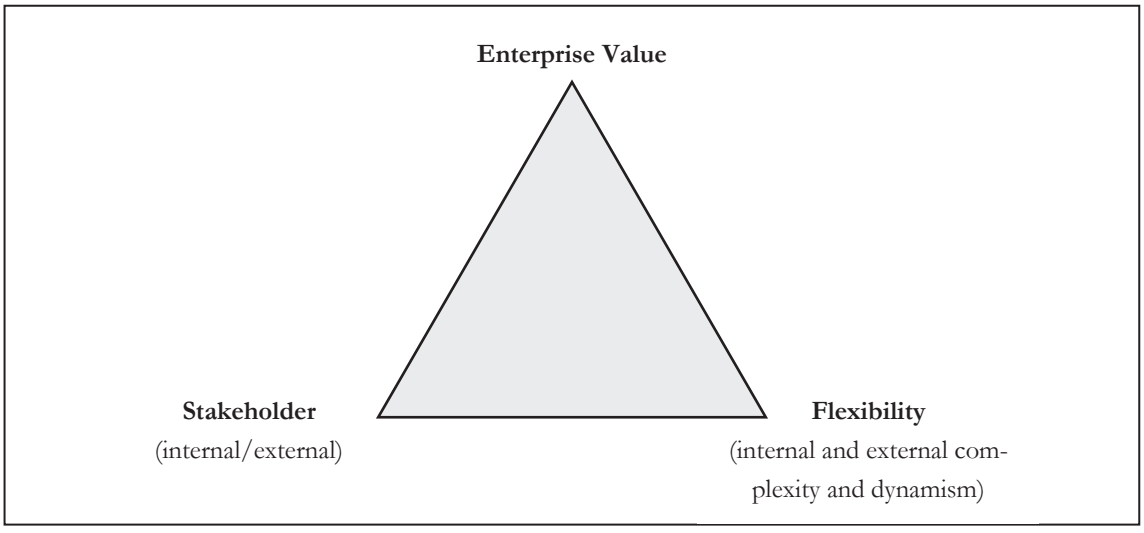

Fig. 3.14: Generic Management Philosophy[218]

[217] cf. Baumgartner et al. (2006), p. 16 f.

[218] Baumgartner et al. (2006), p. 17, transl.

The flexibility concerning internal and external complexity represents one of the three aspects of the generic management philosophy and is fundamental to achieve the requirements of the approach. Primarily flexibility should ensure the management of complexity, adaption capability and anticipation capability, but supports in a holistic view also the intensification of the stakeholder orientation and the increase of the enterprise value.[219]

Concerning to *Ulrich*[220] flexibility is equated with the capability of an enterprise to react and act aligned with the environmental developments. With increasing complexity and dynamism of the environment also the level uncertainty increases, which is involved in the entrepreneurial decisions. This circumstance, gaining more and more topicality, challenges the flexibility, especially the risk and crisis management in an enterprise. To meet the demand, an adequate management of complexity is necessary. In a dynamic view complexity is characterised by the amount of different states of a system and measured by its variety.

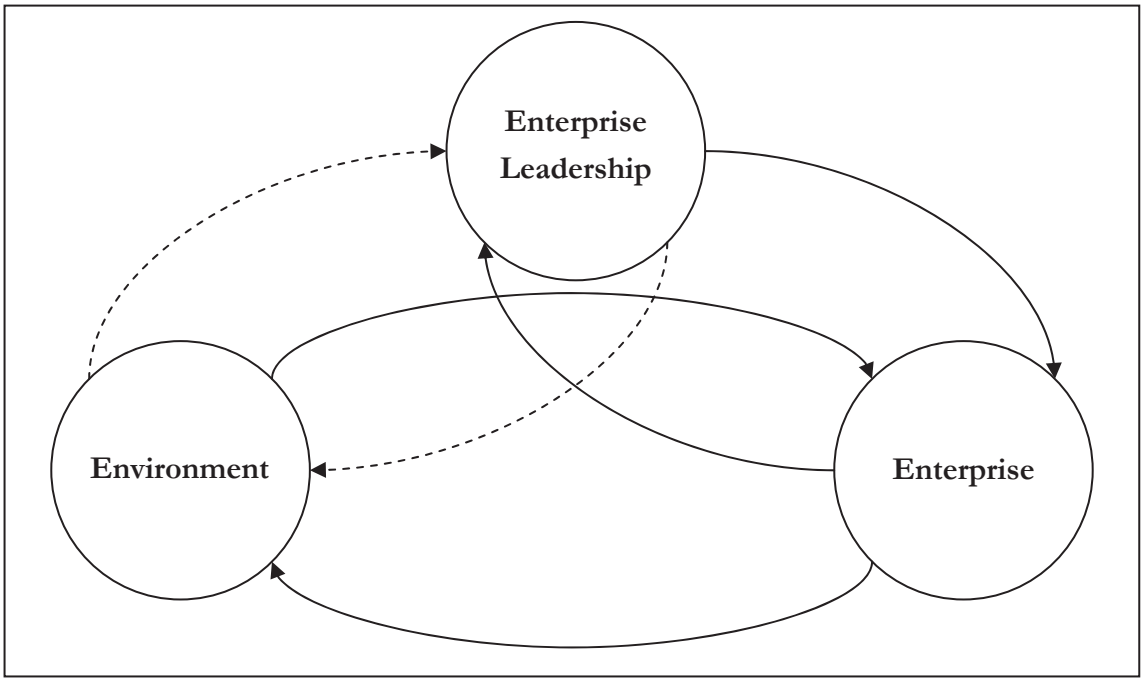

Fig. 3.15: Enterprise Leadership, Enterprise and Environment as Interacting Systems[221]

The enterprise leadership, also exposed to complexity, interacts with other systems affected by complexity, which can be divided in the enterprise itself and its environment in a broader sense (see fig. 3.15). This distinction is above all useful concerning the ability to influence by the enterprise leadership, since the influence of leadership on the enterprise is

[219] cf. Baumgartner et al. (2006), p. 16 f.

[220] cf. Ulrich (1978), p. 186 f.

[221] on the basis of Ulrich (1978), p. 188

incomparable stronger than that on the environment. The enterprise leadership has the opportunity to reduce the variety of the system enterprise by limiting the number of potential behaviour options (system states), whereby the not manageable variety of the environment counteracts this attempt.[222] According to the law of *Ashby*[223] the survivability of a system is determined by adapting its variety with those of the interacting systems. As a consequence the internal complexity of a system is has to be adjusted to the environmental developments. Considering the given situation of an instable environment the internal complexity has to be increased too and the required flexibility has to be ensured. The enterprise objectives can only be achieved by the creation of an adequate variety or have to be modified aligned with the environmental situation. The enterprise leadership itself, as an interacting component, tries to reduce variety by decisions. Very often models are used in the decision process, which are not able to represent the appropriate complexity. Especially exact, quantitative approaches are insufficiently suitable to consider the necessary changes of variety and to meet the environmental demands.[224]

To analyse flexibility internally the structural model of the generic management philosophy is applied, which concretises improvement potentials and makes them transparent. Thereby it is investigated specifically for each enterprise, how flexibility can be created regarding the aspects input (allocation of potential), process (production and services) and outcome. Basically, in doing so it is put into question, how the three mentioned aspects influence the flexibility and adaption capability and how flexibility and adaption capability can be improved in these areas. Concretely, for instance in the context of allocation of potentials, inflexible working time models, precise work instructions and functional trained specialists may cause negative effects on flexibility. On the other hand, decentralisation and diversification of suppliers may have a positive impact on the flexibility of a specific enterprise.[225]

As visualised in the time gap (see fig. 3.16), an enterprise faces not only the challenge to manage the required response time with an adequate degree of internal flexibility, but also to cope with the shorter and shorter available response time to the environmental dynamism. Both the dynamism and the complexity have grown enormously in the course of time and the gap between required and available response time is increasing. Just nowadays the economic and social developments get more and more volatile and are characterised by a accumulation of discontinuities and trend reversals. To extend the available response time it is necessary to anticipate environmental developments earlier and to use a pre-situational pattern of thought.[226]

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[222] cf. Ulrich (1978), p. 188 f.

[223] see Ashby (1970)

[224] cf. Ulrich (1978), p. 190 f.

[225] cf. Baumgartner et al. (2006), p. 24 ff.

[226] cf. Bleicher (1996), p. 38

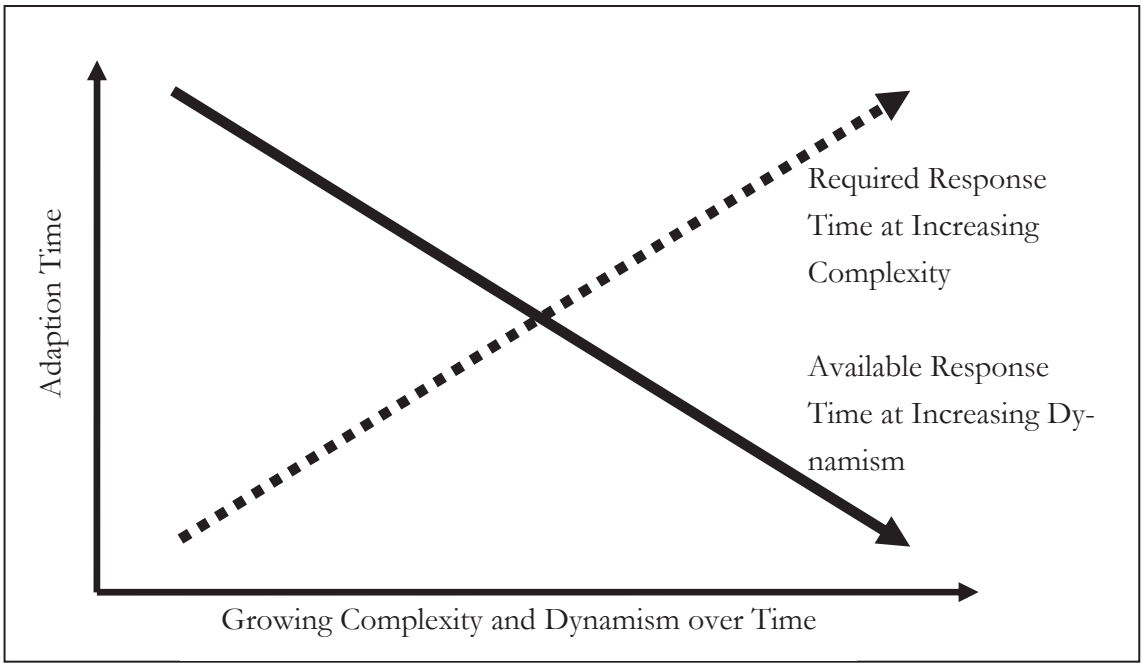

Fig. 3.16: Time Gap between Required and Available Response[227]

The demand for the alignment of internal and external complexity requires an early recognition of external changes. These changes are determined by the dynamism of the environment, which is defined by the change rate. The change rate alludes to the number of changes in enterprise objectives based on environmental dynamism in a specific time period.[228] The formulation of strategic objectives has to be dependent on the internal flexibility and modified corresponding to the external changes. Internal flexibility has only a restricted advantage if diverse external developments are not recognisable in time. Vice versa, an excellent strategic early warning system is senseless if an enterprise is not flexible enough to react on environmental discontinuities. The intensified uncertainty of the entrepreneurial environment creates the need to apply a strategic risk management system including less exact and quantitative methods in the decision process. Therefore strategic risk management represents the basis for the necessity to align the internal degree of flexibility and complexity with the external risks and opportunities by recognising them in time.[229]

The explained demand in the last paragraph is going along with an extension of the strategic thinking by early warning approaches, as demonstrated in figure 3.17, and originates from the continuous changes in the environment.[230] Rising competitive pressure, globalisation, shorter product lifecycles as well as ecological catastrophes are some examples for

[227] on the basis of Bleicher (1996), p. 39

[228] cf. Jurkovich (1974), p. 386

[229] cf. Frieß (2009)

[230] cf. Welge/Al-Laham (2001), p. 8 ff.

drivers of the environmental dynamism nowadays, which shows different impacts in different industries. To recognise and utilisation of new developments it is necessary to integrate early warning systems as complement or substitute for the conventional strategic planning approach. Therefore a change in the pattern of thinking is required, whereas the key contents are:[231]

- Instead of single-point-forecasts alternative developments and ranges are assumed.
- It is tried to recognise threats, risks and chances in time.
- The objective is the processing of information of all environmental areas in the planning, which are relevant for the enterprise.
- Unrealistic expectations are evaluated concerning their accurateness and their probability of occurrence. The meaning of forecasts is restricted to orientation purposes.

A first concept of strategic early warning is developed by *Ansoff* and discussed in chapter 3.3.4 after explaining early warning systems in general. He termed the concept „strategic issue analysis" complementary to the conventional strategic planning.[232]

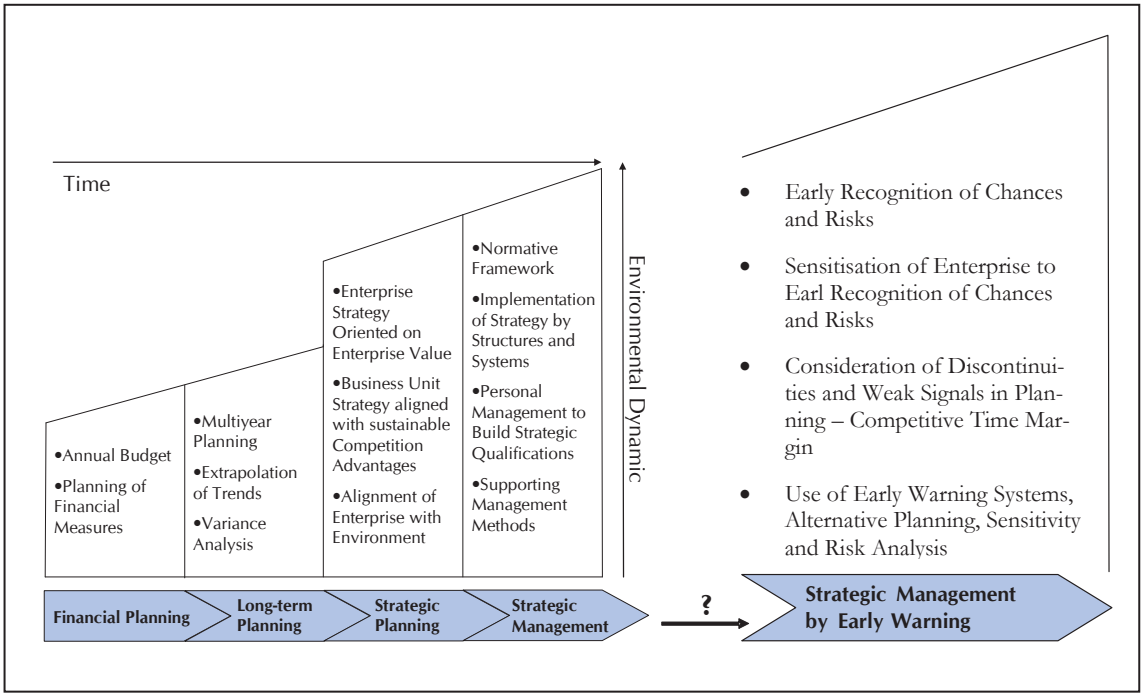

Fig. 3.17: Development of Strategic Thinking in the Context of Strategic Risk Management[233]

[231] cf. Kreilkamp (1987), p. 26

[232] see Ansoff (1976)

[233] on the basis of Gluck et al. (1980), Kreilkamp (1987) and Timmermann (1988)

3.3.3 Strategic Early Warning Systems

In this chapter the fundamentals of the previously mentioned strategic early warning systems should be described including the development of these systems in the course of time. Up to the conceptions known today early warning systems passed divers development phases (see fig. 3.18). The first generation was introduced in the seventies and was based on figures and projections. The warning of threats and risks, which endanger the survival of the enterprise, were brought into focus. In the course of time and the increasing environmental dynamism it was recognised, that the scanning for chances is essential to ensure the existence too. Therefore the early warning systems of the second generation also considered the search for chances and used different indicators for this purpose. The state-of-the-art strategic early warning systems of the third generation actually applied differ from the previous ones primarily by the extension of the process. In this context next to the evaluation of their relevance also measures for the prevention of and the reaction to the identified risks respectively chances are formulated.[234]

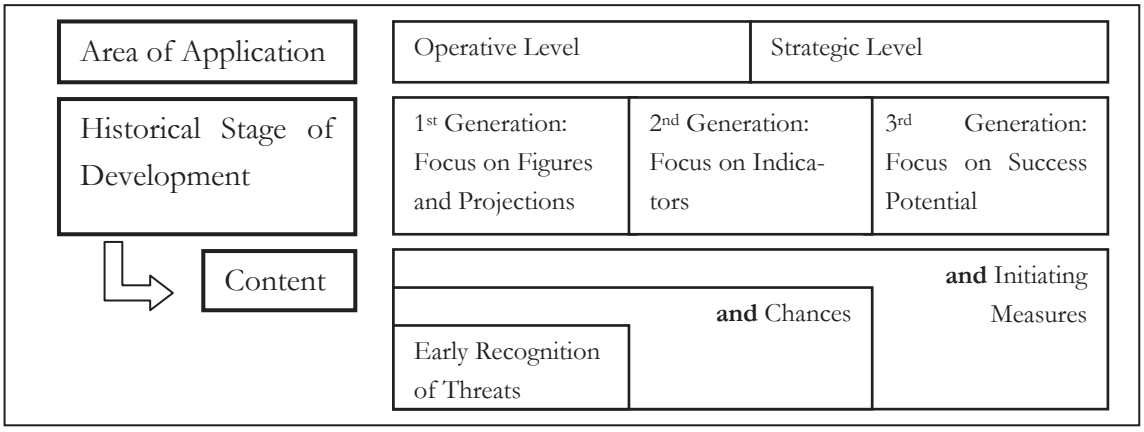

Fig. 3.18: Typology of Early Warning Systems[235]

Accordingly the expressiveness of the systems has been improved aligned with their advancement. Whereas systems of the first generation were applying projections based on past data and consequently were not qualified for prevention of crisis, they are not able to contribute to the early warning as it is understood nowadays. The second generation determines indicators, which should be capable to represent chances and threats for the enterprise and to control them continuously. Above all indicators are useable, which display changes of the performance metrics of an enterprise with an adequate lead time (e. g. number/volume of incoming orders as indicator for sales developments). The challenge con-

[234] cf. Krystek/Müller (1999), p. 178

[235] on the basis of Krystek/Müller-Stewens (1993), p. 26

cerning these systems is the definition of suitable early warning indicators. If the right indicators are found and monitored sufficiently, the concept may meet the requirements for strategic early warning in a relatively stable environment described by unambiguous causal relationships. In a more dynamic environment not only continuous changes are expected, but rather surprises, which are announced by discontinuities. To anticipate the unsteadiness of the external developments systems of the third generation are demanded. Basically it is assumed, that each discontinuity is announced by certain signals. Those are vague, not structured and are therefore named weak signals (see chap. 3.3.4).[236]

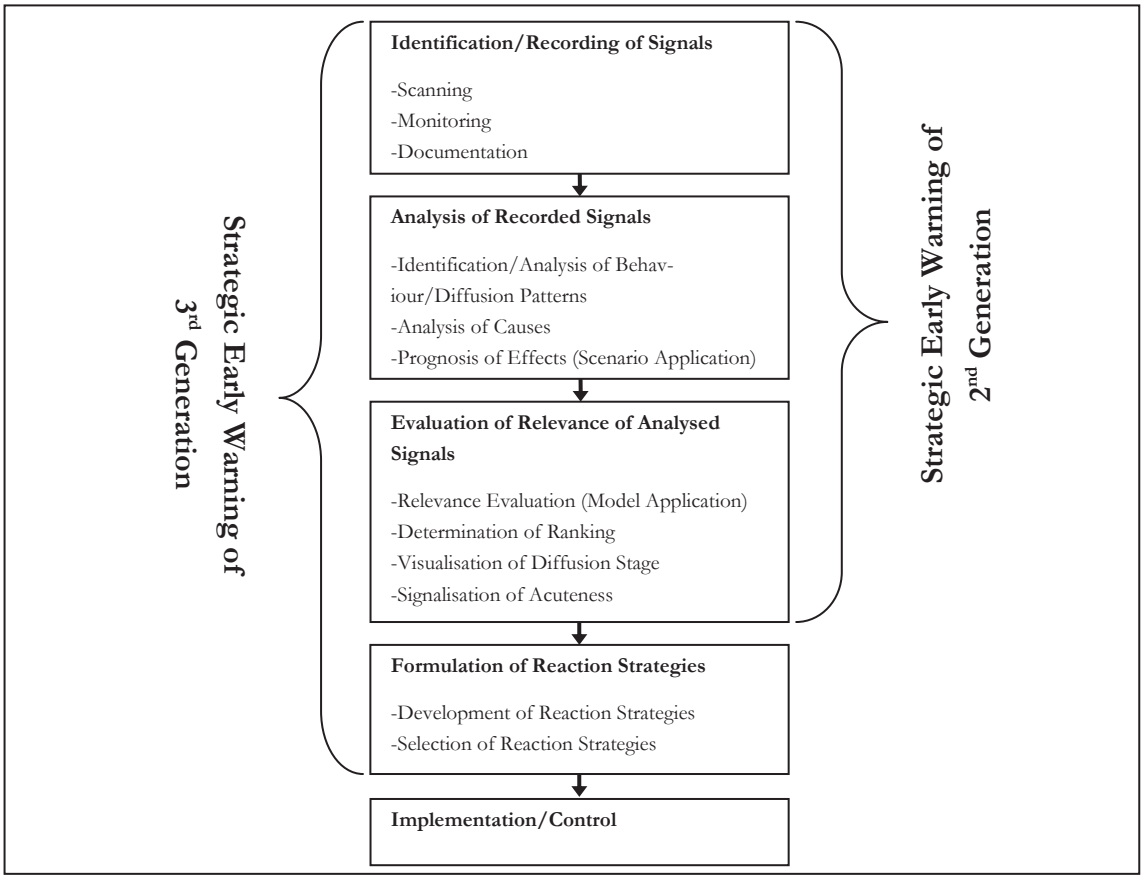

Fig. 3.19: Process of Strategic Early Warning Systems[237]

The general procedure of strategic early warning system is described by the process steps represented in figure 3.19. In the first phase the information acquisition as well as the scanning and monitoring for weak signals is in the focus. Scanning stands in this context for the undirected search for signals (e. g. newspapers, opinions of experts, …) with or without a reference to a certain topic. If signals are detected, they are examined closer by the moni-

[236] cf. Kreilkamp (1987), p. 258 ff.

[237] on the basis of Krystek/Müller (1999), p. 181

toring by considering information regarding the contents of the signals.[238] In the second phase the information sources are analysed concerning their diffusion patterns as wells as the causes and effects of the signals. The analysis of the effects results in the most cases in alternative development paths, whereby the scenario technique is recommended as a suitable tool for the analysis. Besides sensitivity analysis can be applied for giving information about the deviations of the output figures dependent on variations of input figures. Before reaction strategies for possible events are formulated, a prioritisation based on the evaluated strategic relevance for the enterprise is performed and results in the determination of the acuteness of measures.[239]

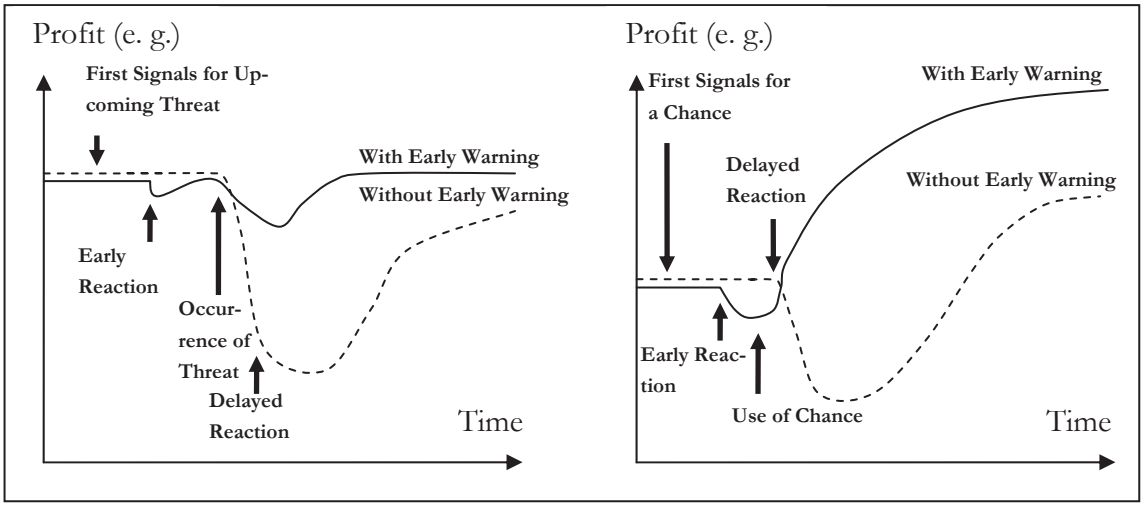

Fig. 3.20: Benefits of Early Warning Systems in Case of a Risk respectively a Chance[240]

Despite the usefulness of the application of strategic early warning systems in enterprises their distribution is limited in practice. In figure 3.20 the benefits of the concepts are visualised in case of a risk respectively a chance. The figure shows the profit development of two enterprises, one with and one without an early warning system, in the case of an occurring threat respectively chance. In the first example the enterprise with an early warning system is able to react earlier, whereby the necessary measures represent only a marginal impairment of the profit and after the occurrence of the threat only moderate and short-term profit setbacks are recognisable. The second enterprise reacts with a delay and has to expect higher and long-term losses. Also concerning the use of chances the prepared enterprise has a clear advantage since after a short profit impairment caused by the implementation of reaction measures an earlier and clearly stronger benefit is the result. The competi-

[238] cf. Müller-Stewens (1990), p. 200 f.

[239] cf. Wolf/Runzheimer (2003), p. 163

[240] on the basis of Rauscher (2004), p. 3 ff.

tor reacts once again with delay and is only able to make use of the chance at a later point of time and at a lower magnitude. Besides by the disadvantageous situation in comparison to the competitor also short-term profit reductions are possible.[241]

As already mentioned the implementation of strategic early warning systems in practice faces resistance in the most companies, which may be reasoned by the pitfalls of implementation perceived in organisations. An interrogation of 27 European companies and their 48 associated companies from the chemical sector showed that although 70% uses early warning systems, only 20% apply them on a strategic level. Early warning systems are consequently primarily used based on indicators and figures.[242] A case study identified six pitfalls which influence the acceptance in enterprises:[243]

- Wrong scenarios as a basis: Constructed scenarios do not represent alternative pictures of the future as intended by this method, but only consider favourable trends for the enterprise instead of changing the mental models of the constructors.
- The lonely manager: The responsible manager does not push the interaction with other experts like the strategists as the addressee in effect, therefore only on perspective is considered.
- Scenarios limit scanning and monitoring: The scanning and monitoring activities are concentrated on the areas within the borders defined by the scenario instead of representing radars in all directions of the environment.
- No unique understanding of trends: The search for trends or weak signals fails due to misunderstandings, so that the recognition is much too late (e. g. already a mass phenomenon or a product is already launched by a competitor).
- The quantitative temptation: Since weak signals are "soft data" they are often ignored due to the fact, that they are verifiable by figures and prognosis.
- Organisational early warning disability: The enterprise culture has to accept, that it is more important to understand the origin of trends and that the results are never certain or verifiable.

Recapitulating, the most challenging fact is, that the managers and deciders respectively the organisation have to accept relying on a method, which will not forecast future developments but will help to be prepared for various situations or discontinuities.

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[241] cf. Rauscher (2004), p. 2 ff.

[242] cf. Herzhoff (2004), p. 189

[243] cf. Schwarz (2005), p. 26 ff.

3.3.4 Strategic Issue Analysis

Nearly all studies concerning strategic early warning systems are based on the concept of weak signals designed by *Ansoff* [244]. The concept is operationalised by the strategic issue analysis and broadly accepted, since it tries to recommend time points of each type of reaction. The procedure to identify and treat weak signals should be discussed subsequently.

The initiation point of the concept is the information problem of the conventional strategic planning approach. On the one hand the information has to be forecasted in a reliable manner to gain time for responses of the organisations and on the other hand the impact of changes must be known to select an adequate type of response. In unstable environments this approach is doomed to failure due to the missing time for planning and implementing responses and the acceleration of environmental changes respectively the appearance of potential surprises. Under these conditions the required information should not be derived from a priori decisions as in the strategic planning approach but the decisions should represent responses to the available information as intended by the strategic issue management.

The fundamental differences between strategic issue management and conventional strategic planning are:[245]

- Consideration of potential discontinuities instead of the total strategic future of the business
- Consideration of discontinuities from all areas instead of a concentration on product, market and technology
- Adequacy for a desired protection against surprises instead for a desired strategic reorientation
- Reaction on weak instead of strong signals
- Decisions are based on available information instead of deriving the information demand from the taken decisions
- Continuous process instead of periodical application
- Focused on the problem instead on the organisation

As already indicated the strategic issue management approach can be applied alternatively or complementarily to the strategic planning. *Ansoff* recommends that enterprises in a surprise-free environment and with an unsatisfying strategic future should rely on strategic planning. In the case of satisfying strategic trends in a turbulent environment the issue management should be applied. The combination of both approaches is recommendable if

[244] cf. Ansoff (1976), p. 133

[245] cf. Ansoff (1976), p. 150

the enterprise is confronted with both problems.[246] Subsequently the methodology to implement the concept is described.

Starting with the fundamental premise, that discontinuities never occur without being announced by weak signals, *Ansoff* formulated states of ignorance. Dependent on the level of ignorance concerning a signal the information content regarding the impact on the enterprise can be determined. At the beginning there is only a sense of a threat respectively an opportunity, which should lead to the conviction, that discontinuities are imminent. In the next state the source of the signal (e. g. policy, legislation, …) is already known, by which information about the area to monitor is available. If the risk or the opportunity can be concretised, the type, the potential impact and the time of occurrence can be estimated. In the next step response possibilities can be determined (e. g. time point, activity, programs, budgets, …) since the types of response alternatives become apparent. At the end the result of the event is known and information about impacts on profit and consequences of the response are computable.[247]

The state of ignorance concerning the content of the signals is confronted with defined internal and external response alternatives to determine the time point and the type of reaction for the enterprise (see fig. 3.21). As potential response strategies *Ansoff* differentiated between direct actions, flexibility and information awareness in internal and external response areas. Direct external actions are for instance the entry in new markets, risk share with other enterprises or to secure supply of scare resources and an internal action would be the acquisition of technology or skills. External flexibility can be reached by balancing product lifecycles or the diversification of economic, technological or political risks and internal flexibility with alternative planning or resource liquidity for example. The information awareness is implemented by the application of tools like environmental monitoring (external) or value analysis (internal).[248] This procedure ensures the identification of discontinuities in time and simultaneous the preparation of adequate response strategies as well as the determination of corresponding activities saving time for responding to the signal. In other words, the required time for an organisational response decreases and the available time to respond increase due to the prior awareness of the discontinuity.

[246] cf. Ansoff (1976), p. 150

[247] cf. Ansoff (1976), p. 134 f.

[248] cf. Ansoff (1976), p. 136 ff.

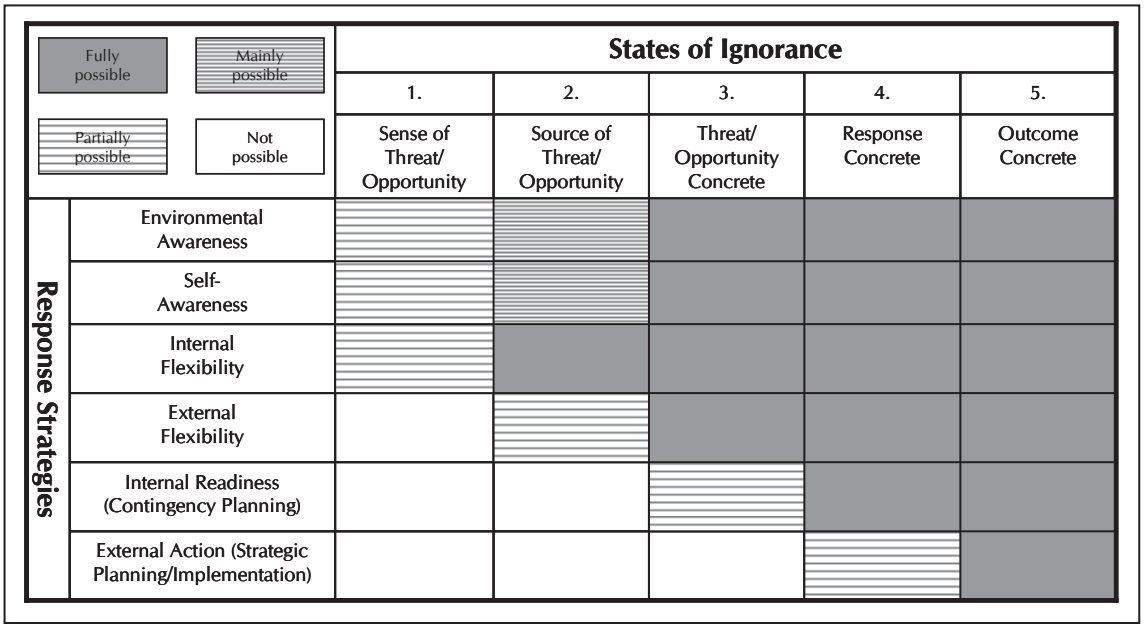

Fig. 3.21: Feasible Ranges of Response Strategies[249]

Problems corresponding to the application of the concepts occur primarily in the context of the definition of weak signals and their differentiation from strong signals, which induce a discontinuity immediately. If a weak signal is once identified, the next problem is the uncertainty, if it leads to better decision-making. Here understanding has to be created, that these signals will not forecast the future, but are only a basis for the preparation of alternative plans and response measures. Additional there are difficulties to achieve an enterprise-wide participation in the scanning for signals. If early warning systems are used in praxis, then the implementation is committed to externals or staff positions in the most cases.[250] Other problems within the scope of implementation occur, if the staff is not sensitised to the concept since the success respectively the quality is dependent on the ability and readiness of the employees to observe and interpret weak signals and use them as basis for decisions. Other disadvantages are the missing direct compulsion to act and problems with the evaluation of the success of the approach.[251]

[249] on the basis of Ansoff (1976), p. 141

[250] cf. Müller (1987), p. 4

[251] cf. Bea/Haas (1994), p. 489

3.4 Implications for the Thesis

Chapter 3 combines the theoretical input from two management approaches, the strategic management and the risk management, to define strategic risk management and puts it in the context of the research questions.

Before risks are associated with the strategic development the strategic level including the management process is discussed to define and classify the object at risk. Primarily the long-term horizon and the associated uncertain character of strategic decisions should be highlighted in this context. Additionally it is important to understand how of a business strategy arises whereas alone by the existence of ten different schools of strategic thinking the missing of uniquely defined structures for the development process is demonstrated. The strategy content is driven by success factors ensuring the long-term existence of an enterprise which should be preserved consequently. Besides the different views of strategic management discloses the significance of the decisions which concern the resource base and/or the position in the market. In conclusions the strategic level is primarily characterised by the impact and the long-term validity of the decisions.

The strategic behaviour is also dependent on the business environment since the field of action for an enterprise is restricted by the environmental developments. For this purpose different classifications of the business environment are analysed and a link to the strategic behaviour is established. More turbulence creates the demand for more analysis and an increasing uncertainty triggers the scanning activities and changes the strategic patterns. The key message for the thesis is the application of emergent strategies and strategic issue management in turbulent times instead or as a complementation to the conventional planning approach.

A general view on risk management is also content of the chapter to adapt it to the strategic level. After the definition of terms and the classification of uncertainty it is also evident that next to the legal requirements the more and more turbulent environment is a driver for risk management in general. The holistic risk management process including the identification, evaluation, treatment and control of risks discloses where that the thesis contributes to the identification and evaluation (risk analysis) and which complementing steps are recommended.

Finally the definitions and contents of strategic and risk management are opposed to get an understanding of the strategic risk management and the impact and long-term threat originating from the risks. Additionally the significance in the context of a generic management system is described to highlight possibilities for the integration of strategic risk management. The basic concepts to handle the tasks are introduced to understand their development, contents, usability and the ideas behind representing a framework for the subsequent chapters.

4 Methods and Instruments of Strategic Early Warning Systems

When facing a problem to solve, in various subjects it is recommended to apply methods and instruments to overcome this task in a systematic manner and as a preparation for subsequent decisions. Selected methods and instruments aligned with the concept of weak signals are content of this chapter. Per definition instruments are the systematisation of a special procedure for the solution of a concrete demand and methods are a bundle of instruments, which are applied mostly in sequence and complement one another to solve the demand.[252] Their application depends on the different requirements of the company or the situation, therefore strategic early warning systems do not dictate the use of a specific method or instrument. In figure 4.1 the most common methods are assigned to the steps of early warning, whereas the scenario technique represents the most powerful, holistic and applied method of those und partially uses the other instruments too. Since each of the steps in strategic early warning systems represents another specific demand, different methods and tools are recommended in literature.

As visualised some methods and instruments are able to fulfil the demands of more than one step in the early warning process. The scenario technique supports the identification of signals directed to a chosen subject, analyses it by creating causal relationships, considers occasionally the impact of discontinuities and provides a basis for the evaluation of the impact on the enterprise. By the intensification of weak signals as an extension of the portfolio analysis uncertainties concerning the position of the business are considered. The investigation of diffusion processes is a way to indentify and visualise the stages of weak signals. The analysis of the diffusion behaviour allows prognosis of further developments and by visualising the diffusion stages the acuteness of actions can be determined. The discontinuity interrogation identifies, analyses and evaluates potential events which may result in a risk for the business. The cross-impact analysis focuses on the visualisation of causal relationships and on the assessment of the impact of the consequences. The vulnerability analysis aims especially on the estimation of the harmful impact on respectively the opportunity to the business.[253] The methods and instruments are discussed in detail further on with a special bias on the holistic scenario approach.

[252] cf. Klügl (2005), p. 94

[253] see also Kreilkamp (1987), p. 276 ff.

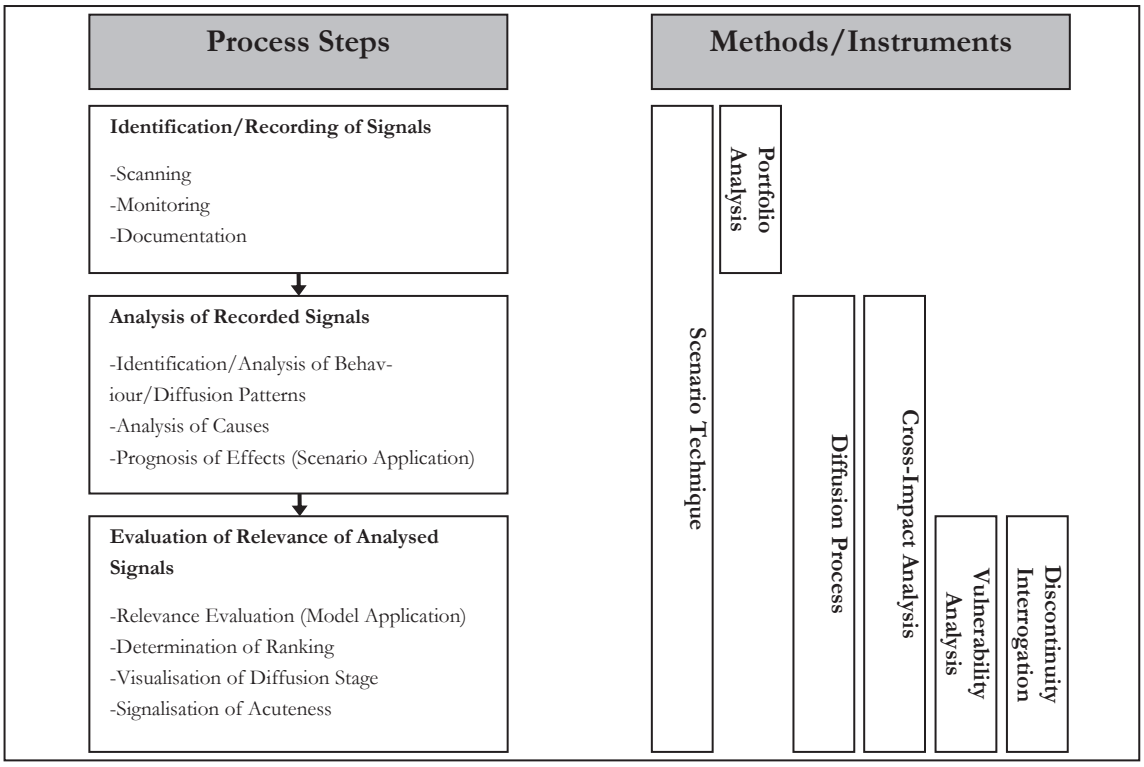

Fig. 4.1: Selected Methods and Instruments for Strategic Early Warning Systems[254]

4.1 Strategic Early Warning with Scenario Technique

Besides the concept of weak signals the scenario technique is the most significant method for strategic early warning systems. For example 43% of European companies in the chemical sector apply different forms of the scenario technique, especially the larger ones.[255] If the two concepts are compared the strategic issue management is primarily responsible for undirected search for environmental changes, whereas the decisions should be made dependent on the available information and the sensitisation of the enterprise for weak signals is essential. The scenario technique on the other hand is based on system thinking and opposes the object of investigation relevant for the business to the external developments. The described characteristics of both concepts make the complementary application of the two concepts apparent. While the concept of weak signals searches for discontinuities in the environment, the found information can be interpreted and the consequences analysed by means of the scenario technique. As a result the competencies of the business can be reflected on the environmental demands.[256]

[254] on the basis of Krystek/Müller (1999), p. 181; Kreilkamp (1987), p. 276 ff.

[255] cf. Herzhoff (2004), p. 162 ff.

[256] cf. Bea/Haas (1994), p. 490 f.

4.1.1 Characteristics of Scenarios

Gausemeier et al.[257] define scenarios as possible future pictures, whose occurrence is not predictable with certainty. It is based less on prognoses, but primarily on projections and predictions. Besides it is a complex picture of the future since it is based on potential developments of several influencing variables, which are linked to each other. A more application-oriented definition originates from *Reibnitz*[258], who defines a scenario as the description of a future situation and the development respectively the visualisation of the way, which leads from today to the future. Further on the scenario method is a technique to plan, which creates normally two considerably varying, but consistent scenarios and derives the consequences for the enterprise, the area or a single person.

The first definition emphasises the existence of uncertainty regarding future developments and the character of scenarios to represent an alternative to conventional prognosis, which are not able to overcome uncertainty. Besides it covers another significant aspect of scenarios: the ability to implicate the underlying variables as an interacting system. The second definition is a complement covering the objects of investigation: the description of specific time points in the future and subsequently of the potential ways representing the developments necessary to achieve the situation at this point. Both together are describing the fundamental assumptions and the procedure to get an overall understanding for scenarios.

Nevertheless the most definitions of scenarios aim at the description of its characteristics, which are summarised by *Götze*[259]. According to that a scenario…

- represents a hypothetical future picture of the socio-economic area and the development path to this picture.
- indicates in combination with other scenarios a scope for potential future developments of the investigated area.
- is created systematically and transparently as wells as under consideration of the development of several factors and the interrelationships between them and is therefore plausible and consistent.
- contains quantitative and qualitative statements, which build a formulated text.
- serves as an orientation concerning future developments and/or the decision preparation.

The most of the mentioned characteristics appear in different dimensions in certain scenarios. The first three characteristics are visualised in figure 3.23 including the potential future

[257] Gausemeier et al. (1996), p. 90

[258] von Reibnitz (1991), p. 14

[259] cf. Götze (1991), p. 38 f.

pictures and the potential paths to this situations in the course of time. Since the influence of the initial time point is decreasing with time the potential developments are extended in the form of a cone. Especially in the case of discontinuities the initial conditions may loose their impact in the future. In the figure two basic scenarios (A and B) are shown, whereas a discontinuity will lead to a deviation resulting in scenario C or D, dependent on the initiation of counteractive measures. The outer lines of the cone represent the extreme scenarios.[260]

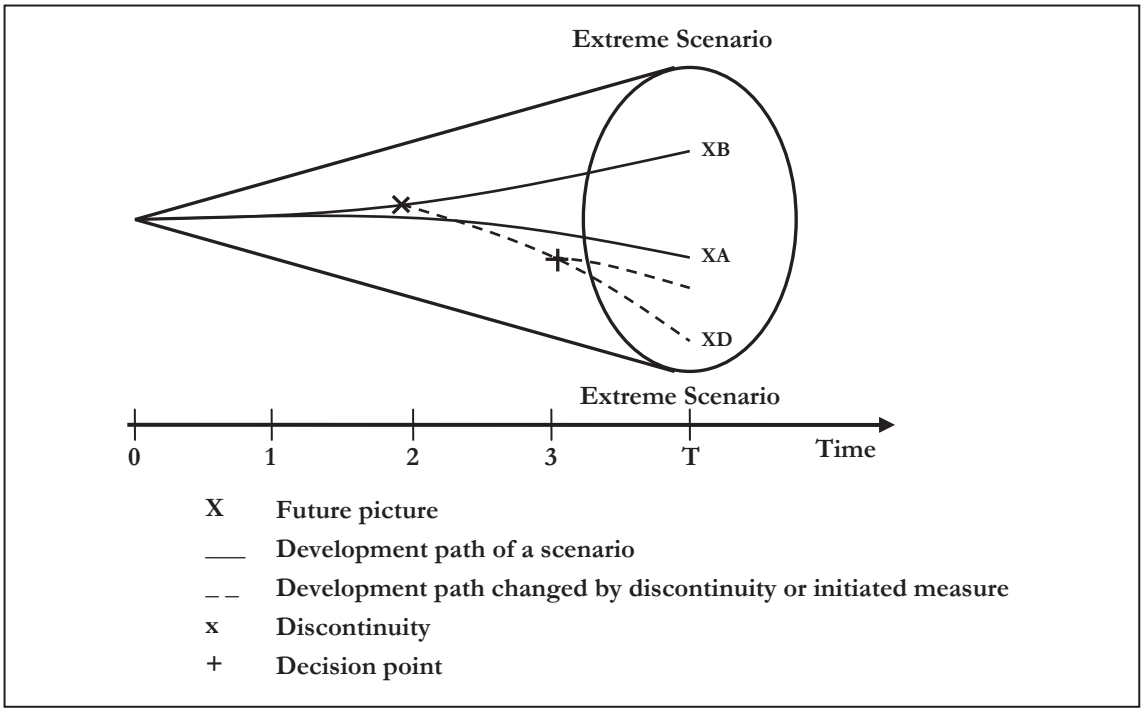

Fig. 4.2: Cone for the Scenario Characterisation[261]

Scenarios represent a way of thinking, in which alternative developments of the future are available to avoid the problem of the inability to prognosticate the future exactly. Since the environment is more and more dynamic and complicated, the future must be described by complex pictures instead of simple systems. To meet this concerns scenario thinking is based on the theory of multiple futures and system thinking.[262]

The consideration of multiple futures is the first fundamental assumption of the scenario method. In times of stable growth and surplus demand businesses have an one-dimensional goal to grow, which corresponds to more or less certain future. If markets

[260] cf. Götze (1991), p. 39 f.

[261] on the basis of Geschka/Reibnitz (1986), p. 129

[262] cf. Gausemeier et al. (1996), p. 83

become saturated, competition is growing, product lifecycles become shorter and customers discriminating businesses have to adapt their objectives aligned with the changing environmental conditions. In history the first reactions on these developments was the attempt to prognosticate the future. Increasing dynamism and uncertainty resulted in a rising number of false prognosis which disclosed that prognosis are no longer adequate for planning purposes. The demand to consider multiple futures was rising, but in practice the extrapolation of trends was still more popular in long-term planning. The lack of acceptance was reasoned by the inability to forecast the future exactly and the requirement to prepare for potential situations, which may never occur. Multiple futures are visualised in a cone (see fig. 4.2) whereas all possible future situations in the considered future horizon build the future scope.

The second fundamental approach of scenario management is the theory of system thinking. In the sixties businesses were more or less independent on their global environment, they only focussed on themselves. The change from the seller to the customer market in the next decade demanded a higher flexibility, which was determined by environmental factors. The development of enterprises was since then dependent on the development of cities, the environment, the technology or the society. The consideration of the business and its environment as holistic system is influenced by the increasing variety of entrepreneurial activities on the one hand and the rising external dynamism on the other hand. The combination of variety and dynamism is known as complexity, which can only be handled by system thinking. The different elements of the total system are not in a mono-causal relationship, but have to be considered as a network which corresponds to the idea of system thinking. To gather information for decisions it is crucial to identify the key drivers and the key indicators in the system.[263] The development from prognosis to scenarios incorporating system thinking and multiple futures is shown in figure 4.3.

The area of application for scenarios covers primarily global or business specific issues but the investigation of future perspectives for individuals is also possible. Global scenarios are mostly created on behalf of associations, governments or other (inter)national institutions and consider the future of the whole world. Popular objects of investigation are industrial sectors, technology or social concerns. Enterprise specific scenarios have a more limited scope and focus on the environmental perspectives in the view of the own business, whereas overlaps by content with global scenarios are possible or even desirable. Both types can be linked by consulting the statements of global scenarios for the business scenarios for example. Contents of enterprise specific scenarios may be economic growth, inflation, employment, exchange rates, availability of energy and raw materials, technologi-

[263] cf. Gausemeier et al. (1996), p. 83 ff.

cal changes as well as developments of the social and political area.[264] When considering the mentioned objects of investigation similarities to global concerns become obvious.

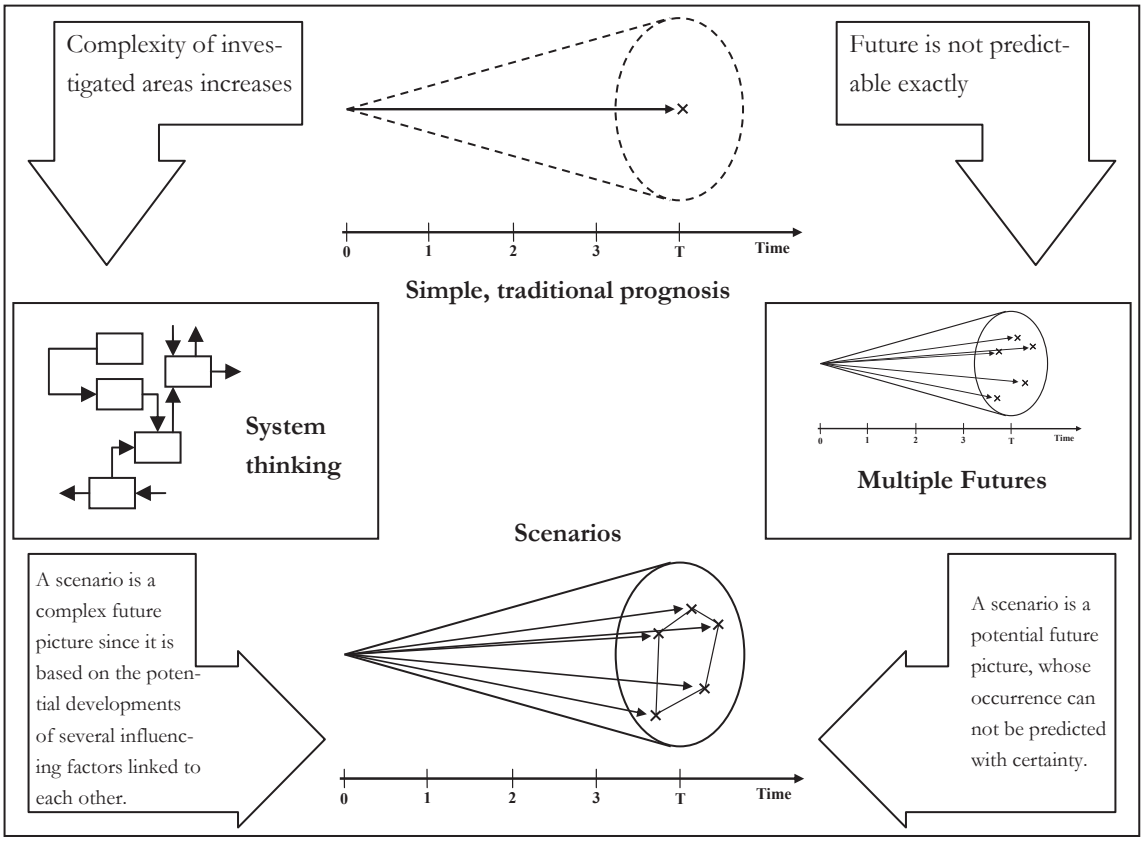

Fig. 4.3: Scenarios as an Advancement of Linear Prognosis[265]

The primary function of enterprise specific scenarios is providing information about the future within strategic as well as operative planning. Nevertheless the contribution to the strategic planning in research and development, innovation, diversification, acquisitions, locations, products, investments, finances or other is at the fore. Herein the analysis of potential future developments resulting in the investigation of the relationships of the environment and the business offers relevant fundamentals for the single phases of the strategic planning process. Scenarios are used to indentify new objectives or problems or to create alternative strategies. Scenarios may disclose discontinuities incorporated in the strategy formulation. By assessing the impacts of scenarios alternative strategies can be evaluated or existing strategies respectively the premises for those examined. In general a scenario is also applied as an early warning system for the strategic planning. Additionally scenarios are used as instruments for learning and communication. The learning effect is reasoned by the

[264] cf. Götze (1991), p. 41 ff.

[265] on the basis of Gausemeier et al. (1996), p. 91

knowledge transfer within the scenario creation in teams consisting of experts from different departments, whereas creativity for new ideas and potential developments is triggered and a better understanding of the environment and uncertainty is created.[266]

4.1.2 Development of the Scenario Technique

The term "scenario" (see fig. 4.4 to follow the development) was first mentioned by the futurologist *Kahn*[267] in the fifties as a member of the RAND corporation, an institute of the American Department of Defence. He worked on war planning and investigated different outcomes for alternative paths (e. g. consequences of a nuclear war). He criticised the conventional military planning for considering rather wishes than reasonable expectations und recommended therefore the application of scenario planning. In the beginning of the sixties *Kahn* changed to the Hudson Institute, where he introduced the scenario writing together with *Wiener*[268]. For the first time a method for the scenario creation was presented and scenarios were described as a hypothetical sequence of events disclosing potential developments. The transfer of scenarios to business management was the next step, whereas they are already used as business planning tool. General Electric (GE) conducted the first major scenario project resulting in four alternatives for the US economic and social-political environment. Besides the efforts of the Stanford Research Institute (SRI) also Royal Dutch Shell started to create business scenarios, whereas especially the scenarios of the latter organisation where exemplary for the benefit of scenarios.[269]

The development of scenarios with Royal Dutch Shell (RDS) is driven by *Wack*[270] in the beginning of the seventies. RDS was not only a pioneer in using scenarios, but their superior performance due to application of scenarios also attracted attention to this method. RDS was the only oil company which was prepared for the oil price crises in the seventies and thereby the former weakest one ("ugly sister") of the so called seven sisters (BP, Exxon, Mobil, Chevron, Texaco, Gulf and Shell) developed itself to the world's leading oil company until its profit collapsed in the nineties.[271] *Wack* was able to predict the skyrocketing oil prices of the first oil crisis in 1973 since he recognised the weak signals for a supply shortage and for the political interventions of oil producers to make use of the shortage to increase prices. As a consequence RDS was made aware that a crisis will occur, but they did

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[266] cf. Götze (1991), p. 49 ff.

[267] see Kahn (1960); Kahn/Wiener (1968)

[268] see Kahn/Wiener (1968)

[269] cf. Millett (2003), p. 17 f.

[270] see Wack (1985a), Wack (1985b)

[271] cf. Boyle (2002), p. 11 ff.

not know the time point of occurrence.[272] The first scenarios of RDS were based on unweighted alternative variables and were aimed at generating a different understanding instead of the preparation of measures. Later on more sophisticated scenarios were developed with a detailed investigation of the potential behaviour of oil producer and consumer. The scenarios were not accepted by the deciders in the first attempt to integrate them into strategic planning. As a consequence so called phantom scenarios were created based on the actual assumptions and the deciders were persuaded that these are not realistic in the future. The conviction of a forthcoming oil crisis was conveyed to the deciders in this way. The exploration and production departments were prepared for loosing concessions and production rates and the refining, transport and marketing units for a slow down of economic growth. As the oil crisis occurred in 1973 RDS was prepared and came back to their well prepared alternative strategies during other oil companies just started with crisis management. The result was the gain of competitive advantage and the superior performance of RDS in the forthcoming decades.[273]

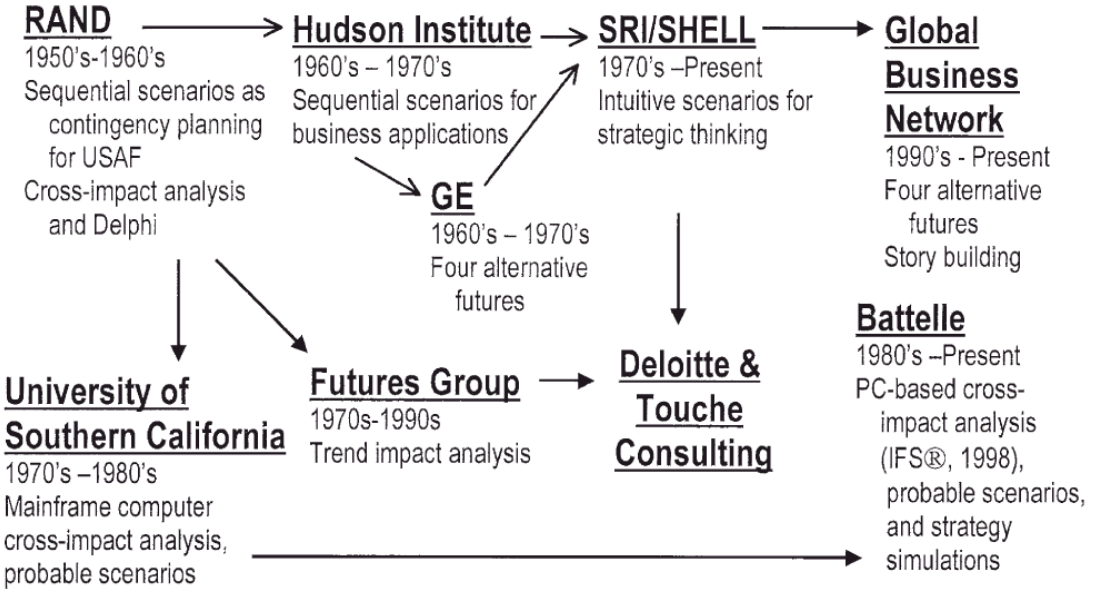

Fig. 4.4: The History of Business Scenarios[274]

A parallel stream of development starting in the seventies and initiated by two former RAND employees focussed on the analytical rigour. In contrast to the development mentioned above, whereas discontinuities where seen as starting point for the learning process, the second approach primarily investigated tools for expert judgement and cross-impact

[272] cf. Wack (1996) p. 413 ff.

[273] cf. Wack (1986a)

[274] Millett (2003), p. 17

analysis. The path resulted in the support of the scenario method by software programs like the "BASICS" of Battelle. Herein scenarios are not based on intuition and creativity but on calculations including cross-impact analysis, modelling and simulation of scenarios.[275]

4.1.3 Types of Scenarios

Typologies of methods are necessary for their communication, understanding, comparison and development. Especially in the field of scenarios various typologies are available from different sources. For example, *Börjeson et al.*[276] classify scenarios in a broader sense and include forecasts in their typology (see fig. 4.5), although they are strictly distinguished from scenarios in the conventional definitions. Their typology is the result of a holistic classification of typologies of several authors. The three categories should answer specific answers about the future: predictive scenarios (What will happen?), explorative scenarios (What can happen?) and normative scenarios (How can a specific target be reached?).

Predictive scenarios are mainly based on the concepts of probability and likelihood and try to predict future developments. They are aimed at the adaption of expected situations and consider them in the planning approach. The laws of the considered system are assumed to maintain over a period of time and historical data is primarily used to construct these scenarios focussing on the causalities within the system. The two types of this category are forecasts and what-if scenarios. Forecasts target at determining the most likely future developments and may be completed by a span for the highest or lowest outcome. What-if scenarios consider the occurrence of a specific event which would play a major role for the future development, such as external events but also internal decisions. This type consists of a group of forecasts, in which the occurrence of a possible event is represented by a bifurcation point. The difference of the two types is the character of the outcome, whereas forecasts result in sensitivity spans and what-if scenarios provide distinctly different outcomes.

Explorative scenarios are classified in external and strategic scenarios. The former focuses on the development of external factors and the latter with possible outcomes of certain internal actions. Within explorative scenarios possible futures should be explored by spanning a wide scope of possible developments in the scenario creation. In the most cases these scenarios investigate a long-term horizon and allow structural changes within the course of time with the exception of surprise-free scenarios, which are often used as a reference. Especially in times of external dynamism explorative scenarios are a help to disclose potential alternative developments not considered in the actual system. External scenarios

[275] cf. Millett (2003), p. 18

[276] cf. Börjeson et al. (2006), p. 723 ff.

(e. g. global energy or climate scenarios) consider factors which can not be controlled by the enterprise and are created for the purpose to deliver information for the planning units, especially to develop robust strategies resistant to several possible events. External scenarios provide an important input for finding flexible and adaptive solutions and open up the possibility to be more receptive to weak signals. Strategic scenarios consider actions and measures of the enterprise respectively possible consequences of strategic decisions. These consequences are significantly dependent on future developments. Therefore strategic scenarios focus on the test of different measures and their impact on predefined target variables.

The normative scenarios are divided in preserving and transforming scenarios dependent on the need to change the system structure of the underlying variables. In general normative scenarios are created to test if a realisation of future situations or objectives can be reached. Regarding preserving scenarios the objective could be reached by modifying the actual situation within the existing system structure. Here (cost-) efficiency is primarily in the focus and the most efficient paths to the objectives (e. g. environmental, social, economic or cultural) represent the scenarios. The transforming scenarios consist of paths to a prioritised target whereby the system structure has to be changed. Ongoing developments are not sufficient to meet the demands and the needed changes to break the trend to reach for instance a societal problem are discussed. As a consequence the scenarios consider a long-term perspective and try to find options to satisfy long-term targets.[277]

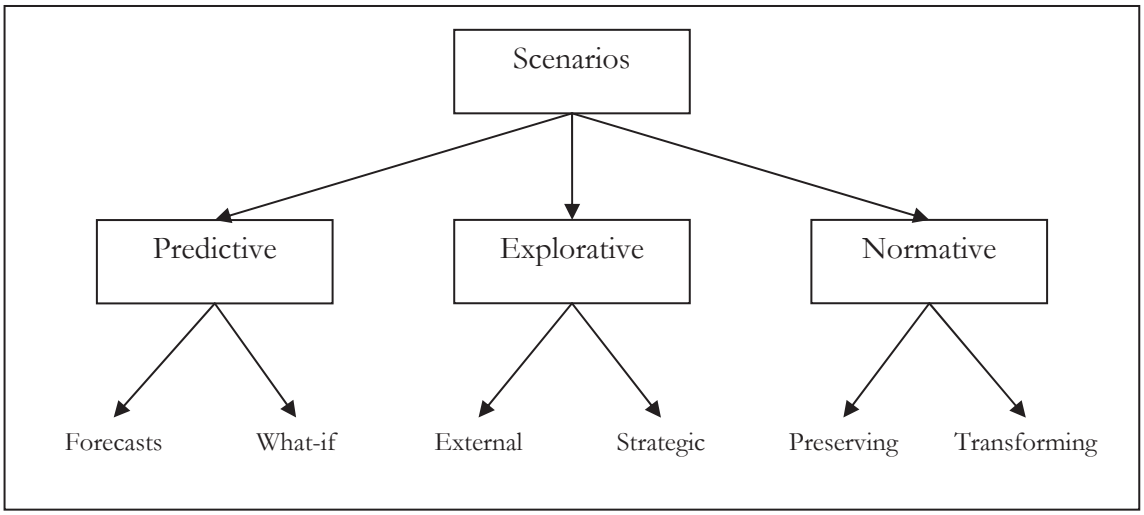

Fig. 4.5: Scenario Typology with Three Categories and Six Types[278]

[277] cf. Börjeson et al. (2006), p. 726 ff.

[278] Börjeson et al. (2006), p. 725

Scenario typologies of other authors are based on the scenario definition in a narrower sense and exclude predictive scenarios. *Götze*[279] distinguishes scenarios concerning their chronological sequence (anticipative or explorative), their target dependency (descriptive or normative) and their static development (trend or peripheral scenarios). This classification is only partially comparable to the former one. Both defines explorative scenarios and the normative scenarios of *Börjeson et al.* can be equated with the anticipative scenarios, since both focus on paths to a predefined future objective or situation (see fig. 4.6). Descriptive scenarios are investigated without considering their advantageousness in contrast to normative scenarios, which incorporate the ideals of the creators in this context. Trend scenarios are based on the most probable developments of the factors without considering discontinuities. On the contrary within peripheral scenarios also unexpected factor values are assumed.

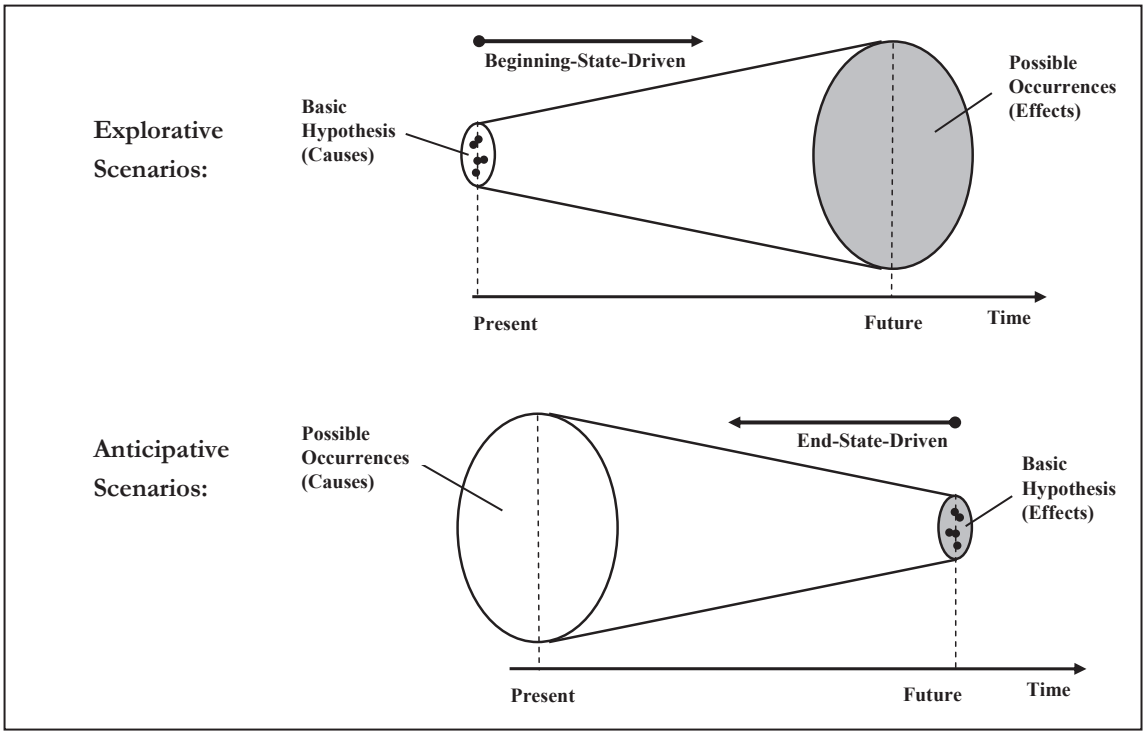

Fig. 4.6: Scenario Cones for Explorative and Anticipative Scenarios[280]

The typology of *Gausemeier et al.*[281] is similar to that of *Götze* with the exception of replacing trend and peripheral scenarios by situation and process scenarios. Situation scenarios describe a snapshot in time by respectively a future situation and the path form the present to

[279] cf. Götze (1991), p. 87 ff.

[280] on the basis of Gausemeier et al. (1996), p. 111

[281] cf. Gausemeier et al. (1996), p. 107 ff.

this situation is neglected in this "static" scenarios. A process scenario aims at the description of the path to the situations, whereas the future situation is a result of the different paths including discontinuities and bifurcations in this "dynamic" perspective. The enumeration of only three typologies already discloses differences in the terminology as well as non unique typologies of different authors and therefore difficulties for a common understanding and communication of scenario types.

4.1.4 Phases of Scenario Development

The different approaches for the scenario development are primarily characterised by application of an inductive or a deductive procedure, by the number of considered factors and by the instruments. The distinction between inductive and deductive approaches is reasoned by the dependency on whether the initial scope of the scenarios is restricted or not. The initial scope of deductive scenarios is delimited. The scope of the scenario draft is in this case represented by the consistent combination of a few key factors. The predefined scope is further on filled out with several additional factors, whereas different methods such as intuitive approaches or trend impact analyses can be used. The assumed developments of the key factors and the additional derived factors build the scenarios. Within the inductive procedure the consistent assumptions of possible developments of the factors are constructed without delimiting a scope. Initially even more factors are considered as with deductive scenarios, whereas the number of factors is reduced mainly intuitively to a practicable amount subsequently. A to high amount of factors would result in a too high number of possible assumption bundles which are very difficult to handle. In contrast to deductive approaches all potential factors are considered in the first attempt and reduced afterwards.[282]

Subsequently different classifications of the inductive scenario process, which is the preferred approach in the field of business management and characterised by starting with singular information and resulting in general statements, should be discussed starting with the process consisting of eight steps from *Reibnitz*[283] (see fig. 4.7).

[282] cf. Götze (1991), p. 91 ff.

[283] cf. Reibnitz (1991)

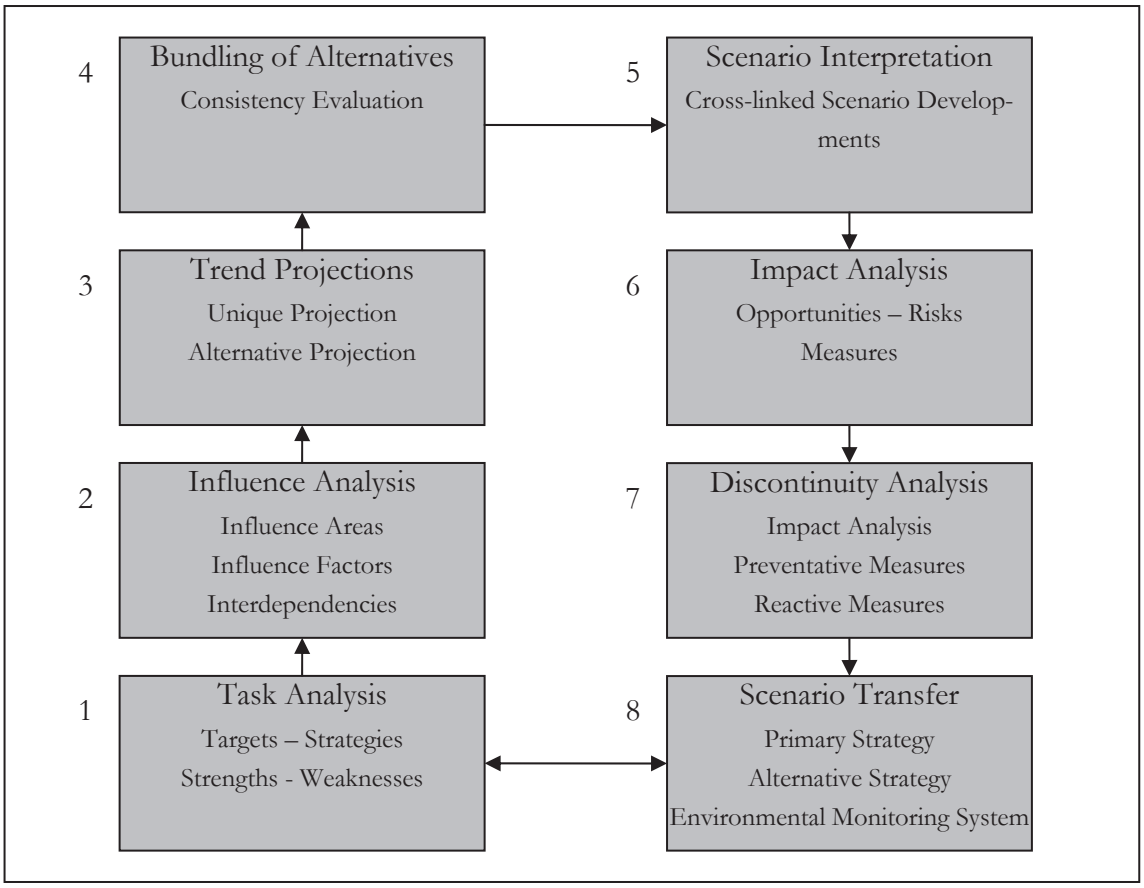

Fig. 4.7: The Eight Process Steps of Reibnitz[284]

In the first step the object of investigation (e. g. enterprise, strategic business unit, product group,…) is analysed. Starting with questioning the actual products or services provided, the mission statement, the targets and strategies, the strengths and weaknesses and so on the actual task should become clear. The result of this analysis, conducted by groups of managers of the business, should disclose if the object of investigation is chosen adequately.

The influence analysis starts with the identification of external influence areas (market, competition, policy,…), which may have an impact on the business. Subsequently influence factors describing these areas are determined and evaluated. Finally the influence factors are cross-linked to consider the interdependencies between them, whereas an interdependency matrix is recommended to fulfil this task and to identify drivers for the total system.

The aim of the third step is to find descriptive variables (descriptors) based on the identified influence factors. The descriptors are used to demonstrate the actual and the future state of the respective development. If a descriptor (e. g. for market growth) is projected

[284] on the basis of Reibnitz (1991), p. 30

into the future a unique descriptor can be assumed, if the development is relatively certain and relevant data is available. In the case of uncertainty alternative descriptors for the specific influence factors have to be determined. Here it is important to use neutral formulations to allow an alternative thinking, such as questioning market development instead of market growth.

The next step attempts to test the consistency and logic of the identified bundles of alternative developments in the former step. If only a few descriptors are considered the problem can be solved intuitively, otherwise the application of a consistency matrix is recommended. In the matrix the potential correlation of the alternatives are evaluated and by the aid of computer programs consistent bundles of alternatives for several influence factors are constructed.

The fifth step consolidates the consistent scenarios, the unique descriptors and the results of the interdependency analysis to form and interpret scenarios. First the projections for the unique descriptors are added to the bundles of alternative projections. Further on the scenarios are interpreted considering the factor interdependencies for discrete time steps. The results are two contrary scenarios since the approach of *Reibnitz* is content with only two alternative developments.

In the impact analysis based on the created scenarios opportunities and risks for the business are derived and evaluated to determine the prioritised measures and activities. The resulting measures after the risk respectively opportunity evaluations, which are compatible to both scenarios, are bundled afterwards to find recommendations for the formulation of a primary strategy. These recommendations are confronted to the strengths and weaknesses of the business identified in the first step and adjusted.

The discontinuity analysis considers the unexpected occurrence of internal or external events impacting the business. The impact is evaluated and the corresponding preventive and reactive measures (contingency plan) are determined. The step starts with the collection of potential discontinuities, whereas those with the most significant impact are described and analysed. Finally from this analysis counteractive measures are defined.

In the last step the measures resulting from the sixth step are used to formulate a primary strategy. Since one strategy does not overcome the developments of both scenarios in the most cases, alternative strategies are formulated too. By the introduction of an environmental monitoring system for the considered influence factors the strategies can be tested and potentially modified.[285]

[285] cf. von Reibnitz (1991), p. 30 ff.

Another phase model of scenario development originates from *Gausemeier et al.*[286] and consists of five steps (see fig. 4.8). Similarities to the approach of *Reibnitz* are obvious, nevertheless the comparison of the two procedures should disclose different solutions to the same problem.

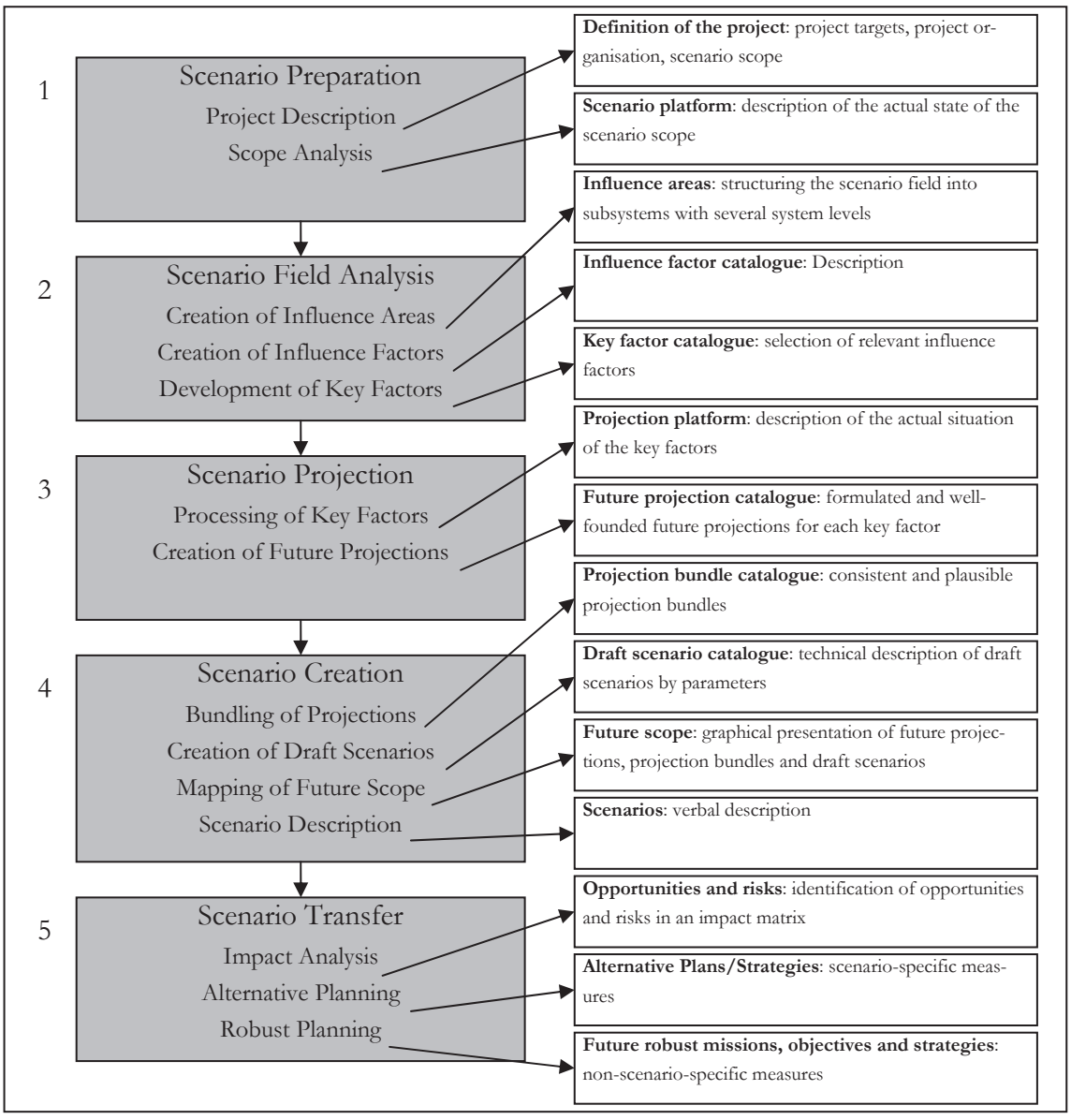

Fig. 4.8: Phase Model of Gausemeier et al.[287]

In the sketched phase model the scenario management starts with the preparation phase. The first task is to determine the targets, organisation (e. g. scientific, consulting, workshop

[286] Gausemeier et al. (1996)

[287] on the basis of Gausemeier et al. (1996), p. 101

or internal approach) and the scope of the scenario project to outline the contents of the scenario and to fix the responsibilities within the project team. Another target of the preparation phase is to analyse the actual situation of the object of investigation (e. g. enterprise, product, technology,…). In this step components within the scope are identified and internal strengths and weaknesses are assessed.

The scenario field analysis starts with the creation of influence areas, whereas the system is divided into several levels (e. g. global – market – enterprise – product). The single levels are considered in the view of different aspects and subsystems (e. g. different business activities or functions) are developed, with which the scenario field is described. The potential influence factors are derived from the influence areas and described in detail prior to composing a catalogue of all factors of the scenario field. Based on the catalogue key factors are developed by evaluating the impact of the factors on the scenario field and investigating similarities between certain factors. The key factors are summarised in a catalogue, which is composed of the influence factors with the most significant impact and which do not show similarities to others.

Within the scenario projection the key factors are processed at the beginning. In doing so the key factors are described by their characteristics and their actual state is analysed. The future projections are created by describing the development possibilities of the key factors, selecting one to three projections of these possibilities, assessing the occurrence probabilities for the critical projections and formulating and founding the projections for all key factors.

The scenario creation per se consists of the bundling of projections, the creation of draft scenarios, the mapping of the future scope and the scenario description. The projection bundles are tested regarding their consistency respectively if no contradictions appear. After determining the plausibility of the bundles by assessing the probability of their occurrence a catalogue of consistent and plausible bundles is formulated. The creation of the draft scenarios is based on a cluster analysis, whereas the most homogeneous bundles are identified and grouped mathematically. Subsequently the scenarios are described by their parameters (draft scenarios). Based on the results the draft scenarios, projection bundles and future projections are visualised in graphs. Afterwards the resulting scenarios are described by lists of their unique and alternative specifications as well as in a verbal form.

The concluding scenario transfer starts with an impact analysis by means of a matrix for the purpose to disclose opportunities and risks for the business. Additionally based on the created scenarios a common understanding of the future is created in "future conferences". Subsequently the alternative planning is conducted, whereas preventive and reactive measures to make use of opportunities and avoid risks based on the scenarios are determined. The plans corresponding to each scenario are bundled to scenario-specific strategies in the next step. Additionally robust plans are created, which should withstand all scenarios and

are bundled to strategies for each scenario field.[288] The procedure of *Gausemeier et al.* is well structured and recommends all methods and instruments applicable along the process whereas the procedure of *Reibnitz* is rather based on intuition.

In spite of the varying concepts for the scenario development phases of the most used inductive approach five basic steps can be defined:[289]

1. Definition and analysis of the object of investigation: After determining the task the investigated object is defined, analysed and structured.
2. Identification, analysis and prognosis of environmental factors: In this step influencing factors are identified and categorised. The influence on the investigated object and between the factors is analysed. The aim is the selection of critical descriptors for the environment, which are prognosticated to consider alternative developments.
3. Creation and selection of draft scenarios: The developments of the single descriptors are opposed and summarised to plausible bundles. The resulting draft scenarios are selected for the further processing corresponding to their probability of occurrence.
4. Development of scenarios: Based on the actual situation possible developments are determined and as required completed by additional descriptors. After analysing the sensitivities the scenarios are formulated.
5. Interpretation of scenarios: Concluding the results and their potential impacts are utilised in the strategic management.

The most considerable differences between the concepts are the restrictions of the process, such as where the project preparation starts and where the scenario transfer ends. Also within the steps different instruments are used to solve the given problem, whereas they range from intuitive methods to hard methods (e. g. simulation or other computer-based applications) and the extent of instruments applied to create a plausible and consistent scenario is also varying.

4.1.5 Scenario Technique and Strategic Management

The most established application of scenarios come along with existential, long-term respectively strategic decisions (investment decisions, diversification, mergers and acquisitions,…).[290] Especially in larger enterprises scenarios are an essential element supporting

[288] cf. Gausemeier et al. (1996), p. 125 ff.

[289] cf. Götze (1991), p. 98 ff.

[290] cf. von Reibnitz (1991), p. 195

the strategic management. The application can be restricted to single phases of the management process, such as complementing the strategic internal and external analysis with a future oriented perspective.[291] On the other hand the area of application can also be extended to the other phases of strategic management like strategic target planning, strategy formulation, strategy evaluation or strategic controlling (see fig. 3.2).

The strategic planning approach is conducted by planner, which often faces problems like the suppression of uncertainty, complexity or change. Concerning the first impairment planner often rely on the certainty of the past and reason a predictable future with the past developments instead of accepting uncertainties. The complexity as a matter of variety and dynamics respectively the thinking in systems is a weakness of the human mind per se and leads to the assumption of linear causal relationships in planning. The concentration on monetary success as the primary goal often results in the neglect of changes, whereas an intensified stakeholder orientation for instance may be a way to overcome this problem. The application of scenarios in strategic planning offers a couple of advancements in this regard. First of all thinking in scenarios allows the development of orienting knowledge, which decouples the thinking horizons from the planning periods. In this way the plans are more flexible and incorporate a long-term perspective. It also became evident, that the consideration of scenarios is a method to identify market opportunities in regard of customer needs, new technologies, products and many more. Further on, scenarios initiate a strategic dialogue which broadens the perspectives of the managers beyond the traditional limits of thinking. This also includes the consideration of developments outside the own industry respectively "outside the box", which is often the source of innovative strategies. Scenarios also allow the integration of the lower management levels in the scenario development and thereby in the strategy development process, in this way the implementers are also involved in the planning phase. Another strength is the handling of complexity since also qualitative developments can be part of scenarios, where prognosis, simulations and simple projections failed. Finally the scenario development process is also able to generate the future knowledge of the participating individuals, which would have lain waste otherwise.[292]

In the phases of strategic management the benefit of scenarios is widespread. Basically scenarios provide general information as a basis for the planning by considering not only the enterprise related environment but also the global environment.[293] In the phase of strategy analysis a future oriented perspective can be integrated and thereby the characteristics of strategic early warning are considered to recognise trends and external developments ear-

[291] cf. Welge/Eulerich (2007), p. 70

[292] cf. Fink et al. (2004), p. 173 ff.

[293] cf. Götze (1991), p. 47

lier. Besides also the internal analysis can be supported by considering the scenarios in the analysis of the own value chain.[294]

In the phase of strategy formulation it is often the aim to determine strategies which are robust to all potential developments identified by scenario development since basically no probabilities for the occurrence of a certain scenario are available. The decision is asserted to uncertainty and as a consequence different patterns for the strategy formulation are recommended:[295]

- **Focus on the most probable scenario**: The strategy should be formulated in way that the resources are allocated corresponding to the expectation of the most probable scenario, which is chosen by the intuitive estimation of the decider. The risk inhered in this behaviour is that the occurrence of another scenario limit the ability to react.
- **Focus on the "best" scenario**: Corresponding to the available resources and the initial position of the enterprise the scenario promising the most success is chosen. The risk is similar to the first possibility, but if the expected scenario occurs the most significant competitive advantage is possible.
- **Assure against losses**: The enterprise chose a strategy, which restrict the maximum losses (minimax-strategy) in the case of the occurrence of several scenarios. The risk is reduced in this way, but also the use of opportunities is limited since no scenario can be capitalised at its optimum.
- **Maintain flexibility**: The enterprise determines its strategy not until uncertainties are partially disappeared and the occurrence of a certain scenario becomes evident. The disadvantage of this behaviour pattern is that the leading-edge is transferred to the competitors, therefore the risk is very low.
- **Exert influence**: The enterprise itself tries to induce the optimal scenario by using resources to influence the influencing factors. Since the influence is limited and involve high expenditures in the most cases the gained competitive advantage in the case of the occurrence has to be opposed to the costs.

These behaviour patterns meet at the same time with criticism on the scenario technique since a preferred concentration on the best-, worst- and probable case is emphasised.[296] In this view only the focus on flexibility is consistent with the conventional scenario definitions and able to make use of the advantages of this method in strategy formulation. There-

[294] cf. Welge/Eulerich (2007), p. 70 f.

[295] cf. Porter (1986), p. 591 ff.

[296] cf. Mietzner/Reger (2005), p. 236

fore it is essential to monitor the developments of the influencing factors continuously for the consideration of all potential scenarios instead of relying on an arbitrarily chosen single one.

In the strategy evaluation scenarios of different developments are opposed to the alternative strategies, which are formulated and not yet or already pursued. The decision for a strategy out of the alternatives can be taken by choosing the most adequate strategy for a specific scenario or by choosing that strategy which fits best to all scenarios. The way to determine the strategy is dependent on the risk attitude of the deciders and the best possible achievement of the business objectives.[297] In the strategic controlling phase the circumstance that scenarios represent the development from the actual state to a future situation is useful for the controlling of existing strategic plans. Thereby the premises for the chosen strategy can be reappraised and changes in trends recognised. If changes in the existing assumptions are disclosed they will result in new scenarios and subsequently in modified, new or alternative strategies.[298]

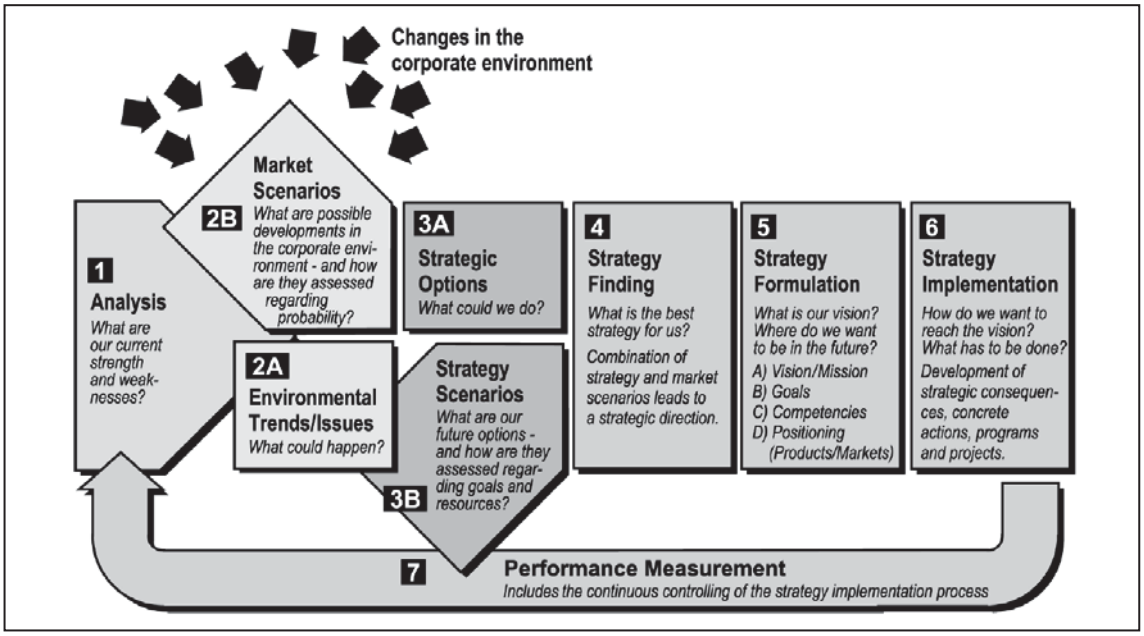

Fig. 4.9: Process of Scenario-based Strategic Planning[299]

Fink et al.[300] introduced a scenario-based strategic planning process to integrate internal and external scenarios between the steps strategic analysis and strategy finding for the purpose

[297] cf. Götze (1991), p. 277

[298] cf. Hahn (2006), p. 455

[299] Fink et al. (2004), p. 177

[300] cf. Fink et al. (2004); Fink et al. (2005); Fink/Siebe (2008)

of strategic early warning respectively foresight (see fig. 4.9). The basic idea behind using internal and external scenarios is to combine the resource-based and market-based view in the form of scenarios.

The process integrating scenario thinking into strategic planning starts with the conventional strategic analysis, whereas the actual situation is described with instruments like the portfolio analysis, value chain analysis or the help of success factors. In the second and third step scenarios are introduced to consider potential future developments in the external environment as well as for the internal options aligned with the visions, goals and available resources. Whereas the external scenarios correspond to the market based-view and focus on political, economical, social, legal or technological trends and issues the strategy scenarios represent the coordination of the results of the first two steps with the resource-based view. The result is either a single strategic option or a bundle of consistent options. The strategic finding is based on the former steps and can be performed in four different ways when alternative descriptions are considered:

- Valuation of strategies and investment decisions with market scenarios
- Development of new strategies based on market scenarios
- Strategy mapping based on alternative strategy scenarios
- Strategic framing in a scenario matrix

After finding the fundamental strategic direction the strategy is formulated including visions, mission statements, goals and strategic competencies and positioning. Finally the strategy is implemented by providing programmes and measures to achieve the formulated objectives.[301] Additionally to the visualised process a strategic early warning approach can be understand as a link between the strategy implementation and the market scenarios, whereas the environmental changes are monitored and the premises for the strategies are revised.[302] The most important part of the integration of scenarios to the strategy development process is the matching of the strategy options with the market scenarios respectively the resource-based with the market-based view. Therefore applying a scenario matrix (see fig. 4.10) is recommended to find either the best strategy for a single scenario or a strategy robust to all scenarios.

[301] cf. Fink et al. (2004), p. 176 f.

[302] cf. Fink/Siebe (2008), p. 72 ff.

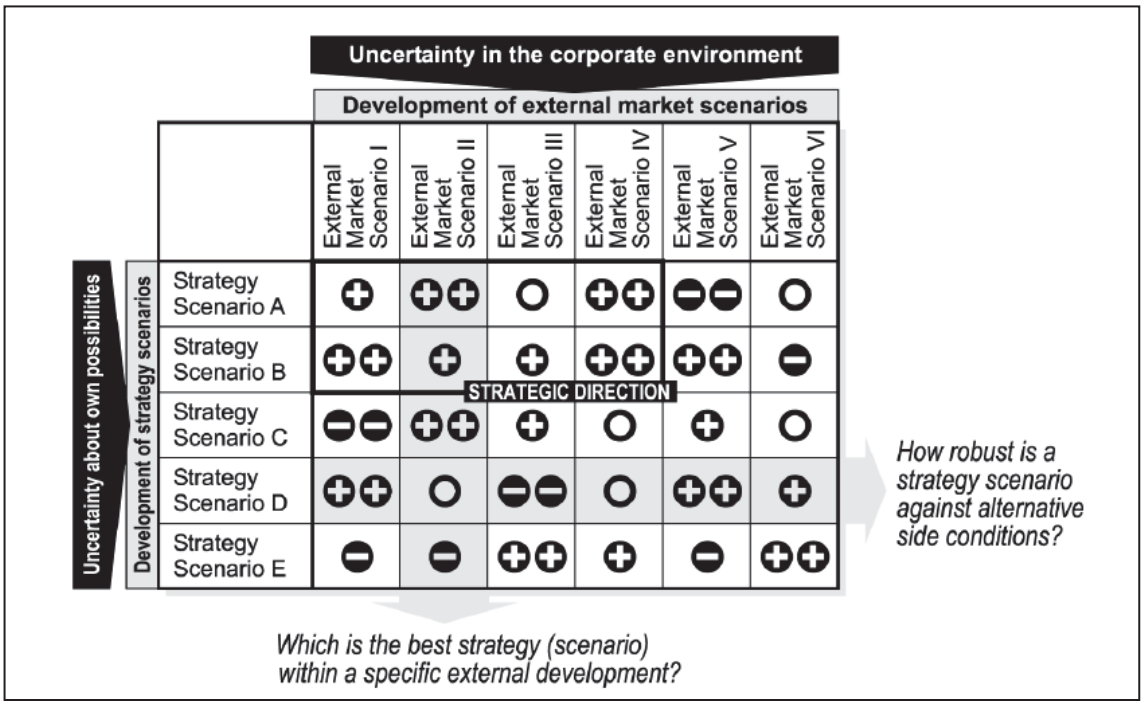

Fig. 4.10: Scenario Matrix[303]

The scenario matrix is an instrument to analyse how robust strategy scenarios are and to find the most adequate strategy for a specific market scenario. It opposes the potential strategies with the external scenarios and the suitability is valued. The rows disclose how robust the bundle of actions is against the different identified scenarios and the best one in this regard can be determined. By comparing the different strategy options in the columns the most suitable strategy for a specific situation represented by the market scenarios can be found.[304] This concluding example should concretise a possible way of the integration of scenarios into the strategic management process.

The differentiation between the application of scenarios in the strategic management process and for the purpose of strategic early warning is not defined clearly, since the function of scenarios is similar in both regards. Nevertheless the subsequent chapter should outline the benefits in the perspective of strategic early warning systems separately.

The scenario technique supports the strategic early warning in several respects:[305]

- Scenarios supports early warning processes by considering a long-term time horizon after a relatively short introduction phase and is able to deliver important indicators for the environmental monitoring.

[303] cf. Fink et al. (2005), p. 373

[304] cf. Fink et al. (2005), p. 373

[305] cf. Fink et al. (2004), p. 183 f.

- By the specification of a restricted scope for the environmental monitoring scenarios may be sources for weak signals.
- By specifying alternatives scenarios may initiate change processes regarding the mental models of the management and make weak signals plausible for the managers.
- Early warning processes may bring up new relevant issues for the business, which may be analysed in detail by scenarios again subsequently.
- Early warning systems and scenarios are based on the same information insofar that well-structured knowledge improves the quality of scenarios and on the other hand exact scenarios may deliver information for the early warning system.

4.1.6 Scenario Monitoring

After developing scenarios corresponding to the phases described previously they should not only be used one-time. Therefore a continuous observation of the scope spanned by the scenarios should be conducted which is also known as scenario monitoring. For this purpose the observed scope has to be restricted, structured and described. Consequently the identified key factors are monitored to gain information about the potential occurrence of a scenario.[306]

Tab. 4.1: Basic Activities of Strategic Early Warning[307]

	Directional Search	**Undirectional Search**	
Informal	Scanning of (weak) signals outside the domain, without a fixed subject reference	Scanning of (weak) signals within the domain, without a fixed subject reference	**Scanning**
Formal	Scanning of (weak) signals outside the domain, with a specific subject reference	Scanning of (weak) signals within the domain, with a specific subject reference	
	Observation and intensive search of information outside the domain with a specific subject reference for an already identified signal	Observation and intensive search of information within the domain with a specific subject reference for an already identified signal	**Monitoring**

Within strategic early systems monitoring is differentiated from scanning in dependence on the level of formalisation and the availability of an already identified signal (see tab. 4.1). Scenario monitoring is corresponding to the mentioned definition the search of informa-

[306] cf. Fink/Siebe (2006), p. 74

[307] on the basis of Krystek/Müller-Stewens (1993), p. 177

tion with a specific reference to the subject of the scenario for already in the scenario identified signals.

Reibnitz[308] also uses scenarios besides their application for developing and revising visions and strategies and the evaluation of strategic decisions explicitly for the environmental observation respectively the monitoring too. Therefore after the scenario development time points are fixed, at which observation are made and the premises of the actual strategy based on the identified developments. If there are tendencies to a specific scenario the time intervals for the observations should be shortened. If trend changes or a clear development in favour of a specific scenario appear the decisions in this phase should be oriented on this scenario.

In the view of *Fink* and *Siebe*[309] the scenario monitoring is an integral part of the strategic early warning process starting the process as mentioned above with the continuous observation of the key factors with a special bias on the most important „scenario indicators". In a second step it is determined how the relevant information is acquired for the monitoring. This task can be fulfilled by the organisation of workshops for internal and external experts as well as by using an indicator-based early warning system. Subsequently the acquired information is linked to the scenario and development tendencies are derived. The results are analysed afterwards and integrated in the decision process, whereas the need for information has to be assessed for the decider. Finally the scenario itself is revised in regard of its suitability corresponding to the developments or if the considered scope is already left. In this case the scenario has to be modified or even a new one has to be developed. Due to the necessary effort scenarios are modified or adjusted all two to six years in practice dependent on the size of the enterprise respectively the available resources.[310]

The monitoring is a significant component for handling scenarios for all potential applications to recognise the wrong selection of a scenario but above all for the reduction of uncertainty in the case of a flexible strategy determination. Even if the developments are known the uncertainty can not be diminished completely with the available methods. One solution is the determination of probabilities for the occurrence of different scenarios and the observation of the change in time to transform the uncertainty into a determined risk. In literature it is discussed if future trends should be evaluated with probabilities since this is only possible in a subjective manner and the discovery of future trends is rather in the focus of the scenario technique than the difficult question dealing with the probability of a

[308] cf. Von Reibnitz (1991), p. 208 ff.

[309] cf. Fink/Siebe (2008), p. 75 f.

[310] cf. Reibnitz (1991), p. 214

specific future development. The arguments for a probability evaluation are the increasing acceptance of the deciders and the possibility to determine the relevance of the scenarios.[311]

4.1.7 Critical Review of Scenario Application

After discussing the benefits of the application of the scenario technique for business purposes the weaknesses of this method should be mentioned too. The investigation of different literature sources results in three superordinate disadvantages: the fulfilment of the quality criteria, the management acceptance and the resource investments.

A scenario is always as good as the quality criteria are fulfilled. The fulfilment of those is dependent on the selection of suitable instruments and the qualifications of the participating experts in the scenario development.[312] Especially in the case of a more qualitative approach the selection of experts is critical for the quality since a deep understanding and knowledge of the investigated subject is needed.[313] Due to the impairments caused by the use of different scopes of design (participating persons, selection of instruments in different development phases, procedures) transparency should be created. The transparency can be increased by using well-structured and reproducible procedures, but due to the high number of subjective components the fulfilment of this demand is restricted.[314]

Scenarios are always created as an information source for decisions, therefore the acceptance of the management must be given. The weaknesses of scenario planning in this regard are the disconnectedness from the priorities of the managers and that scenarios can be divorced from real management decisions.[315] This is a consequence of the fact that no certain information results from the scenario approach and that no compulsion to act is given.[316] Moreover the handling of scenarios is often misunderstood and the primary focus is on best-case, worst-case or wishful scenarios, which dominates the scenario building process.[317]

Finally the application of scenarios (development, establishment and maintenance) in practice is often refused due to the required large resource investments for the time consuming approach.[318] The costs for the implementation of the scenario approach are dependent on the work intensity, which is in turn responsible for the quality of the outcome. Especially

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[311] cf. Gausemeier et al. (1996), p. 225 f.

[312] cf. Bea/Haas (1994), 490

[313] cf. Mietzner/Reger (2005), p. 236

[314] cf. Götze (1991), p. 255

[315] cf. Raspin/Terjesen (2007), p. 117

[316] cf. Bea/Haas (1994), p. 489

[317] cf. Mietzner/Reger (2005), p. 236

[318] cf. Raspin/Terjesen (2007), p. 117

the costs for the participating personal are dominating, whereas the involvement of the deciders in the top management is crucial and induces even higher costs per working hour. Concluding the advantageousness of scenarios over alternative methods can not be evaluated since their application is dependent on the given task.[319]

4.2 Other Methods Supporting Strategic Early Warning

Besides the method of scenario technique other instruments are used to support the strategic early warning process. Although they are all instruments for the third generation of early warning systems, their level of acceptance in practice is rather restricted in contrast to scenarios. Another evidence for their limited significance in practice is that even in actual literature the original publications decades ago are cited and no improvements of the instruments or adoptions of the individual instruments became apparent.

4.2.1 Consideration of Weak Signals in the Portfolio Analysis

The consideration of uncertainty due to weak signals within strategic early warning systems may also be realised by advancing existing instruments like the portfolio analysis. Therefore instead of indicating a single point for the position of an object in the conventional portfolio analysis is extended by ranges to visualise uncertainties resulting from deviating opinions in the expert team creating the portfolio. The larger the area of uncertainty the more indications for weak signals are given, whereas the origin of the signals has to be investigated in detail by subsequent analyses. Consequently the aim of the application of uncertainty areas is the disclosure of weak signals and the indication of their intensification.[320]

The procedure starts with individual assessments of criteria dependent on the portfolio to create (e. g. the evaluation of the single components of market attractiveness for strategic business units) and the subsequent determination of distribution functions. The single components are linked for example by a Monte-Carlo-simulation and after determining a confidence interval the uncertainty areas can be indicated in the portfolio.[321] An alternative to indicate uncertainty in portfolio-matrices without advanced mathematical applications is to determine the most optimistic, probable and pessimistic value for both dimensions of the matrix (see fig. 4.11). The figure shows the uncertainty rectangle originating from the expert judgements in a portfolio opposing the competitive position and the market attrac-

[319] cf. Götze (1991), p. 255 f.

[320] cf. Kreilkamp (1987), p. 298 f.

[321] cf. Kirsch/Trux (1979), p. 55 ff.

tiveness. The side lengths of the rectangle are determined by considering the highest and lowest of these three values in the visualisation.[322]

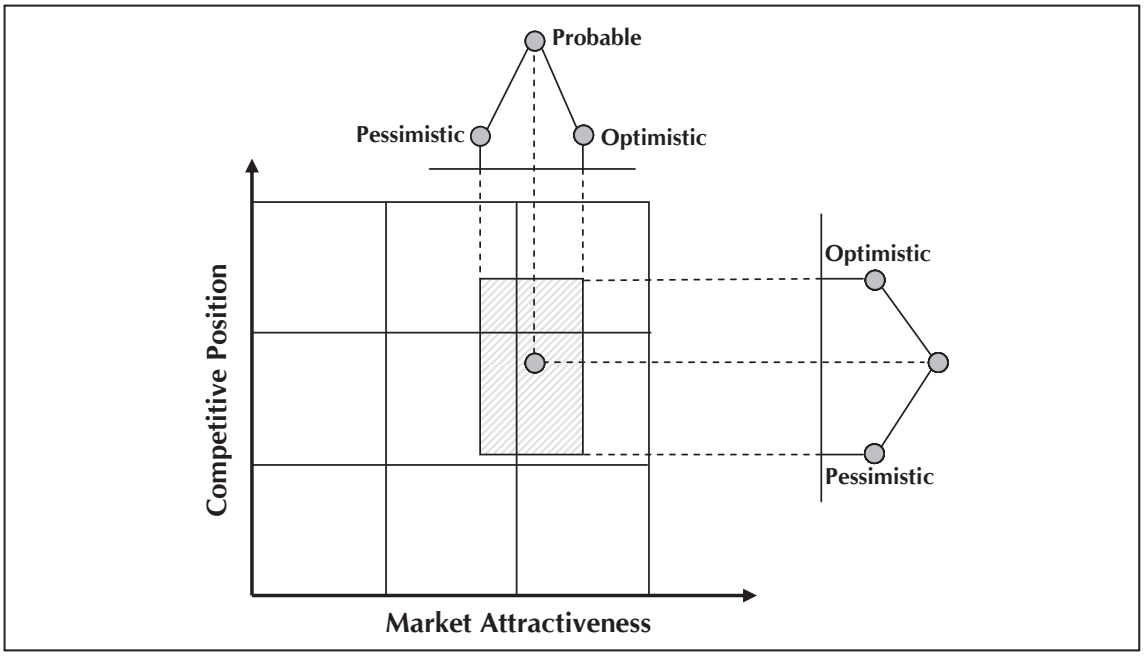

Fig. 4.11: Competitive Position-Market Attractiveness-Portfolio with Uncertainty Rectangle

The benefit of the method is that by the comparison of the sizes of the uncertainty areas of the single positions risks and opportunities can be derived. Large areas also indicate large information asymmetries, which have to be analysed in detail. Outstanding small areas may indicate blindness by routine and has also to be investigated.[323] Especially deviations recognised in revaluations may reason the existence of weak signals.

A disadvantage of the instrument is the limited application area because weak signals can only be identified in the business units considered in the portfolio. The identification of risks and opportunities is based on the characteristics of the units and no separate holistic risk identification is performed previously. Therefore only a small area of risks and opportunities is covered in the discussed application.[324] The benefit is also restricted by the fact that detailed analyses are necessary subsequently for the purpose to give evidence why the uncertainty areas are of different size. The differences may have several reasons, for example the missing qualification of a member of the team of experts or simply a false estimation. The instrument is a meaningful extension of the portfolio analysis but the benefit is

[322] cf. Ansoff et al. (1983), p. 247

[323] cf. Kirsch/Trux (1979), p. p. 61 f.

[324] cf. Rauscher (2004), p. 47

limited to the suggestion of weak signals, which demands to make efforts to interpret and analyse the uncertainty areas subsequently.

4.2.2 Monitoring of Diffusion Processes by Structural Trend Lines

The main problem in science and business practice is the acceptance of strategic early warning systems due to their inability to forecast long-term environmental developments as well as to manage discontinuities. Discontinuities are structural interruptions or an unsteadiness of the development of certain factors. Based on the diffusion theory the monitoring of diffusion processes was developed to investigate the structure of a factor and allows in this way the anticipation of the future developments instead of considering past data.[325]

The underlying idea of diffusion functions is that a subject with a specific cognition is able to infect other subjects, whereas the number of individuals infected by the cognition is more and more increasing. These developments correspond with theory of paradigm changes and in combination with the diffusion theories distribution patterns respectively diffusion curves can be constructed. Thereby change is seen as the overcoming of an old paradigm as wells as an invariance within an existing paradigm. A new subject may be infected by a new cognition if uncertainties concerning the validity of existing paradigms or invariance appear. This uncertainty creates a susceptibility to new ideas.[326]

Within business management research especially the behaviour of consumers respectively their readiness for innovations is of key interest. Based on the different reaction structures over the time consumers can be categorized concerning their adaption behaviour (see fig. 4.12). The differentiation of early adapters, early majority, late majority and laggards demonstrates an ideal type of the distribution of new products or ideas. The diffusion pattern is visualised as a function of infected subjects, in this case the noncumulative number of consumers respectively the sales of a product. For each time point the state of the diffusion process is known.[327] This example demonstrates, that the assumption of an ideal type curve allows the prediction of future sales if the behaviour of innovators or early adapters is already known. The structural trend line of the product life-cycle allows thereby the anticipation of the future performance of a product and delivers information for the decision whether a product should be withdrawn from the market or not in an early stage.

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[325] cf. Krampe/Müller (1981), p. 384

[326] cf. Krampe/Müller (1981), p. 389 ff.

[327] cf. Kreilkamp (1987), p. 276 f.

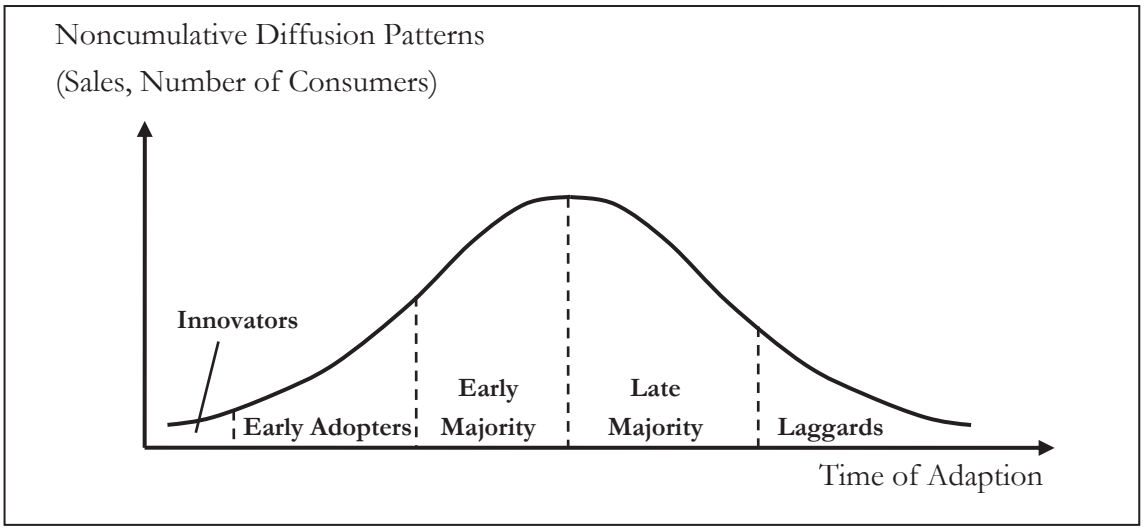

Fig. 4.12: Diffusion Process as Diffusion Function[328]

The example above can be adapted for the prediction of strategic discontinuities, which are announced by weak signals. The regularities involved in the infection of consumers in the product-life cycle respectively of subjects in general are transferable to the diffusion of events. In this case the diffusion is based on doubts about the utility of existing technologies for instance. As a consequence diffusion patterns in a broader context can explain besides social also technological, political or economical changes too. In practice diffusion curves are constructed as structural trend lines. The change is characterised by the following theses:

- Technological, social and political changes are not at random, they are created by humans and controlled by their interests.
- Changes are based on certain development mechanisms and relatively stable diffusion patterns.
- Changes in the business environment are caused by events respectively triggered by pioneers.

As a consequence the benefit of the application of structural trend lines is to forecast future developments reasoned by analogy from known diffusion processes. The early recognition of potential technological, social and political tendencies presumes the knowledge of the development mechanisms and typical diffusion patterns. Based on those precipitating events or pioneers can be identified and monitored. These weak signals are of qualitative nature and acquired from the subsequent sources:

[328] on the basis of Wind (1982), p. 28

- Events and accumulation of events relevant for the business
- Opinions and statements of key persons
- Announcements of institutions and organisations
- Diffusions of opinions, ideas etc. in media
- Legislation and jurisdiction national and abroad

By the monitoring of the mentioned sources structural trend lines can be determined, which inform the corporations about tendencies and also allows the forecasting the time point when an event may occur.[329] In figure 4.13 two examples of the visualisation of structural trend lines for the pioneers of ideas as well as for the diffusion of ideas in the media are shown in a simplified manner.

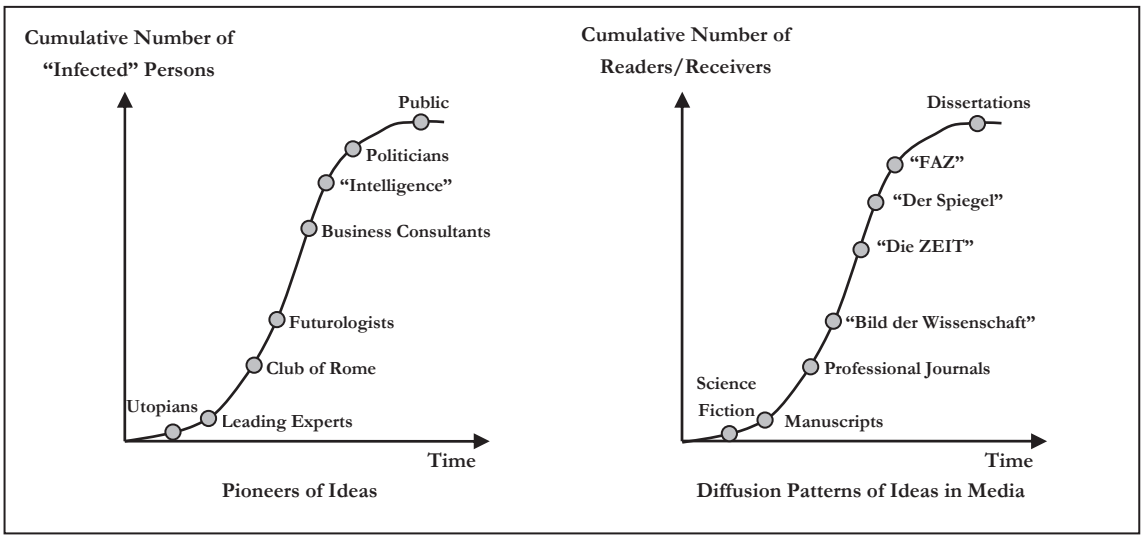

Fig. 4.13: Examples for Structural Trend Lines[330]

The advantage of the application of the diffusion curves is creating the awareness that diffusion patterns exist and sources for information are identifiable, which represents the triggering pioneers of a potential event along structural trend lines. Conclusions by analogy allow the forecast of events, since weak signals always have the same initial source. The Scandinavian countries are pioneers concerning legislation and technological innovations originate from manuscripts of scientific meetings rather as from dissertations to name two examples. The continuous monitoring of the diffusion functions results in the benefit to

[329] cf. Krampe/Müller (1981), p. 395 ff.

[330] on the basis of Krampe/Müller (1981), p. 397

anticipate environmental developments earlier and the availability of an instrument to prognosticate the time of occurrence of a certain event.[331]

One of the disadvantages of the diffusion concept is the missing definition of some sources, it is for example a subjective evaluation who utopians or leading experts are. Another impairment of the instrument is the necessity of experience concerning the area of an identified weak signal since similar diffusion patterns have already to be available respectively a conclusion by analogy must be possible. Even if curves corresponding to the identified signal already exist, their validity for future diffusion patterns has not been given.[332] Especially in the new information age, triggered by the introduction of the World Wide Web, the diffusion of ideas, opinions or inventions may not coincide with diffusion patterns valid 20 years ago. Additional difficulties arise concerning the time point the monitoring activities should start and a potential new development should be taken seriously. A corporation is not willing to accept the effort to trace a weak signal if one utopian has an innovative idea. On the other hand the ignorance of the opinions of experts in the corresponding field may already mean to eliminate the strengths of the instrument since its impact is insignificant if politicians or even the public are already discussing an idea.

4.2.3 Cross-Impact Analysis and Vulnerability Analysis

The cross-impact analysis focuses on the analysis of interactions between potential events to identify the relevant environmental influences. The method is suitable for the case if the occurrence of an event is dependent from the (non-)occurrence of another event. The problem is solved by analysing the interdependencies between possible events. The method can be applied for the following purposes:[333]

- Analyse interdependencies in a system
- Determination of consistent and plausible assumption bundles (within the scenario technique)
- Assessment of the impacts of discontinuities and extreme assumptions for descriptors (sensitivity analysis)
- Examination of the impact of strategies

The umbrella term cross-impact analysis covers three different types:[334]

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[331] cf. Kreilkamp (1987), p. 279 ff.

[332] cf. Rauscher (2004), p. 42

[333] cf. Götze (1991), p. 163 ff.

[334] cf. Gausemeier et al. (1996), p. 263 f.

- Correlated cross-impact analysis: Based on a consistency analysis, which evaluates the extent of the fit of the combined occurrence of two events, the cross-impacts are assessed as conditional or common probabilities.
    - Example for a conditional probability: The probability of a decreasing mobility, if the oil price increased in the same year.
    - Example for a common probability: The probability that the both the mobility decreased and the oil price increased in a certain year.
- Static-causal cross-impact analysis: The focus is on causal conditional probabilities – e .g. the probability that the mobility is decreasing if the oil prise increased before. The probabilities correspond to only one specific future horizon.
- Dynamic-causal cross-impact analysis: In contrast to the static analysis several time horizons are considered and the impacts of conditional probabilities emerge in the course of time. This analysis shows similarities to the simulation technique.

The terms and procedures in the context of cross-impact analyses are not consistent in the literature. As already mentioned the analysis is applied to examine the interrelationships of different environmental influences to analyse the recorded signals in the early warning process on the one hand, but the majority of authors use the method to assess the impact of potential changes on the strategy to identify the most significant developments with a positive or negative influence. The latter application is performed by means of an assessment matrix, in which the potential environmental developments indicated in a column are opposed to existing or planed strategies listed in rows. For each strategic alternative the positive respectively negative impacts of the development are evaluated by a scale and filled in the matrix. By the separate summation of an individual potential development or event across all strategies the most significant ones are identified and their monitoring is highly recommendable. Additionally by the summation of the impacts on one strategy across all potential developments the inhered total risks and chances respectively the susceptibilities of a strategy are evaluated. Especially if the cross impact analysis, like explained exemplarily in this paragraph, is performed without the determination of probabilities the additional application of the vulnerability analysis is recommended.

The vulnerability analysis is also done with a matrix and considers the occurrence probability of an event too. Basically the probability is opposed to the impact of the event on the enterprise as the second dimension (see fig. 4.14). An acute need for action is given in the case of a high occurrence probability and a high impact on the business.[335]

[335] cf. Kreilkamp (1987), p. 294 f.

Environmental Vulnerability Matrix

Harmful impact on the business	Probability that the event/condition will occur			
	0-25%	25-50%	50-75%	75-100%
Catastrophic				
Severe				
Moderate				
Limited or none				

Environmental Opportunity Matrix

Opportunity to business	Probability that the event/condition will occur			
	0-25%	25-50%	50-75%	75-100%
Tremendous				
Very High				
Moderate				
Limited or none				

Fig. 4.14: Examples for Matrices for the Vulnerability Analysis[336]

The advantage of the combined application of the two methods in the described form is the ability to identify the most significant developments and to evaluate the acuteness of reactions as well as the susceptibility of the strategies. The prioritisation of the signals for potential upcoming events allows a focussed monitoring of the most significant influences and gives a reference for the adaption of strategies. Disadvantages result from the assessment of impacts and probabilities by scales and ranges. The value differences in the scales used within the cross-impact analysis do not represent the differences in the impacts on qualitative key figures. The vulnerability matrix mentioned before consists of 16 fields, whereas the position of a potential event is determined by four qualitative categories and wide ranges of probabilities. In a subjective view each expert evaluating the impact has a different understanding of the terms. In addition there is a significant difference between a probability of 1% or 24%, but both values will be indicated in the same column. Therefore the application should only focus on the prioritisation of the investigated potential events.

4.2.4 Discontinuity Interrogation

In the focus of the discontinuity interrogation is the evaluation of discontinuities by experts regarding their impact on the business. In this way weak signals, which may imply a chance or a risk for the company, are concretised.[337] The results represent the acuteness of reactions on the potential discontinuities, whereas especially the opinion outliers are of special interest for further interpretations.[338]

The discontinuity interrogation is performed after identifying, structuring and determining the resulting events of weak signals. A group of experts in the related field is chosen and interrogated with a questionnaire. Although a homogeneous evaluation is expected as a

[336] on the basis of Wind (1982), p. 202

[337] cf. Kreilkamp (1987), p. 282 ff.

[338] cf. Müller/Zeiser (1980), p. 605

result, primarily outliers should be identified which may be a sign for strategic surprises respectively discontinuities. In the questionnaire each of the weak signals is represented by a statement concerning the resulting event which may occur in the future as a consequence of the signal. The events have to be assessed regarding their probability of occurrence and the extent of the impact on a decisive figure for the business (e. g. product price, sales or earnings). For each of the potential events scales for the impact, which can be positive or negative, are indicated and the probability has to be assessed by a number between 0 and 100 for example. The number of experts polled should exceed 30 in the ideal case and 20 at least.[339] The results of the interrogation are summarised graphically and ellipses or rectangles representing the probability density (e. g. 95%) are indicated, which are separating the outliers from the rest of expert opinions (see fig. 4.15).

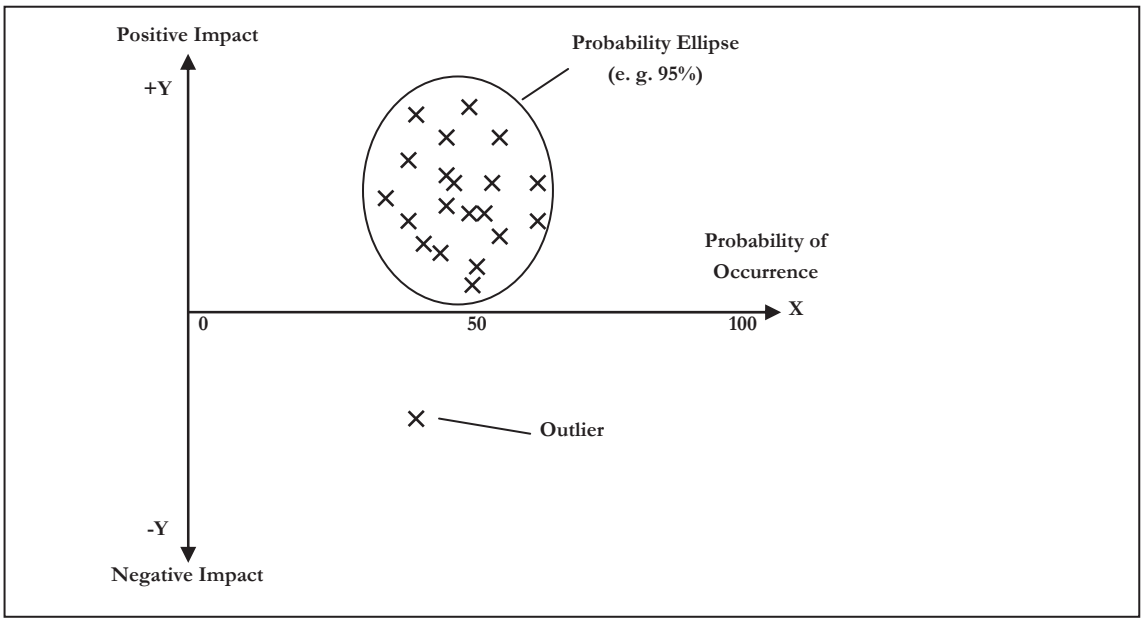

Fig. 4.15: Result of the Discontinuity Interrogation[340]

By graphing the individual assessments outliers do not disappear as it is the case when calculating a mean value, but after their identification the experts can be questioned once more about the reasons for their deviating assessment. A deviation of an opinion is caused by four different reasons:

- Imprecise formulation of the problem
- Misunderstandings, e. g. concerning the terminology

[339] cf. Müller/Zeiser (1980), p. 606

[340] on the basis of Müller/Zeiser (1980), p. 608

- Unjustified positioning of the interrogated person as an expert
- Cognition of new fundamental structures of interrelationships

If the outlier is indicated due to the fourth reason attention should be directed to this opinion since essential changes are often not recognised by the majority of experts and it must be analysed in depth. It is also recommended to repeat the interrogation in constant time intervals to monitor the changes of the probability ellipses for the purpose to signal the acuteness of reactions to potential discontinuities.[341]

The most significant advantage of the discontinuity interrogation is the opportunity to identify outliers and to discuss the reasons for deviations as regards content with experts. The variance of opinions as additional result allows conclusions concerning the level of diffusion. The higher the variance the higher the uncertainty as regards the occurrence of a discontinuity, whereas the change of the variances in the course of time should also be monitored. The benefit of this procedure is to obtain the opportunity to evaluate the acuteness of the situation.[342] An impairment of the method in its original form is the application of an ordinal scale (e. g. from -4 to +4) for measuring the impact of the potential event. As a consequence the differences in the assessment (e. g. between 1,5 and 2,5) do not represent the increase of the magnitude of the impact.[343] A further weakness is the arbitrariness of the selection of experts, which is a success factor for a qualified evaluation of discontinuities and important for the interpretation of outliers.

4.3 Implications for the Thesis

In the chapter the scenario technique as the most holistic and mostly applied method for strategic early warning is presented. The method is covering the requirements of the most steps of strategic early warning systems and can be applied more generously than other methods applied in this field (see fig. 4.1). Nevertheless the user has to pay attention that not all aspects of the steps can be considered by using a scenario which is limited to the factors considered and therefore unable to cover all factors which may impact the success of a business. Especially if continuities arise combined with the appearance of new impact factors a holistic strategic early warning system has to be complemented by other methods to discover new developments with a potential impact not involved in the scenario.

In the context of the thesis the scenario technique is followed up due to the described advantage of covering all three primary steps of the early warning process. Besides the de-

[341] cf. Müller/Zeiser (1980), p. 613 ff.

[342] cf. Kreilkamp (1987), p. 284

[343] cf. Rauscher (2004), p. 64

mand of using some of the other mentioned methods complementarily, some of them are also recommended for application in the scenario creation process. Especially the cross-impact analysis plays an important role in aggregating the projections to consistent bundles. Further on the identification of discontinuities in scenarios can be implemented by a discontinuity interrogation and the impact on the scenario paths evaluated by a cross-impact analysis again or a vulnerability analysis.

The anticipation of oil price developments addressed subsequently requires a holistic approach from identifying the varying influence factors to assessing the impact to the enterprise like represented by the scenario technique. The portfolio analysis only identifies weak signals for already defined parameters and would not be a suitable instrument for this purpose. Structural trend lines would be a helpful instrument to identify new impact factors on the oil price but would also not overcome the whole range of the task. Cross-impact analyses as well as vulnerability analyses are only able to support one or two steps of the scenario creation process and are dependent on subjective probability assumptions which are not adequate for the given state of uncertainty. Finally the discontinuity interrogation is limited to discontinuities and able to complement the scenario technique this way but is not covering trends which are of main interest for the thesis.

It may be also harmful to rely on scenarios without knowing their characteristics, especially that they are a method to learn about potential futures and not to represent reality. They are per se not an aid to minimize uncertainty and risk but to handle them and consequently delivering an input for the planning approach or to evaluate strategies by opposing them to the scenarios. Only by the preparation of measures for the scenario paths the impact of the uncertainties can be reduced. This target is supported by monitoring them resulting in the recognition of the most realistic scenario path and the recommendation of the measures to handle the uncertainty respectively the risk if the significance of a scenario path can be quantified.

5 Characteristics of the Petroleum Upstream Sector

The following chapter should describe the petroleum upstream industry in terms of its success factors, the significance of the oil price and the description of the business environment based on the classification from the literature.

5.1 Success Factors of the Petroleum Upstream Industry

All generations of early warning systems can be used to anticipate not only risks, but also entrepreneurial crisis, which are indicated by the loss of the key success factors and consequently by competitive disadvantages and earnings crisis. In this context strategic crisis are difficult to recognise in contrast to a liquidity crisis for example.[344] As a consequence it is essential to know the success factors of an industrial sector or the business in general. The topic success factor research is already discussed in the strategy content research in chapter 3.1.3.

Investigations identified the need to define success factors not only related to the industrial sector. *Kühn* and *Grünig* formulated four categories of success factors:[345]

- General success factors are valid for all sectors and markets. They should explain success differences between companies and business units and their impact is generally given. They are abstractly defined variables like market position, product or service quality and customer orientation.
- Market specific success factors are valid for sectors and markets, their impact is alternating by time and they represent more concretely defined variables like a specific dimension of product quality, the density of the service network or cost efficient production.
- Company specific success factors stand for the quality of the usage of general or market specific factors by a company. They are valid for the company or a business unit and their impact is dependent on the behaviour of the competitors. These defined states or values are for example a realised quality leadership, technological predominant production facilities or more service locations as the competitors.

[344] cf. Wolf/Runzheimer (2003), p. 56

[345] cf. Kühn/Grünig (2000), p. 92 ff.

- Success Factors focused on functional or sub-functional activities explain the success of certain activities. They are generally valid and formulated as concrete behaviour proposals, such as success factors of the business process reengineering (support by top-management, employee training, integration of suppliers and customers,…) or of management recruitment (work content, leadership style, company image,..).

Studies considering general success factors are widespread, above all the already discussed PIMS-program[346] as well as the study of *Peters* and *Waterman*[347] are pioneers in the field of empirical research on success factors. On the other hand the investigation of sector specific success factors is quite rare and restricted to a small number of industries. Due to the fact that each branch has its specific characteristics and measures for success, general results are limited in their representative value and not able to serve as a reference basis. Therefore new procedures have to be developed to acquire significant results, where advisors with a close knowledge of the business have to be involved in the research. This chapter is based on a study[348], which investigated the success factors of the petroleum exploration and production (E&P) sector empirically. By content the chapter represents the success determinants of the upstream industry, the methodology of the study and the relevant results.

5.1.1 Success Determinants of Exploration and Production

The petroleum E&P industry is at a state, where globalisation and an increasing level of integration in form of mergers, acquisitions or strategic alliances shape a business of vanishing resources. A few years ago promising acreage and ownership of state-of-the-art technology were perceived as the decisive components of a positive business development. In case of profitability ensuring oil prices companies are able to acquire competitors as well as acreage to an extent which is not affordable otherwise, additionally the new development supports the trend of increasing commoditisation of technologies. The severe competition forces the enterprises more and more to formulate adequate strategies and to identify the significant success factors in the race for reserves. The underlying study should represent and discuss the results of a worldwide survey, which purpose exploring success factors regarding the situation in the industry where a rising oil price causes significant changes for petroleum businesses. The data acquisition is performed by a questionnaire, which was sent to the chief executive officers of 361 companies operating in the exploration and produc-

[346] see Springer (1973), p. 1177 ff.

[347] see Peters/Waterman (1984)

[348] see Frieß et al. (2008), p. 145 ff.

tion business. The 21 returned questionnaires (see tab. 5.1) correspond to a response rate of 5,8 %.

Tab. 5.1: Responding Exploration and Production Companies

Companies (alphabetic order)	Country	MMboe proved Reserves
APF Energy	Canada	20-50
BG Group plc	United Kingdom	1000-5000
Clear Energy Inc	Canada	<20
Contango Oil&Gas Company	United States of America	<20
ECOPETROL S.A.	Colombia	1000-5000
El Paso Production	United States of America	300-1000
EXCO Resources	United States of America	50-100
Lundin Petroleum AB	Switzerland	100-300
Mission Resources Corporation	United States of America	20-50
MOL PLC.	Hungary	100-300
Noble Energy Inc.	United States of America	300-1000
North Coast Energy	United States of America	100-300
OMV	Austria	300-1000
PrimeWest Energy	Canada	100-300
Questar E&P Company	United States of America	300-1000
RAG	Austria	20-50
RWE Dea AG	Germany	300-1000
Teton Petroleum Company	United States of America	<20
Türkiye Petrolleri A.O. (TPAO)	Turkey	1000-5000
Williams Companies Inc.	United States of America	300-1000
Wintershall AG	Germany	300-1000

In the first step it is essential to define success, before a correlation of certain parameters with success is realisable. Comparable to all industries profitable growth is a common goal for a long-term oriented business, which is also confirmed by the results of the study, only the indicators to measure it vary from case to case. In the study two indicators for both, profitability and growth, are introduced to represent success in E&P. These parameters are selected in workshops together with experienced managers deployed in the fields of E&P, economics, finance, strategy and technology.

Considering profitability understandably the oil price plays a major role, but a company can only influence the profit margin on the cost side. Besides possible acquisition expenditures the costs involved in E&P and therefore of major concern are:[349]

- Finding costs: Exploratory expenditures per barrel of oil equivalent spent in locating new reserves including geological, geophysical, lease acquisition, exploratory drilling and other costs

[349] cf. Allen/Seba (1993), 509 ff.

- Exploration costs: Expenses incurred in performing geological and geophysical studies and in the positioning and drilling of test wells
- Development costs: Expenses incurred in drilling and developing a property for production
- Production costs: Expenditures to operate and maintain wells, related equipment and facilities including depreciation

The oil and gas price as the other direct influence on the margin is determined by the market and not linked to the performance of a single company. Another difference to the generality is that investments in new petroleum ventures are exposed to a high risk of drilling dry holes and that in this case not at any time of the project a positive cash flow will be generated.

Regarding the survey representative indicators should be identified reflecting several performance aspects of an enterprise. As the first determinant the return on average capital employed (ROACE) is chosen, which is calculated by dividing the net operating profit after taxes (NOPAT) by the average capital employed (ACE). Among other things this indicator is influenced by the extent of investments and the associated risk, the costs and certainly the oil price.

Since the majority of petroleum companies is quoted at the stock market the total shareholder return (TSR) is the second measure reflecting the market performance and equity changes of an enterprise. It quantifies the total return of a share and is evaluated as the ratio between the dividend plus the capital gain over a period of time per share and the initial share price.

In terms of growth, reserves and their replacement as well as the amount of production are decisive. The estimation of petroleum reserves represents a complex issue and is associated with uncertainties. Therefore they are given by probabilities and only proved reserves are taken under consideration. Another source for deviations are different definitions of proved reserves, as an example the Energy Information Administration defines them as follows:[350]

"Proved reserves are those volumes of oil and gas that geological and engineering data demonstrate with reasonable certainty (probabilistic methods use a probability of at least 90 percent) to be recoverable in future years from known reservoirs under existing economic and operating conditions."

[350] cit. EIA (2003)

This definition gives evidence that not only the access to new reserves is decisive, yearly revisions have to consider the oil price, the operating costs and the development of technology too. The EIA attribute the increase of proved reserves to revision increases, acquisitions, extensions, new field discoveries, new reservoir discoveries in old fields as well as adjustments of statistical estimation methods and the decrease to sales, revision decreases and production.[351]

It is comprehensible that in a long-term view an enterprise can only ensure its existence if reserves are replaced consistently. Consequently a significant measure in the industry is the reserve replacement rate respectively ratio (RRR), the proved oil equivalent reserve additions are divided by the production in a certain time period. It is reasonable to evaluate the reserve replacement rate as an average of several years (in the survey a three years average is used), since especially smaller companies face recognisable yearly fluctuations concerning this parameter.

The other growth related indicator is production growth and represents the relative yearly change of production rate expressed as a percentage. It is amongst others a mirror for the field development progress, the technology used in an enterprise and reserve additions ready to produce.

Summarised, four indicators for the success of an E&P company are determined for the purpose to apply a correlation analysis (see tab. 5.2). The participants should specify their return on average capital employed and total shareholder return standing for profitability and their reserve replacement rate and production growth expressing growth. Additionally the term "Total Success" is introduced in the study representing the average of the four discussed measures, therefore the capability of a company to combine growth and profitability. The balance of the two targets is considered to be controversial, i.e. the study of *Osmundsen et al.*[352] states that the strong focus on the ROACE prevents from investments at the expense of organic reserve replacement.

5.1.2 Research Methodology

Since no similar studies focusing on the same or a related industry are available only the framework is based on a literature review. The contents of the survey are developed empirically with the integration of the knowledge and experience of several senior managers of the sector. The project phases, the corresponding activities as well as the sequential outputs are described subsequently.

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[351] cf. EIA (2003)

[352] see Osmundsen et al. (2005)

After defining the problem, the first task is to get to know potential success factors of the industry and which categories of them are significant. For this purpose the people involved in business are interrogated by an internal survey in a petroleum corporation. To cover all aspects of an E&P company in this survey, the organisation charts of various departments are summarised in an overall table and contact persons are identified. Next to the interrogation of the success factors themselves the key performance indicators to measure them are of interest in the survey. To provoke creative answers the potential improvements if creating a new company are put into question too. The questions were developed in workshops with practitioners in the interrogated company.

The survey is carried out by e-mail and confronted the contact persons with three general questions:

- What are the most critical success factors for an E&P company?
- Which key performance indicators (KPIs) correspond best to (measure) these success factors?
- If creating a new E&P company, what would you do differently?

One fourth of the addressed managers respond to the request. The list of acquired possible success factors and performance indicators is extended by investigating internal information, annual reports, information from analysts and consultants as well as the database of John S. Herold.[353]

Based on the lists, categories are identified covering all mentioned potential success factors to provide a classification for analysing purposes. Finally seven categories are defined:

- Finances: characteristics of project financing
- Quality of acreage: description of acreage
- Technology: significance of technology in company
- Staff: staff competence and development policy
- Corporate culture: cultural characteristics
- Stakeholders: significance of stakeholders
- Organisation: description of organisation structures

Subsequently, the created questionnaire should gain information about success, company characteristics and strategy besides acquiring the contact data and the company profile.

[353] see Herold (2005)

The success related part should ask the participants to define success by themselves, to assess their success in terms of given specifications, to rank the importance of the success factor categories and above all to fill in success factors and key performance indicators of their enterprises.

The characteristics section should investigate specified data covering all aspects of the business based on the success factor categories. In this way special relationships should be detected, which may indicate different success factors in an objective view.

Concerning strategy, future plans should be interrogated to identify trends of the industry and the behaviour of successful corporations. Additionally strategy related performance indicators as well as management systems and tools implicating the strategy are questioned.

The company profile should complete the data acquisition and serves for the purpose of checking the interrelationships of the results to the other questionnaire parts like type, size, age, profitability and growth of the companies.

To be able to interpret the results meaningfully, certain supplementary analysis methods are applied which are visualised in extracts in figure 5.1. After the general statistics (mean values, standard deviations) the data is correlated with the company profile, above all with the success determinants. This procedure is based on the methodology of the PIMS-program[354], where certain parameters are correlated with the success determinants return on investment and return on sales, but with an adaption to the determinants of the petroleum upstream sector. Since the study is primarily of explorative nature the focus is on the characteristic differences between more and less successful companies. Consequently no dependencies are analysed due to the limited samples for the separation of dependent and independent variables and a correlation analysis with equal weighted variables without identifying cause and effect is performed instead of multivariate analyses (factor analysis, conjoint analysis,…). The resulting correlation factors give evidence about the interrelationships between the specifications and should identify performance drivers respectively success factors and are represented in detail in table 5.2. The underlying questionnaire is content of the appendix including the explanation of the questions corresponding to the abbreviations in the table.

The second method separates a group of seven top performers from the other companies for the purpose to find out how very successful enterprises differ from the average. Therefore the mean values of the two groups are compared and the relative difference should answer which details cause the above-average achievements. In this way further success factors of the industry should become apparent. Finally growth and profitability variables including the company size and two types of strategy specifications are opposed graphi-

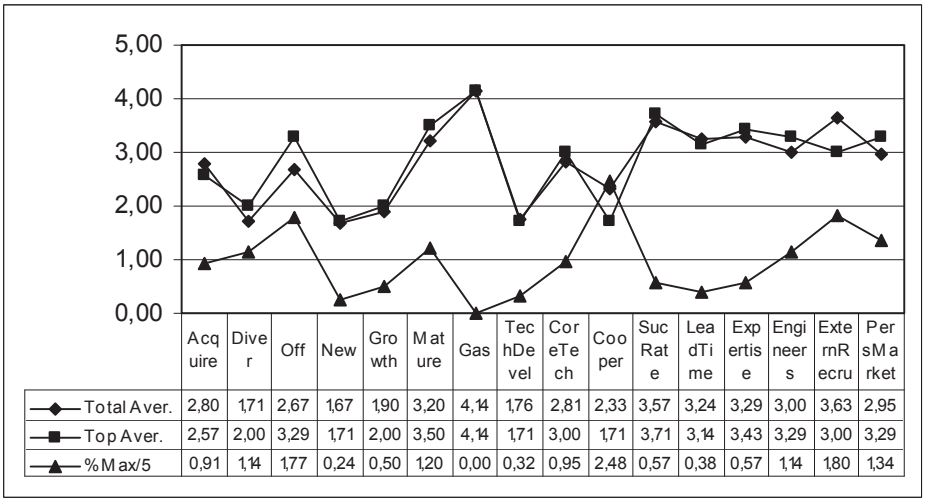
[354] see Springer (1973), p. 1177 ff.

cally. This method aims at the identification of interrelationships between growth and profitability, of a size-related performance as well as a strategic direction in the business.

Correlation Analysis

Turnover	Empl	Years	Return	TSR	Prod	ProdGrow	ProvedRes	RRR	TotalSuccess	
-0,354	-0,310	-0,364	-0,662	-0,069	-0,231	0,184	-0,224	0,046	-0,219	Acquire
0,229	0,291	0,101	0,162	0,156	-0,019	0,285	0,322	-0,153	0,083	Diver
0,500	0,254	0,032	0,324	0,323	0,232	0,005	0,348	0,196	0,354	Off
-0,034	0,089	-0,013	-0,162	-0,423	0,026	0,369	0,060	0,128	-0,236	New
0,514	0,394	0,304	0,175	-0,112	0,380	-0,055	0,483	0,339	0,119	Growth
-0,106	-0,144	-0,095	0,275	0,381	-0,101	-0,185	-0,186	-0,127	0,316	Mature
-0,158	-0,314	-0,085	-0,154	0,037	-0,022	0,018	-0,144	0,415	0,262	Gas

Top Group Analysis



	Acquire	Diver	Off	New	Growth	Mature	Gas	TechDevel	CoreTech	Cooper	SucRate	LeadTime	Expertise	Engineers	ExternRecru	PersMarket
Total Aver.	2,80	1,71	2,67	1,67	1,90	3,20	4,14	1,76	2,81	2,33	3,57	3,24	3,29	3,00	3,63	2,95
Top Aver.	2,57	2,00	3,29	1,71	2,00	3,50	4,14	1,71	3,00	1,71	3,71	3,14	3,43	3,29	3,00	3,29
%Max/5	0,91	1,14	1,77	0,24	0,50	1,20	0,00	0,32	0,95	2,48	0,57	0,38	0,57	1,14	1,80	1,34

Growth-Profitability Analysis

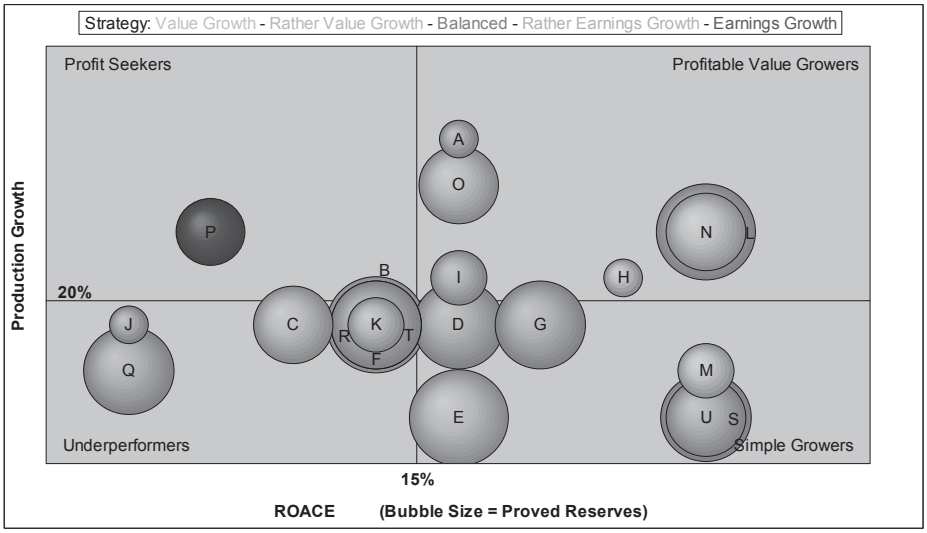


Fig. 5.1: Methods for Data Analysis[355]

[355] Frieß et al. (2008), p. 157

Tab. 5.2: Correlation Analysis and Significance

	Turnover	Empl	Years	Return	TSR	ProdGrow	RRR	TotalSuccess
DefSuccess	-0,046	-0,377 *	0,027 **	0,072 *	0,464	0,316	0,337	0,541
Recovery	0,179	-0,068 *	0,100 *	0,160 *	0,044	-0,053	0,288	0,279
Replacement	-0,022	-0,455 *	-0,139 *	-0,189	0,324	0,148	0,303	0,344
ProdGrowth	-0,201	-0,375 **	-0,374 *	-0,316	0,140	0,660 *	0,393	0,397
ExpSuc	0,287	0,030	-0,209	0,308 **	0,000	-0,122	0,068	0,193 *
CostRed	0,078	0,014 *	0,244 **	0,104 *	0,151	-0,575	-0,370	-0,267
LowTax	-0,071	-0,052 *	-0,239	-0,067 *	-0,064	0,016	-0,068	-0,068 *
BalRisk	0,000	-0,254 *	0,102 *	0,093 *	0,334	0,206	0,368	0,472
CoreComp	-0,053	-0,297 *	-0,082 *	0,223 *	0,215	0,104	0,198	0,354
Talents	-0,176	-0,267 *	-0,080 *	0,083 *	0,379	0,534	0,155	0,466
Entre	-0,005	-0,151	0,173	-0,045 **	0,281	0,200	0,138	0,138 *
StakeSat	0,167	0,011 **	0,256 **	0,262 *	0,308	0,232	0,037	0,356
EmpSat	0,025	-0,178 *	0,000 *	0,179 *	0,365	0,420	0,198	0,489
GetDeal	0,375	0,428 *	0,137 *	0,221 **	0,319	0,078	0,041	0,282 *
Contact	-0,237	-0,032 **	-0,082 **	-0,074 *	0,143	0,226	-0,329	-0,076
Reput	0,020	-0,212 **	0,202 **	0,138	0,155	0,086	0,224	0,281
ShareRet	0,009	-0,160 **	0,155 **	0,282	0,188	0,081 *	-0,101	0,221
EarnGrowth	0,126	-0,031 *	0,113 *	0,082 *	0,375	0,048	0,002	0,251
Value	0,157	-0,031 *	0,011 *	0,041 *	0,335	0,048	0,087	0,251
Roace	0,230	-0,025 **	0,303 **	0,335 *	0,265	-0,120	-0,118	0,161
RankFinan	0,093	-0,165	0,083	0,163 **	0,277	-0,228	0,078	0,204 *
RankAcreage	-0,508	-0,324	-0,239	0,105 **	-0,013	0,517	-0,123	0,080 *
RankTech	-0,600	-0,597 *	-0,373 *	-0,395	0,054	0,258 *	-0,098	-0,144
RankStaff	0,138 **	0,227	0,471 *	0,376 **	-0,080 **	-0,313 *	-0,225 *	-0,213 **
RankCult	-0,310 *	-0,070 **	0,319 **	0,132	0,392 *	0,025 **	-0,426	-0,054 *
RankStake	0,325 **	0,352 **	0,283 **	0,411	-0,074	-0,403 **	-0,244 *	-0,157 *
RankOrg	0,153 **	0,091 **	0,198 **	0,146	0,435 *	-0,261 **	-0,039 *	0,271 *
Opec	0,501 **	0,386 **	0,270 **	0,092 **	-0,088 **	-0,186 **	0,148 **	0,000 **
Oecd	-0,195	-0,309 *	0,074 **	0,301	0,370	0,337	0,239	0,648
Polit	0,730 **	0,600 *	0,292 *	0,190 **	-0,073 **	-0,302 *	0,339 **	0,116 **
Acquire	-0,354	-0,310	-0,364	-0,662 *	-0,069	0,184	0,046	-0,219 *
Diver	0,229 **	0,291 *	0,101 *	0,162 **	0,156 **	0,285 **	-0,153 **	0,083 **
Off	0,500	0,254	0,032	0,324 **	0,323 *	0,005	0,196	0,354 **
New	-0,034 **	0,089 *	-0,013 *	-0,162 **	-0,423 **	0,369 **	0,128 **	-0,236 **
Growth	0,514 **	0,394 *	0,304 *	0,175 **	-0,112 **	-0,055 **	0,339 **	0,119 **
Mature	-0,106	-0,144	-0,095	0,275 **	0,381	-0,185	-0,127	0,316 *
Gas	-0,158	-0,314 *	-0,085 *	-0,154	0,037	0,018	0,415	0,262
TechDevel	0,750 **	0,484 **	0,502 **	0,415 **	0,080 **	-0,602 **	0,176 **	0,085 **
CoreTech	-0,090	-0,229	0,081	0,185 **	0,178 *	-0,277	0,143	0,189 **
Cooper	0,634 **	0,595	0,362	0,271 **	-0,242 *	-0,499	-0,047 *	-0,198 **
SucRate	0,144	0,216 *	0,494 **	0,439 **	0,288	-0,308	-0,133	0,163
LeadTime	0,277	0,464 *	0,613 *	0,569 **	-0,046	-0,355	-0,445	-0,193 *
Expertise	-0,495	-0,597	-0,175	-0,212 *	0,178	0,186	-0,157	-0,054 *
Engineers	-0,084	0,093	0,468	0,643 **	0,036	0,000	-0,314	0,193 **
ExternRecruit	0,069	-0,165	-0,599	-0,602	-0,178	0,038	0,412	-0,047
PersMarket	-0,291	-0,317	-0,289	-0,051 **	0,326 *	0,150	-0,059	0,242 *
Female	-0,046	-0,153	-0,224	0,041 *	0,482	0,095	0,058	0,387 *
DecSum	0,140	0,138	0,380	0,423 **	0,000 *	-0,345	-0,239	-0,096 **
HSE	0,014 *	-0,098	-0,072	0,395 **	0,095 *	0,108 *	0,314 *	0,537 **
Incidents	0,152 **	0,406 **	0,276 **	0,000 **	0,069 **	0,067 **	0,071 **	0,073 **
Stake	0,109 *	0,215	-0,175	-0,098 **	0,071 *	-0,126	-0,119	-0,150 **
SatEmp	0,308 **	0,137	0,181	0,165 **	-0,095 **	-0,154 *	0,598 **	0,336 **
SatCust	-0,105 **	0,058	0,000	-0,141 **	-0,408 **	0,000 **	0,073 **	-0,289 **
SalaryLink	0,032	-0,195	0,084	0,076 **	0,146	-0,098	0,428	0,348 *
Decentral	0,313 **	0,063	-0,076	-0,111 **	0,000 **	0,182 **	0,616 **	0,340 **
Flexible	-0,377	-0,573	-0,266	-0,018 *	0,362	0,503	0,252	0,512
DebtCap	-0,252	-0,158 *	-0,074 *	0,217 *	0,000	0,485	0,125	0,409
CostImp	0,412	0,251 **	0,064 **	0,097 *	-0,075	-0,245	0,259	0,000
Auction	-0,212 **	-0,088 **	0,103 **	0,125 **	-0,240 **	-0,350 **	-0,379 **	-0,255 **
LowerHurdle	0,306 **	0,521 **	0,421 **	0,404 **	-0,043 **	-0,358 **	-0,044 **	-0,092 **
Operator	0,268	0,053 *	-0,124 *	0,207 *	-0,181	0,264	0,384	0,345
Concession	0,577 *	0,596	0,583	0,556 **	-0,183	-0,458	-0,074	-0,055 *
ProdShare	0,165 *	-0,020	0,067	-0,365 **	0,263 *	-0,228	0,098	-0,062 **
Service	-0,115 **	0,106 **	-0,171 **	0,310 **	0,075 **	0,635 **	-0,013 **	0,395 **
Harvest	0,172 **	0,095	0,191 *	-0,202 **	0,028 **	-0,608 *	0,030 **	-0,177 **
LowRisk	-0,151	-0,263	-0,051	-0,505 *	-0,309	-0,086	0,073	-0,328
LongTerm	-0,050	-0,011 *	0,077 *	0,047 *	0,248	0,263	0,042	0,191
Acqui	-0,366	-0,280	-0,218	-0,472 *	-0,200	0,186	-0,039	-0,231 *
Indep	-0,053	-0,301 *	-0,285	-0,373 *	-0,220	0,301	0,434	0,127
Diversity	0,267 **	0,335 *	0,180 *	0,176 **	-0,097 **	0,024 **	-0,337 **	-0,205 **
EarnGrow	-0,111 *	0,030	0,238	-0,365 **	-0,351 *	0,085 *	-0,052 *	-0,419 **
Global	0,401 **	0,329	-0,079	0,205 **	-0,079 **	0,010 *	-0,026 *	0,000 **
ResLife	0,410	0,255	0,153	-0,021 **	0,062	-0,010	0,116	0,044 **
Invest	-0,257	-0,096 *	0,040 *	0,217 *	-0,023	0,170	-0,111	0,148
Integration	0,245 **	0,252 *	0,000 *	0,367 **	0,000 **	-0,037 **	0,186 **	0,321 **
GasProd	0,024	-0,196 *	-0,031 *	-0,111 *	0,160	0,104	0,453	0,302
Offshore	0,369 **	0,272	0,067	0,364 **	0,367 **	0,065 *	0,081 *	0,354 **
TechLeader	0,142 *	-0,204	-0,391	0,167 **	0,100 *	-0,020 *	0,391 *	0,383 **

T-test interpretation: *…significant for α = 0,05
**…significant for α = 0,005

5.1.3 Relevant Findings

The interpretation of the gathered data discloses performance drivers in all fields of the business and gives evidence about strategic trends.

The Industry's View on Success

The participating companies define success mainly by growth and low costs, in other words profitable growth. Cost targets can be equated with profitability targets since a company is not able to influence the oil price. Consequently mainly the costs can be controlled besides the minimisation of the investment risk. Corresponding to this statement they measure success mostly by operational and cost related indicators. Rather expected is the special position of Northern American corporations, which partially compete exclusively for satisfying their shareholders and use only measures like earnings per share as key performance indicators.

The participants assess their achievement according to their own definition of success rather moderate, they are aware of the determinants of success but may partially fail to develop their business towards this direction. The petroleum industry evaluates itself rather successful in production growth and shareholder return, but criticises its own results in exploration, entrepreneurial thinking of staff and their ability to attract and retain talented people. When asking for success factors that may enable success, the staff competence takes the lead by a wide margin followed by stakeholder satisfaction, quality of acreage and organisation. When ranking the importance of given success factor categories staff leads significantly again, which may be the driver for success in all other categories. The quality of acreage and the financial power are ranked on second place, although only few success factors are mentioned related to these points.

Basically the industry confirms the validity of the selected success determinants for the study: return on average capital employed, total shareholder return, reserve replacement rate and production growth. Remarkable is the overbalance of soft factors that are hold responsible to ensure success. While finance and technology related factors are a minority those concerning staff and stakeholders are leading.

Financing in the Exploration and Production Business

The acquired data makes apparent that financial power is only of marginal significance in case of high oil prices and that reserve replacement is a prioritised objective. Performance measurement by income indicators is restricted to a small number of companies and turns out to be rather conservative.

Since competition for reserves demands fast reactions the readiness to finance major projects by debt capital is pronounced, the majority accepts even lower hurdle rates due to strategic reasons. Nearly each respondent states that his financial base allows him to participate in auction processes purchasing acreage at a high price.

The negative correlation between the significance of financial power and success reasons that the less a company focuses on financial reserves the better it would perform and the more debt capital it takes up the more it grows and profits from it. In accordance with the outcome the industry becomes aware that it is time for investments instead of building financial reserves.

Acreage Characteristics and their Impact

If acreage is acquired by placing a contract with the host government the quality of this field respectively the output is dependent on several factors. Although the seismic data should be already available further uncertainties like e. g. the risk of dry holes, the real reservoir size and height as well as the oil or gas ratio will remain. Acreage of low quality would mean a low producible amount of oil and/or gas and as a consequence a limited positive cash flow.

The influence of acreage related issues is as expected assessed quite significant. Reserve replacement is performed by exploring in new acreage and acquisition of existing reservoirs in equal shares, where the first method is associated with a far higher profitability. The majority focus on its core areas, only larger corporations are forced to diversify their portfolio in order to extend their reserves. The outcome demonstrates that a higher share of offshore assets also have a positive effect on profitability, but only the larger companies have the abilities to gain a working interest in an offshore project. Altogether more than 50% of the considered reservoirs are in the mature phase and only now they contribute to higher profits, the stages before (classified as new respectively growth assets) cash flows are not high enough to raise the profitability. Nevertheless it is noticeable that the top performers do not attribute so much importance to acreage as a concluding and thought-provoking statement.

Technology as a Commodity

Basically petroleum businesses rather disregard technology and doubt its significance. When asking for the enablers of success this category takes surprisingly the last place. Nearly no fraction of the technology used is developed by the company itself, only larger ones are active in this field. The same trend is shown by the poor cooperation with universities and other research institutions. On the other hand they assess the impact of new

technologies on exploration respectively development projects above average. Obviously the producing industry prefers to purchase it from external providers or contract service companies.

A closer look makes apparent that an improvement of the exploration success rate and the development lead times correlate significantly with profitability. This circumstance is no direct contradiction to the poor ranking of technology, it only states that the enterprises favour to outsource research and development activities so that they do not have to care in this regard.

Shareholders are not the sole Stakeholders

While the contributing companies assess the relationship to their stakeholders as very positive it is recognisable that performance indicators are rather restricted to shareholders. Quoted companies, especially in Northern America, are orientated on stockowners, supported by the fact that they measure success exclusively by shareholder indicators. The companies evaluate the employee satisfaction now and then, rarely periodically, but should be conscious of who will be the source of surpassing results. A correlation with the total success of a company results in the statement that the more they care about staff and the more they motivate them, e. g. by a salary linked to the profit, the better an enterprise compete. On the other hand the seven top performers out of the interrogated companies indicate a three times higher percentage of entries regarding shareholder value when defining success. Nevertheless the latter statement does not reflect how they try to improve their share performance.

Consequently the question, if satisfied and motivated staff or a consequential shareholder orientation contributes more to excellent share earnings is a suggestion for possible subsequent studies on this basis.

Organisation: Decentralised and Flexible Structures

The more and more dynamic business environment increases the demands on the organisation of an enterprise. Only an adequately organised corporation turns out to be successful in competition.

Not only the correlations give evidence of the importance of organisation related themes, also the own judgement of the participants confirms their awareness that these factors are enabler for success. Although most companies indicate to be organised in a centralised form, rarely a corporation is fully controlled by its headquarters without the input of other units, and one third of the structures is even decentralised. As a consequence they assess their organisational structure capable to ensure flexibility regarding business demands in

the subsequent question. Both criteria, decentralisation and flexible structures, correlate significantly with the growth of a company, although they have only a poor influence on profitability. Additionally the analysis of the top performers approves these statements since the more successful group is amongst others also characterised by more flexible and decentralised structures. The outcome justifies terming these two tested organisation parameters as success factors if they are specified in the described manner.

Top Performance by Staff Competence

Staff competence is in the opinion of nearly all participating companies the dominating success factor respectively the main driver for success. Talented staff leads the ranking of the success factor categories by a wide margin and is the most mentioned success assurance, on the other hand related performance indicators are rarely formulated.

Concerning the personnel strategy the engineers, geologists and geophysicists have an average expertise of about 20 years and capture a fraction of 30 to 40 percent of the total white-collar staff. Approximately a third of managers in leading positions are recruited externally and only a half of the companies implement a long-term personnel development strategy.

Taking the impact on success into consideration, the participants who evaluate their ability to attract and retain talented employees better can also capitalise it. A higher fraction of engineers affects the profitability significantly and a flexible personnel strategy dependent on the market conditions instead a continuous long-term development turns out to be advantageous too. The comparison of the top-level businesses and the average countersigns these relationships, additionally they recruit far more top managers internally instead of externally.

Evaluation of the Strategic Direction

The interrogation of the strategic attitude of the participants discloses a significant focus on growth and profitability, especially in a long-term view, again. None of the companies indicated to be in a harvesting mode and a short-term profitability is very unpopular. This specification should be realised by exploration and acquisition in equal measure, but a weak risk aversion is demonstrated by the results. Further on the competitors try to succeed rather without forming strategic alliances and to stay in a niche business in their core areas. Value growth in terms of reserves is more desired than earnings growth, even though the majority is indecisive in this regard, which confirms that the combination of reserves growth and profitability is of key interest. Concerning reserves the companies aim at balancing exploitation and reserve life increase. In case of excellent oil prices they tend to-

wards extended investments, which are mainly used for the core business, vertical integration seems not to be among the goals of the main part. The strategy of the companies indicates an increasing interest on gas production. Offshore assets are obviously more and more popular too, although definitely more barrels originate from onshore reservoirs. Regarding the data technology appears to be only of poor to moderate significance in the future too.

The key performance indicators, which are part of the strategy statement of the participants, are similarly distributed as the measures they use corresponding to the success factors. Operational indicators predominate as an expression of value growth in front of cost metrics ensuring the profitability.

5.1.4 Conclusions

The concluding chapter summarises and interprets the findings categorised with regard to the main objectives of the study: to acquire success factors, key performance indicators and investigate the actual strategy of the industry. The conclusions are mainly based on the separated groups of top performers and companies with a weaker performance as well as on the correlation of the parameters with the success determinants. If the statements are based on the correlation analysis, the parameter investigated is mentioned in brackets as termed in table 5.2.

Success Factors

The analysis implies the conclusion that staff competence is definitely the key success factor ensuring success. The top performers can be distinguished from other competitors especially by their ability to attract and retain talents. The participants state that skilled staff is responsible for business excellence in all other concerns.

To offer an adequate attractiveness for staff, shareholder, business partners, contractors and others the stakeholder satisfaction plays also a major role. The stakeholder category is basically not ranked at a top position, but all other results give evidence that the effect on the performance is indisputable. Especially more successful corporations explain success mainly by the satisfaction of their stakeholders. Contented staff and stockowners seem to be a main driver for business growth.

The quality of acreage is the third important success factor, although the top companies rather ignore this point in their success definition since they possibly evaluate it as given. The concentration on core areas is not necessarily associated with profit, diversity creates slightly better results even concerning profitability. Offshore assets are more and more

popular and justifiable so, the more successful participants produce a far higher fraction offshore.

How a company is organised seems to have a great impact on exploiting the growing potential. Above all decentralised ("Decentral" in tab. 5.2 – significant for reserve replacement) and flexible ("Flexible" – not significant) structures are needed to face the business demands in an adequate way and represent a significant success factor, especially the top companies differ from the other ones by the establishment of sophisticated structures.

Although the companies rank the importance of financial power in the upper third of the categories, the influence on success is rather poor. In a situation of profitability ensuring oil prices the companies the companies are forced to invest instead of building financial reserves. To finance major projects by debt capital ("DeptCap" – significant for profitability) shows a correlation with success, to care about costs only restricts the production growth and is not recommendable in such a situation according to the analysis.

The company culture is not evaluated as a key success factor in the survey, noticeable is only the high effect of a reasonable health, safety and environment policy ("HSE" – significant) on the total success.

Technology turned out to be no decisive factor, none of technology parameters seems to improve the performance. Technology leader ("TechLeader") are slightly more profitable but not able to grow, not only since technology development is rather reserved to large competitors.

Summarised, staff competence represents the key success factor and leads by a wide margin, further success factors are satisfied stakeholders, a balanced acreage portfolio in terms of area diversity, off/onshore and risk, flexibility ensuring structures, a growth strategy in the current situation as well as an adequate health, safety and environment culture.

Key Performance Indicators

The companies' targets are transformed mainly to operational measures expressing the desire to grow, the indicators reserve replacement rate and production rate predominate. In all categories no significant differences between the top performers and the average can be detected.

Since growth should also be profitable the cost indicators take the second place. In this regard finding and development costs as well as other operational costs are leading.

Other measures for growth are the income indicators, which are mainly dependent on the categories above and favourably represented by earnings before interests and taxes (EBIT) related values.

Shareholder value and direct profitability indicators are attached with less importance, although some companies are only oriented on the share performance and certain participants establish measures of these categories in their strategy statement.

Strategies for Success

To succeed in a long-term view means for a petroleum company to replace the produced reserves over the years combined with a reasonable profit. This statement is confirmed by the findings, which indicate a general target to grow profitably, especially production growth and return on average capital employed are suitable measures to determine success according to the results.

A close look at the analysis discloses a contradiction between growth and profitability in the most cases since the replacement itself is only profitable associated with successful exploration activities. To achieve a reasonable replacement rate means also to acquire assets and companies, whereas the earnings growth is retarded.

In other words the study makes apparent that the companies are not able to stay on the top concerning both, value and earnings growth, the growth and consolidation phases are alternating. Successful strategies may be to leave the group of profitable growers consciously and well controlled for a predetermined time and turn back with a new potential. While replacing the reserves have to remain at least at a similar value, only the revenue growth is allowed to decrease. In the consolidation phase a temporary harvesting strategy is recommendable to create new financial reserves for the next investment phase. The key factors of this strategy seem to be the right timing, if a corporation gets stuck in one of the phases the sustainable success is endangered and it risks failing in both concerns. In this situation a return to the profitable growers is nearly impossible for an under-performer without financial and petroleum reserves.

To realise this strategy flexible structures are required. The top performers identified in the analysis care less about technology development, focus more on the personnel market than on a long-term development strategy and establish flexibility ensuring structures, although a similar average size of the top companies and the other ones is given.

In situations of high oil prices unambiguously strategies towards value growth are created since the high prices implicate an excellent profitability at the same time. In an operational view the more successful strategies seem to be a focus on successful exploration, offshore assets and gas reserves.

5.2 Drivers and Impacts of Oil Price

The subsequent chapter discusses the oil price as the most influencing factor for the petroleum industry, which has impacts on a macro- and microeconomic level. After an introducing paragraph about macroeconomic consequences of oil prices the historical and actual price developments are described for the purpose to disclose drivers and interrelationships. Finally the impact on the business level is investigated to highlight the important role of oil prices for petroleum companies. Since the price of gas is linked to that of oil by regionally different mechanisms, only the prices of the crude oil are considered.

On a macroeconomic level oil prices have a substantial power for the economic health of the world. In oil importing countries the production of goods, measured by the gross domestic product (GDP), faces a loss in case of increasing oil prices. This circumstance is even more problematic for developing importers than for industrial countries. It is a consequence of transferring the income from the importers to the exporters and leads to inflation, higher input costs, reduced non-oil demand as well as lower investments. In succession nominal wages are under an upward pressure which increases in combination with a decreasing demand to higher unemployment rates.[356] In sum all macroeconomic indicators representing the wealth of an economy are concerned by oil price increases in importing countries. The impacts of significant oil price increases like in the course of the oil price shock in the seventies or the skyrocketing developments since 2005 until the financial crisis in 2008 can be differentiated concerning their consequences. The oil price shock in 1973 was caused on the supply side primarily by the Organisation of Oil Exporting Countries' (OPEC) oil embargo and provoked an acceleration of inflation as well as a recession. From 2005 to 2008 the increasing prices were a consequence of the expanding demand in a booming world economy triggered by market speculation, which also decreases the GDP growth at a lower extent but rather cause a deflation.[357] It has to be mentioned that this rule was broken by the financial crisis in the end of 2008 and that the negative effects of increasing oil prices are significantly stronger than the positive ones of decreases, thus the contrariwise developments have no symmetric effects on economy. Since oil price changes would have the reverse impact in oil exporting countries, they may partially compensate the decrease of GDP in a global view in case of high oil prices. This would be dependent on the way they spend their additional profits, saving those revenues would cause a higher GDP loss than spending them for imported goods.[358] Recapitulating, oil prices are an essential driver for the global economy and may have extensive consequences, their impact on a microeconomic is content of chapter 5.2.3.

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[356] cf. IEA (2004), p. 2 ff.

[357] cf. Grömling (2008), p. 317 f.

[358] cf. IEA (2004), p. 13

5.2.1 Historical Development of Oil Price

This chapter describes the major events in the historical oil price development and should disclose the sensitivity of the price to geopolitical and economic influences (see fig. 5.2). The excerption of the oil price history is based on the book of *Yergin*[359], the subsequent chapter is dedicated to the trends of the last years.

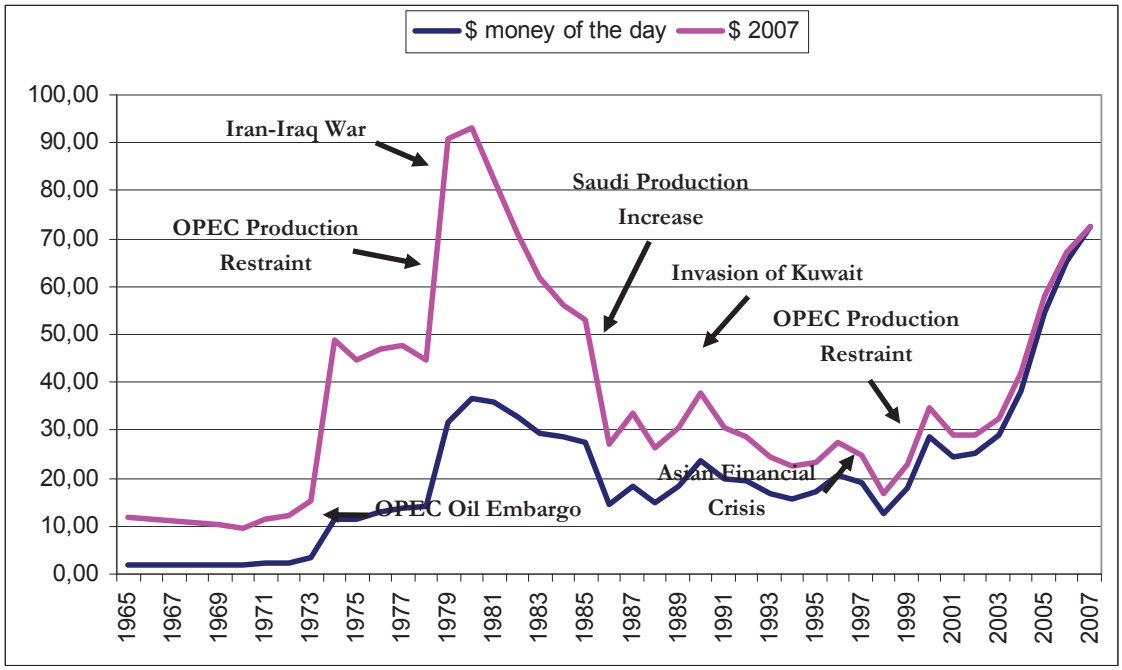

Fig. 5.2: Historical Oil Price Development (Arabian Light 1965-1983, Brent 1984-2007)[360]

Starting in 1960, low oil prices were the trigger for the foundation of the OPEC with the objective to defend oil prices and act united against international oil companies. In the first decade of OPEC's existence the missing willingness of the members to reduce oil production caused rather internal problems than an impact on the global oil market. With the increasing demand the dependence of oil importers on OPEC, especially in Europe, was increasing. Combined with a political turmoil in Libya, the closing of the Suez Canal and a pipeline accident preventing the supply to Europe the OPEC members realised their power for the first time and increased their profit share in contracts with international oil companies massively. The escalating demand and the associated panic buys in the United States caused skyrocketing oil prices in 1973, also known as the first oil crisis. Another increase of

[359] see Yergin (1993)

[360] data: BP (2009)

profit shares in favour of the OPEC and a high inflation of the US-Dollar, which means that the earned money lost more value than the oil in the ground, motivated the members to implement production limits. The support of the United States for Israel in the Yom Kippur War induced a total embargo of OPEC oil for the States. The embargo was lifted after the negotiations of US adviser Henry Kissinger in 1974. While the oil importers faced a recession the petrodollars were used for nationalisations of the oil industry in many OPEC states. A disadvantage of the money flooding was a high inflation, which caused internal turmoil in Iran due to exorbitant prices for goods and ended in strikes of oil employees and the paralysation of exports. Together with the change of the Iranian regime oil prices increased again. With the start of the Iran-Iraq War another lack of exports arose and oil prices were escalating again in 1979 to 1980. Subsequently production increases in Saudi Arabia and non-OPEC states stabilised the oil prices in the eighties. Further on the OPEC lost market share and power too.

The intentions to stabilise the oil price in the eighties were supported by the function of Saudi Arabia as a "swing producer", which adapts its production contrarily to the price trends. At the same time futures markets like the New York Mercantile Exchange (NYMEX) were introduced to offer a possibility for the traders to hedge their risks. Decreasing prices forced the companies to mergers and consolidations and due to the underrated companies at the stock markets acquisitions were cheaper than exploration activities. The lack of markets increased the indebtedness of some oil exporters since the markets for OPEC oil were disappearing. The consequence was the negative oil shock in 1986 provoked by the attempt of the OPEC to gain market share by higher production quotes independent on the oil price. Later on the oil producing countries agreed to limit the production to stabilise the oil price between 15 and 18 US-Dollars per barrel.

The balance of the oil market was then interrupted by Iraq's invasion to Kuwait in 1990, whereas Iraq tried to acquire new reserves and solve its financial problems. Although the allies liberated Kuwait and Saudi Arabia tried to compensate the production deficits the oil price was increasing significantly again. After the slowdown of the situation and the stabilisation of the oil price the trend was interrupted by the Asian crisis starting in 1997. The financial and economic downturn of East Asia combined with a decrease of the worldwide demand caused a collapse of the prices to 10 US-Dollars per barrel oil. The reaction of the OPEC was a reduction of their output to achieve a price between 22 and 28 US-Dollars per barrel, which succeeded due to the compliance of the member countries to the defined production quotes. The price band aimed at was valid with one interception until 2002.

Since 2002 a moderate upward trend for the oil price was recognisable, supported by the Iraq war and the economic boom, especially in China. The rise was accelerated by the appearance of speculative investors on the oil markets as well as a series of hurricanes paralysing the oil production regionally since 2005. The weak power of the OPEC became obvi-

ous in 2005 since the production increases did not stop the price escalation. Experts prognosticated the end of cheap oil forever and new market determinants became obvious, which will be discussed in the next chapter.

The lessons learned from the history are:

- Petroleum is the lifeline of most national economies and its availability is of strategic relevance
- The laws of physical supply and demand as determinants for the oil price are more and more replaced by psychological aspects of the market investors
- Oil prices determine the power distribution between producer and buyer markets
- The market share of the OPEC is a trigger of its power and their influence on oil prices
- At each stage of the value chain (production, transport, refining) bottlenecks have escalating effects on the oil price

5.2.2 New Developments on the Oil Market

Basically the largest volumes of oil are traded on two markets, the spot market and the futures market. The spot market should reflect the scarcity of oil at the date of delivery since physical oil ("wet" barrels) is sold based in an individual deal between buyer and seller. The futures market offers a price indicator for the scarcity expected at a certain future date and is a commodity market, where oil is traded as "paper barrels" and in the most cases not delivered anywhere.

The spot market became popular as a telephone market in the seventies in Rotterdam and gained even more importance after the price crash in 1986. Unfortunately it is difficult to monitor the quantities of oil traded, since there are often a series of sales of the same physical quantity of oil while it is on his way on the sea for example. In certain years (e. g. 1980) more than 80 % of oil was traded on a spot basis and therefore spot markets are an acceptable source for the oil price. Next to Rotterdam the most important spot markets are in Singapore and at the Texas Gulf Coast. The market participants are major oil companies (compensation of the mismatch of their production and refining capacities), traders (speculation), brokers (arrangement of deals) and independent oil companies (sale of their production).[361]

[361] cf. Seba (2003), p. 82 ff.

The futures markets were established due to the high oil price volatilities in the seventies and eighties for the purpose to hedge the risk. Futures are basically contracts to make or take deliveries, whereas the quantity, quality, delivery point and price of the good is determined in advance, even if the good may not yet have been produced. Futures markets are organised commodity markets, where brokers carry out the transactions for the market participants. Due to the independence to price fluctuations until the time of delivery the price risk is transferred. Many major oil companies or industries strongly dependent on oil prices use the markets to hedge prices, but only a fractional amount is delivered in physical oil anywhere. Additionally the markets are often misused by speculators, which will be discussed in the next paragraph. Due to the high number of operators high volumes are traded on futures market and it has a significant meaning for the oil price formation. Besides, the possibility of physical delivery of the oil links the futures prices to the spot prices. The most popular futures markets are the New York Mercantile Exchange (NYMEX), the Intercontinental Exchange (ICE) in London and the Singapore Mercantile Exchange (SMX).[362]

Concerning the influencing factors for the price formation on the mentioned markets various mathematical models were created. Most of them focussed on the fundamental factors of supply and demand like for example GDP, OPEC capacity, OECD crude oil stocks and OPEC quotes.[363] In the course of the significant price increases since 2005 the suspicion of market manipulation by speculators has been substantiating due to the nearly unchanged fundamental data corresponding to supply and demand. Regardless of the production rates and the inventories in the consumer countries traders believed in an upcoming supply shock and associated with optimism and overconfidence they got the power to influence the market prices and followed the noise.[364] In 2006 the inventories are especially in the United States at a long-term high and demand was already increasing primarily due to the economic growth in the emerging countries like China or India, nevertheless the oil supply even increased at a greater amount. So the traditional forces are not alone responsible for the price rise. It is evident that in those years non-commercial traders, who do not produce or use a commodity, like large financial institutions, hedge funds, pension funds or other investment funds made use of the speculative gains in the energy markets. This behaviour created an additional imaginary demand for oil and due to the link to the spot market, both futures and spot prices skyrocketed. Although the effect of speculation on the oil price

[362] cf. Seba (2003), p. 95 ff.

[363] see Dées (2007), p. 179 ff.

[364] cf. Fattouh (2007), p. 30 ff.

cannot be quantified, the increased liquidity on the market caused excessive price volatilities.[365]

The following figures should give evidence about the developments before the bursting of the bubble in the end of 2008 (see subsequent paragraph). In figure 5.3 the number of different oil futures positions is visualised over time. Next to the open interest the positions are distinguished corresponding to the trader type. Non-commercial traders aim at speculation gains in contrast to commercial traders, who produce or use oil physically and try to hedge price risks by trading futures. Corresponding to the expected development short and long positions are distinguished, whereas the former are traded when decreases are expected and the latter if a gain should be achieved by increasing prices. Concerning all positions a moderate increase is recognisable since the beginning of the new millennium. However the most noticeable trend is the significant increase of the long positions of non-commercial traders. The values in the graph are indexed starting with 100 in 1986, so the number of the mentioned positions increased up to the tenfold in the last years.

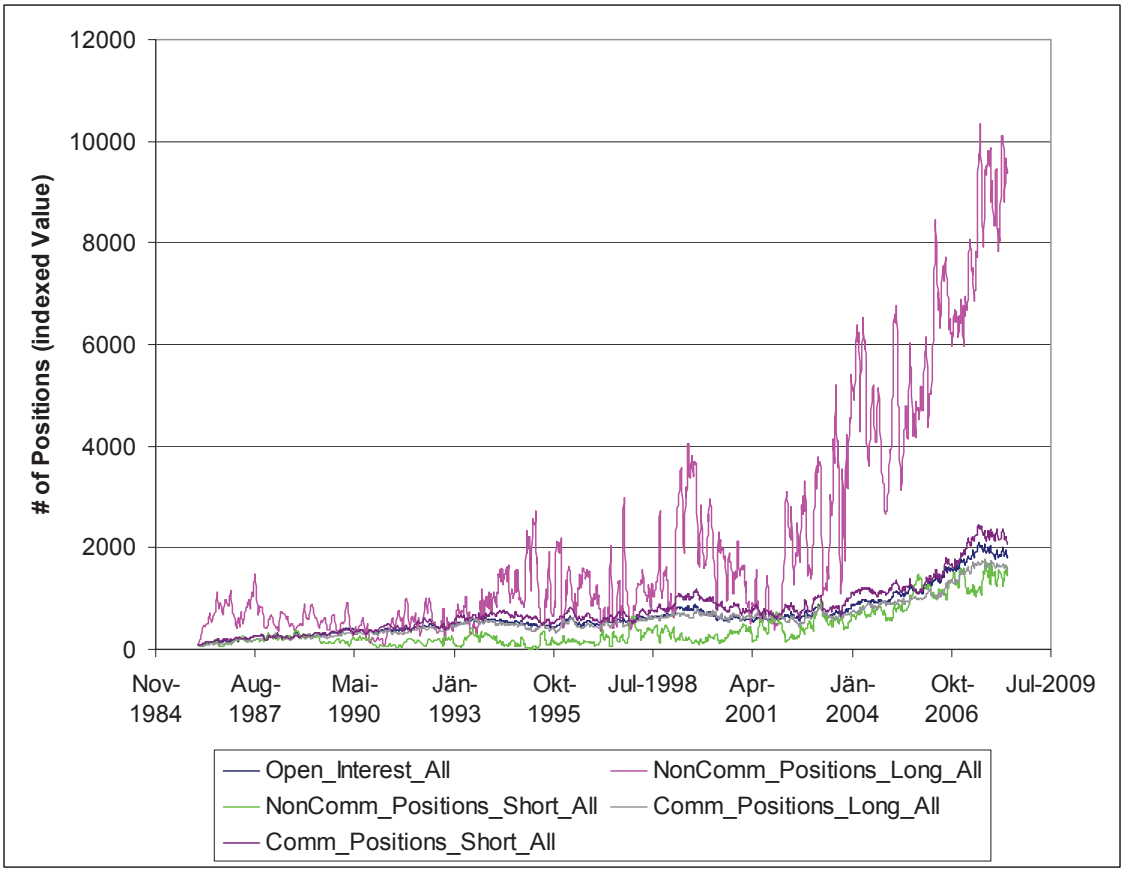

Fig. 5.3: Number of Oil Futures Positions at NYMEX[366]

[365] cf. Coleman et al. (2006), p. 1 ff.

In figure 5.4 the indexed number of long positions of non-commercial traders and the indexed spot price for the WTI are compared, both starting at 100 in 1986. On one side a correlation can be recognised between the courses of the graphs without giving evidence about causal relationships. Nevertheless a potential relationship between the long positions and the oil price is visualised. Although the positions correspond to the futures market NYMEX, the interrelationship with the spot market is also obvious. Whilst the number of positions increased for the 15-fold in the considered years, the oil price is more than five times higher as in the 1986. Although no evidence for the influence and as a consequence no quantification of it is possible numerous organisations support the theory and analysts estimate the influence of speculation on the oil price with at least 30 % even in 1986, where the price was about 100 US-Dollars per barrel. The Commodity Futures Trading Commission (CFTC) take efforts to monitor the nature, extent and effect of speculation since it has the responsibility that prices reflect the laws of supply and demand. The ability of the CFTC to achieve this goal is limited due to the huge influx of speculative traders on the futures market and the missing data for a suitable monitoring.

If the reasons for increasing prices are based on supply and demand imbalances, economic policies to stimulate investments may be a solution. Geopolitical reasons may be handled by changing the foreign policy and increases in price caused by production constraints due to natural disasters can be managed by investments in the protection of the facilities. In case of market manipulation by speculators only an adequate monitoring of the transactions may solve the problem. The Permanent Subcommittee on Investigations confirms that the volume of speculative dollars in futures markets increased significantly, that this circumstance increased prices, that the relationship between the inventories and the oil price altered and that as a consequence an extended reporting is necessary. It is recommend that the CFTC should have more influence on the markets and that also electronic transactions are subject to CFTC rules. Besides the trading of Americans on foreign markets should also be supervised by the CFTC that a closer cooperation with other futures markets like that in the United Kingdom should be established.[367]

After the substantial rise of the oil price (see fig. 5.4) the bubble burst in the last quarter of 2008 like it is symptomatic for all overstated developments in investment markets. The bursting of the bubble was announced by weak signals, which are characteristically for the markets before such an event. Figure 5.5 was published a view months before the crash of the oil prices and prognosticated the same behaviour as for the other markets. The development starts with a growth story, which was in the case of crude oil the fear of vanishing resources, and as a reaction investments in the corresponding markets rise prices. The trad-

[366] data: CFTC (2008)

[367] cf. Coleman et al. (2006), p. 3 ff.

ing volumes on the markets are increasing and more and more derivatives (futures, swaps, options,…) are available, which may have a leverage effect on the price. The consequence is a continuous upward movement of the prices and finally a high volatility due to speculation aspects. First corrections of the course announce the bursting of the bubble in the end. The sequence visualised in the figure turned out to be valid for oil too.

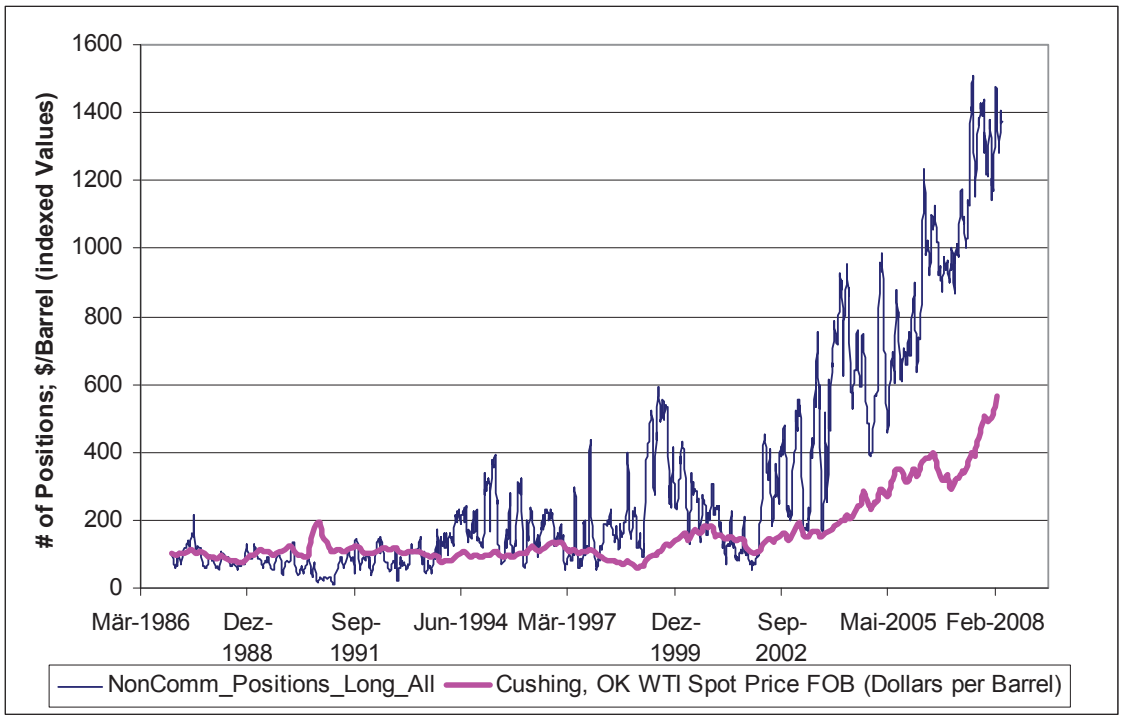

Fig. 5.4: Oil Futures Long Positions and Oil Spot Price[368]

In summary in the last years some new influencing factors became apparent for the oil price formation. Some indicators for supply and demand like the spare capacities of OPEC respectively the inventories of OECD-countries lost their influence. On the other hand the trading volumes of oil derivatives increased significantly, especially the number of long positions of non-commercial traders, and had a not quantifiable impact on the market. A complete control of the market to prevent from this manipulation is desirable but not implementable in the moment. It is put up for discussion if the high oil price in 2008 was fundamentally arguable since no basic market factor changed significantly or if the impact of speculators had the overweight.

[368] data: CFTC (2008); EIA (2008)

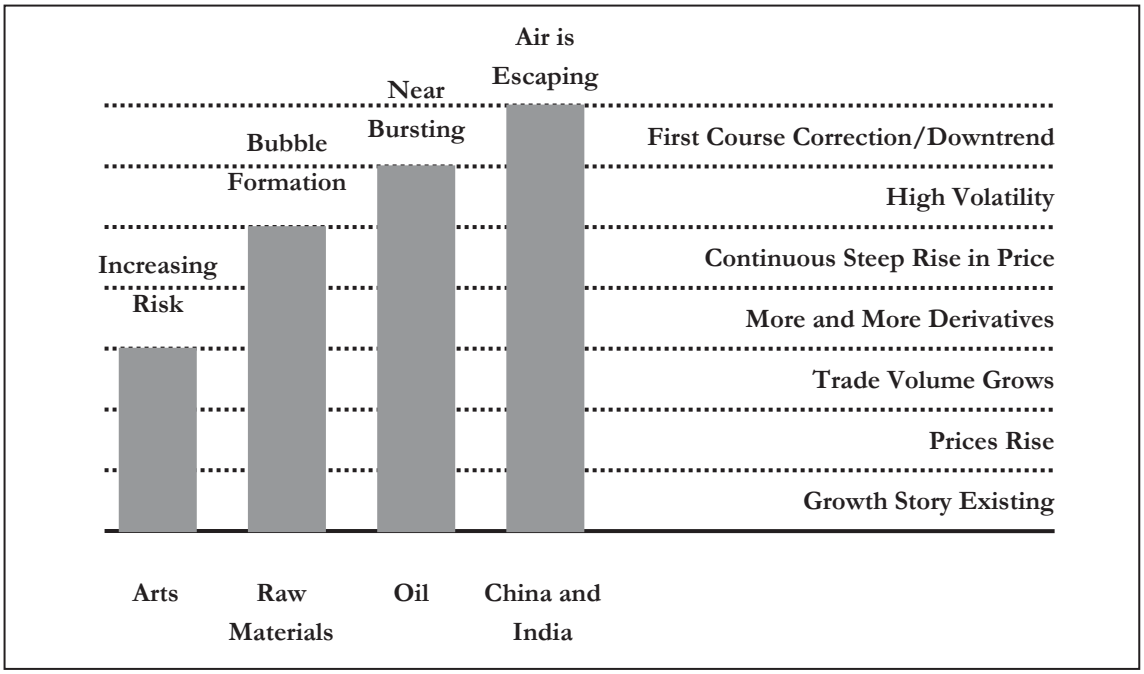

Fig. 5.5: Bubble Barometer: Seven Characteristics for a Hype[369]

5.2.3 Business Impact of Oil Price

This chapter is dedicated to impact of the oil price on the business level, the most significant determinant on the revenue side, on the expense side as well as for the extent of business activities. Volatile oil prices represent a problem for decision making and strategic planning for international and independent oil companies, which are considered here. The cyclic behaviour of the oil and gas markets correlates with capital investments into the industry, profit margins, employed workforce, extent of mergers and acquisitions, drilling activity, exploration activity as well as research and development expenditures.[370]

Subsequently selected indicators substantial for the characterisation of a business are opposed to the oil price. With the exception of the drilling rig count all graphs represent the development of a specific indicator for all integrated and diversified companies as well as for the companies, which are only active in the upstream business. The used database of IHS Herold is composed of the data of 40 integrated, 22 diversified and 228 exploration and production companies in the petroleum business, whereas not all datasets are complete. Nevertheless a representative sample is chosen for the following analysis.

In figure 5.6 and 5.7 the total upstream production revenues respectively the total revenues per produced barrel oil equivalent are compared to the oil price. The upstream revenue as

[369] on the basis of Döhle/Hage (2008), p. 123

[370] cf. Inikori et al. (2001), p. 1 ff.

an absolute figure results primarily from the oil price and the amount produced, which is confirmed by the revenue per barrel produced in the second graph, where the influence of the production is removed and a similar course of the lines is obvious. Since the production is also stimulated by the oil price a similar trend is also expectable concerning the absolute revenue. When analysing the graph a lagged reaction of the revenues on the oil price is recognisable, whereas the reason may be the retarded reaction of the production on changing oil prices since the measures to increase the existing production or to explore new reservoirs are not realisable immediately. Not surprisingly the graphs disclose the significant relationship between the oil prices and the revenues of an oil company and emphasise the dependence of the business success on the market prices.

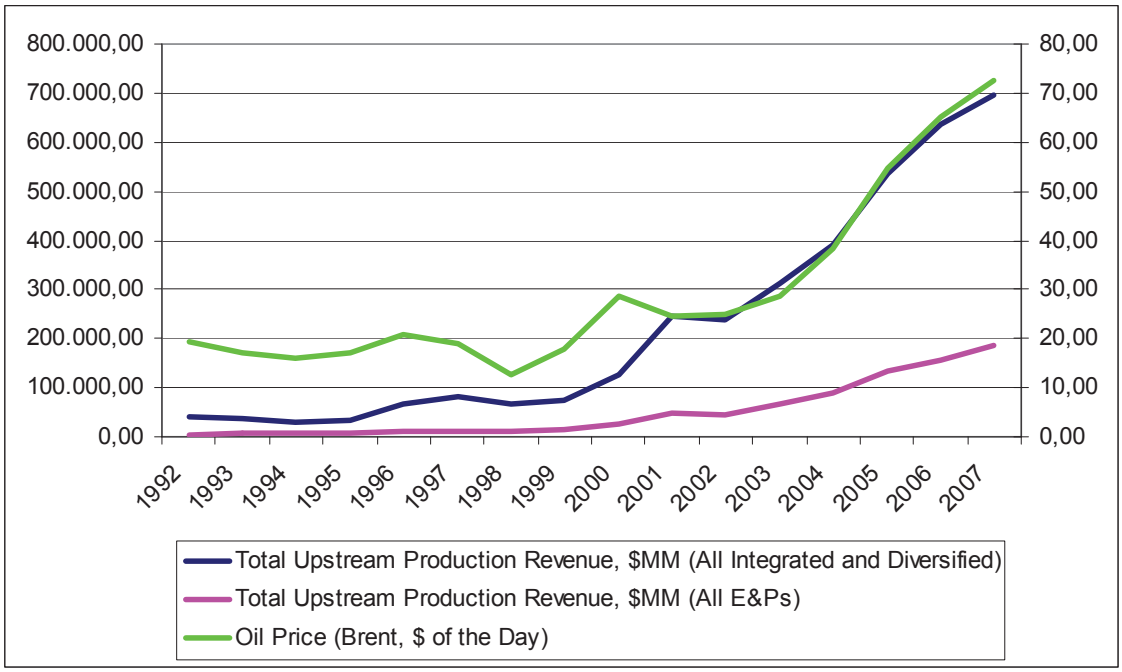

Fig. 5.6: Impact on Total Upstream Production Revenue[371]

[371] data: Herold (2009); BP (2009)

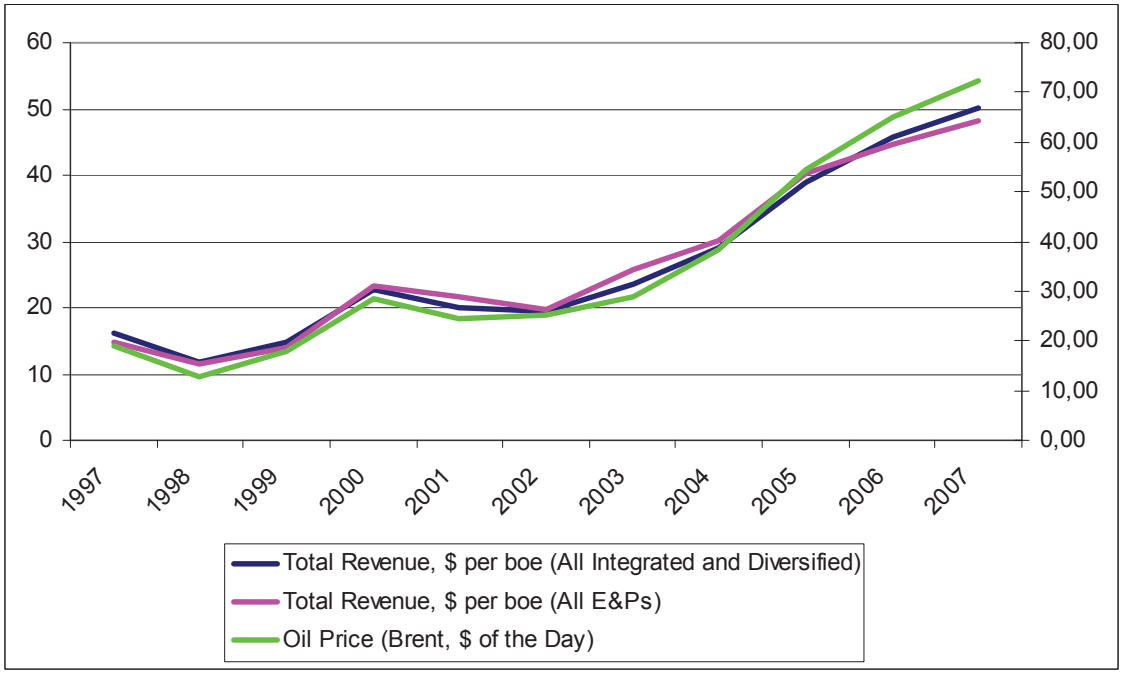

Fig. 5.7: Impact on Total Revenues per Barrel Oil Equivalent[372]

Figure 5.8 analyses the employment policy in correlation with the oil price. Although the magnitude of increase over the considered years is similar for the number of employees and the oil price a countercyclical behaviour is recognisable especially in the late nineties. A reason might be the surprising outbreak of the Asian crisis. Later on the number of employees was increasing again consistent with the oil price with a stagnating trend in the last years with the upcoming engagement of service companies to perform the operations. The statistics of the service firms are not part of the graph as well as the consequences of the economic crisis in 2008. Nevertheless the search for technical staff in advance of the crisis might show the same trends as they are visible in the context of the Asian crisis, characterised by a crash of the prices and a significant previous increase of oil prices. Between the years 1995 and 1999 the analysis is confirmed by a trend, that significant changes of the oil price show a significant relationship to employment figures and the moderate ups and downs are characterised by countercyclical developments. This is also consequence of the fact that the labour force is dependent on the drilling activities in the industry which are retarded corresponding to short-term fluctuations of the price.[373] Concluding, with the exception of short-term cycles the employment opportunities in the petroleum industry are also a matter of the oil price.

[372] data: Herold (2009); BP (2009)

[373] cf. Inikori et al. (2001), p. 4 f.

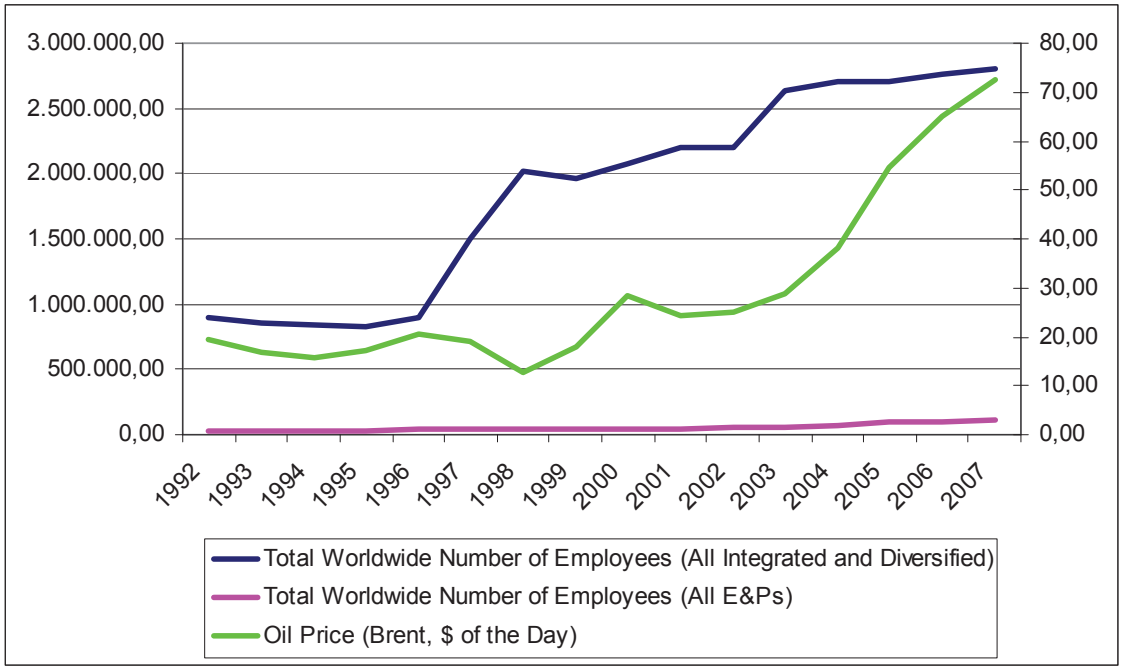

Fig. 5.8: Impact on Number of Employees[374]

Figures 5.9 and 5.10 focus on the earnings and the return on the invested capital linked to them. Therefore the earnings before interests and taxes (EBIT) as an absolute figure as well as the return on average capital employed (ROACE) as a relative figure are visualised. When considering the spikes a lag between the oil price and the EBIT is recognisable. The EBIT is a result of revenue and operating expenses and also a component for the calculation of the ROACE . Both show a direct response to the oil price with one exception: the lag between the spikes in 2000 and 2001 in figure 5.9. Figure 5.10 shows impressively the advantages of an integrated company where the risks are well distributed along the value chain. Although the remarkable price fluctuations the bandwidth of the ROACE is significantly lower as for the companies only active in exploration and production, who are even more dependent on the crude oil price. These companies have to face more intensive reactions of their ROACE on the price, whereas the EBIT and as a consequence the ROACE was even negative in 1998 at an oil price below 13 US-dollars per barrel. On the other hand they may have profited to a larger extent from high oil prices as it was the case in 2000. The conclusion is similar to that for the revenues, that the impact of the oil price is clearly visible as expected.

[374] data: Herold (2009); BP (2009)

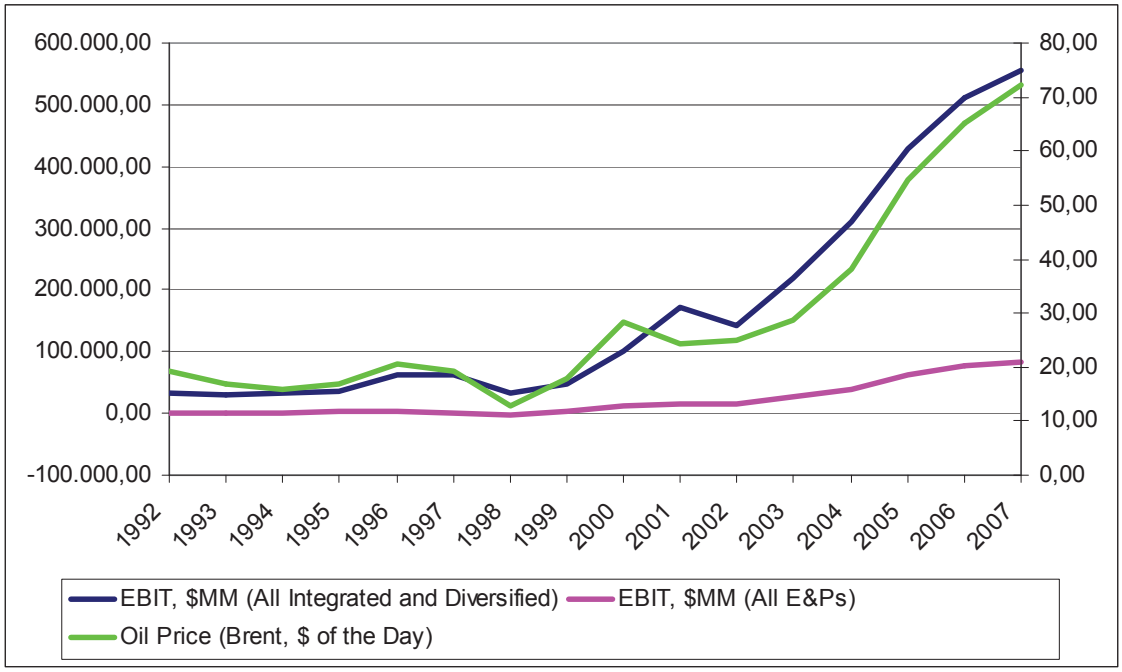

Fig. 5.9: Impact on Earnings Before Interests and Taxes[375]

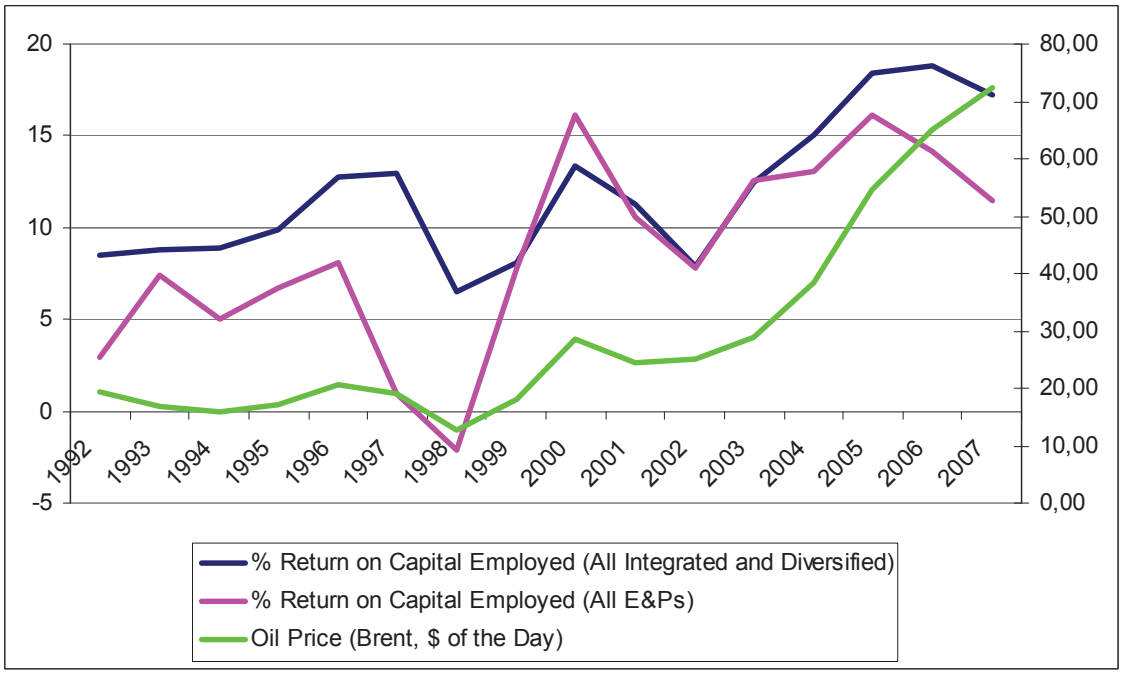

Fig. 5.10: Impact on Return on Average Capital Employed[376]

[375] data: Herold (2009); BP (2009)

[376] data: Herold (2009); BP (2009)

In figure 5.11 and 5.12 the propensity to investments in exploration expenditures as an absolute figure respectively the expenses per barrel of production as a relative figure are described. Basically an upstream company has two possibilities to increase its reserve base, successful exploration activities or the acquisition of acreage or other upstream companies. Due to the threshold costs for exploration activities in times of low oil prices acquisitions are preferred by trend. The oil price plays a major role concerning the initiation and evaluation of potential projects, whereas there is a time lag of years between the planning of a project and the time point when the incurred expenses are reported. The résumé is comparable with that for number of employees. In a short-term view the retarded reactions on price changes disclose a countercyclical behaviour in certain years, again especially after the surprising occurrence of the Asian crisis. In a long-term view respectively in association with the substantial price changes the exploration investment pattern is adjusted to the oil price. The courses of the absolute and negative values of exploration expenses show similar directions with the difference, that the rise of the relative expenses is damped by the increase of production in profitable years. In a broader sense the analysis implies the statement that the oil price stimulates the search for new reserves by justifying the profitability of exploration projects. Another evidence for this tendency is the drilling activity analysed in the next paragraph.

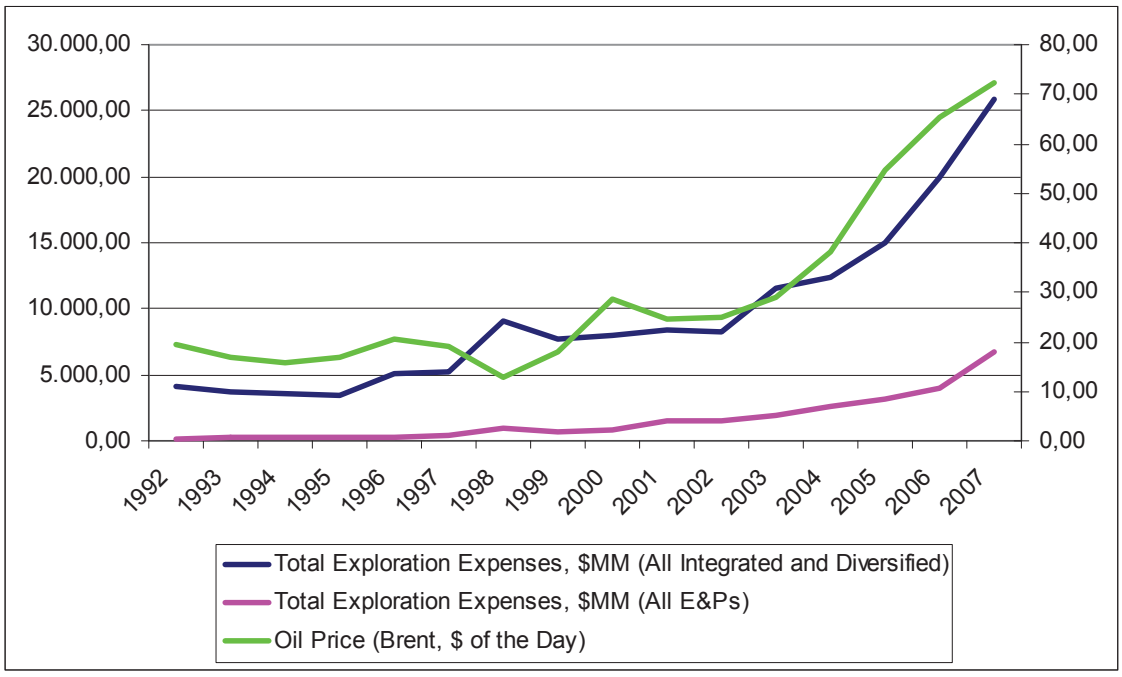

Fig. 5.11: Impact on Exploration Expenses[377]

[377] data: Herold (2009); BP (2009)

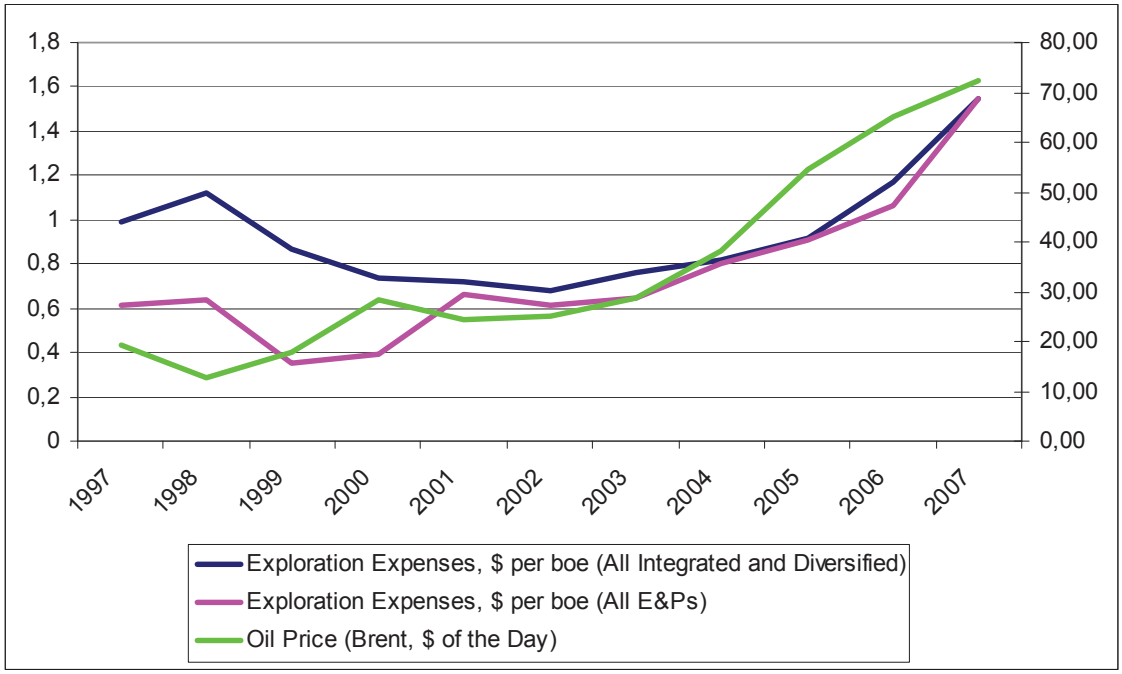

Fig. 5.12: Impact on Exploration Expenses per Barrel Oil Equivalent[378]

Finally the worldwide number of active drilling rigs is compared to the oil price in figure 5.13. In the graph the most spikes show exactly the time lag of one year, which is again reasoned by the time between planning and project evaluation and starting to drill. This is mainly the case if oil prices starts to increase, whereas the availability of drilling rigs is a second limiting and time delaying factor which played a major role especially in the years of skyrocketing prices since 2004. If prices are decreasing the reaction is often immediately without a time lag like in the progression of the years 1986, 1991 or 1998. Concluding, the direct reaction of drilling activities to the oil price is obvious with the aim to explore new reservoirs as well as to increase the production in already discovered fields.

[378] data: Herold (2009); BP (2009)

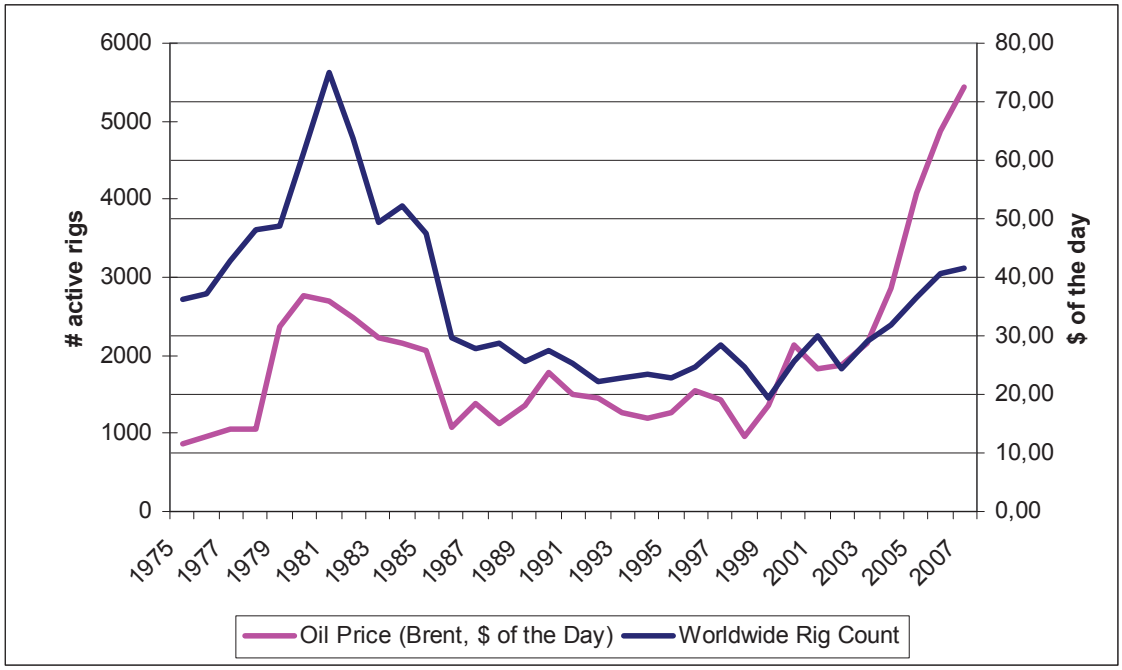

Fig. 5.13: Impact on Drilling Activity[379]

Summarised, the impact of the oil price on the performance of an exploration and production company is as expected substantial. Starting with the stimulation of the production the revenues, earnings as well as the profitability are of course a matter of prices. Additionally the price is also able to trigger operating activities like exploration and drilling. As a consequence the magnitude of the workforce in the industry is also a result of these influences. So all essential components of entrepreneurial success like growth, profitability, earnings and liquidity are influenced by the oil price and as a consequence also financing the company is dependent on the oil price indirectly since success is the best incentive for investors.

5.3 Business Environment of the Industry

Although the petroleum exploration and production industry faces is in a situation where the demand for the product crude oil is ensured, the environment is becoming more and more dynamic. The aim of this chapter is to investigate the development of the business environment based on its most important descriptors, which were already discussed in chapter 3.1.4 in theory. The more actual typologies operationalised the business environ-

[379] data: Baker Hughes (2009); BP (2009)

ment by the number of major goal alterations in a specific period[380], the extent and predictability of changes[381], the availability of resources[382], the opportunism of exchange partners[383] and the extent of competition.[384] The developments concerning the environmental descriptors are discussed subsequently.

5.3.1 Alteration of Major Goals

One indication of a turbulent environment is the alteration of the major goals in a certain period, whereas the major goals are equated to the long-term strategies of petroleum upstream companies. For this purpose the strategic evaluation reports from an online database are analysed by content, the single targets are categorised and their relative share to the total number of investigated companies is visualised (see fig. 5.14). Although the strategic goals are normally formulated for a period up to five years, the alternating heights of the bars in the graphs disclose the alteration of goals. The first category summarises indicators used in the strategy statements for production growth, cost respectively profitability focus, reserve growth, market share or shareholder value. The next category covers the statements regarding the ways to implement the strategy. Here the focuses on going international, production in existing core areas, reserve increase by exploration, reserve increase by acquisition, production from mature fields, risk avoidance, capital respectively spending discipline or vertical integration are distinguished. Finally some types of diversification like a bias on technology, unconventional reserves, partnerships or deepwater production are analysed. In each period of two years with the exception of 2008 the strategy reports of the following companies are investigated: Anadarko Petroleum Corp., Apache Corp., BG Group, BHP Billiton Ltd. (former BHP), BP Plc., Chevron Corp., ConocoPhillips (former Conoco), ENI S.p.A., Exxon Mobil Corp. (former Exxon), Hess Corp. (former Amerada Hess), Marathon Oil Corp., Murphy Oil Corp., Occidental Petroleum, Royal Dutch Shell Plc., Total S.A..

[380] see Jurkovich (1974)

[381] see Jurkovich (1974); Miller/Friesen (1983); Koberg (1987)

[382] see Miller/Friesen (1983); Koberg (1987)

[383] see Sutcliffe/Zaheer (1998)

[384] see Miller/Friesen (1983); Sutcliffe/Zaheer (1998)

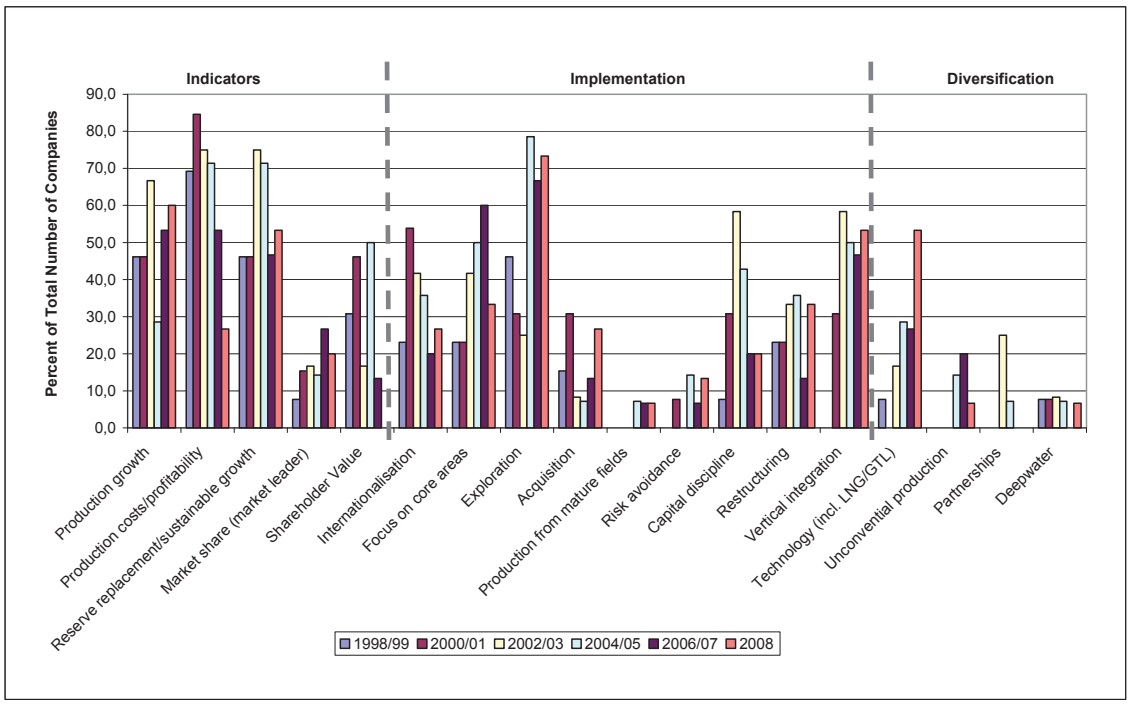

Fig. 5.14: Change of Strategic Goals 1998-2008[385]

The interpretation of the significant changes points out an alteration of goals in reference to the oil price. Until 2004 the companies oriented themselves on the desired price band of the OPEC and expected a price below 30 US-Dollars per barrel, whereas the rise of the prices since 2004 was unstoppable until 2008 and changed the premises for the strategy formulation too. A typical example is the focus on cost or profitability related indicators, which was significant in times of low prices but came second after this period. Concerning the other indicators an alternating development without a clear trend is recognisable, whereas the change of the quantified measures was not content of the analysis.

Regarding the implementation options mentioned in the strategy reports the efforts to operate in more countries respectively to extent the international portfolio was decreasing in the course of time and increasing oil prices, which is also confirmed by a stronger focus on the production from existing core areas. Reasons for this behaviour might be that the selected companies has either already a global portfolio or are primarily active in the United States. The government takes increase linked to the oil prices and therefore the development of new areas is expensive and risky. It is also noticeable that the exploration efforts are increasing which is a consequence of the fact, that explored barrels are generally cheaper than acquired barrels in times of high prices. The emphasis of the capital discipline as strategic target was relevant for more than 50% of the companies in 2002 and 2003 after

[385] data: Herold (2009), Strategic Evaluation Reports

a long period of low prices. Finally the desire for vertical integration is a more and more popular way to diversify risks and to benefit from the growing gas market potential.

Considering the diversification focus an increasing importance of technology is evident in the strategic plans. In a low price environment the engagement of service companies is preferred and since 2004 the increasing profits allowed a stronger focus on the internal development of technologies again supported by the involvement in new affordable areas like unconventional production, deep water drilling or the markets for liquefied natural gas (LNG) or gas to liquid (GTL) techniques. Regarding unconventional reserves only high prices justify projects and this which is also recognisable in the figure. The formulated goal to build partnerships with other oil companies in the end of the low price years is also worth mentioning.

Recapitulating the goals expressed in the strategic plans of the oil companies are exposed to significant changes especially if the main impact factor, the oil price, is changing. This implies that aligned with higher fluctuations of the oil price also the major goals are changing and an environmental turbulence is initiated.

5.3.2 Extent and Predictability of Changes

If the extent and the predictability of changes is projected to the oil price as the most influencing factor of the industry, a chaotic and for sure a non-linear behaviour has to be assumed. The prediction of future oil prices is nearly impossible, especially in the long-term view. Simple models rely on pairs of influencing factors like price elasticity and energy intensity, price elasticity and supply-demand balances or only on the drilling rig count. Due to the different and alternating influences of political events, supply, demand, technology, environment, inventories, speculation and many more the forecasts in history are doomed to failure except they fit to the real oil price developments by coincidence.[386] Figure 5.15 shows the efforts of the Energy Information Administration to forecast oil prices in their annual energy outlooks, which are a reference path of their scenarios. Nearly all attempts were not able to forecast the magnitude or even the direction of the changes. A steep rise of oil prices has been forecasted since 1982 and as the slope of the lines were increasing nearly 20 years later the escalation of the price began. Even a compilation of oil price forecasts for a small time range of one to two years from 19 different analysts from commercial and public institutions discloses a range from 77 to 200 US-dollars.[387] This substantial difference and the impossibility to forecast the oil price even for a short time horizon is another evidence for the unpredictability.

[386] cf. Agbon/Araque (2003), p. 1

[387] see PetroStrategies (2009)

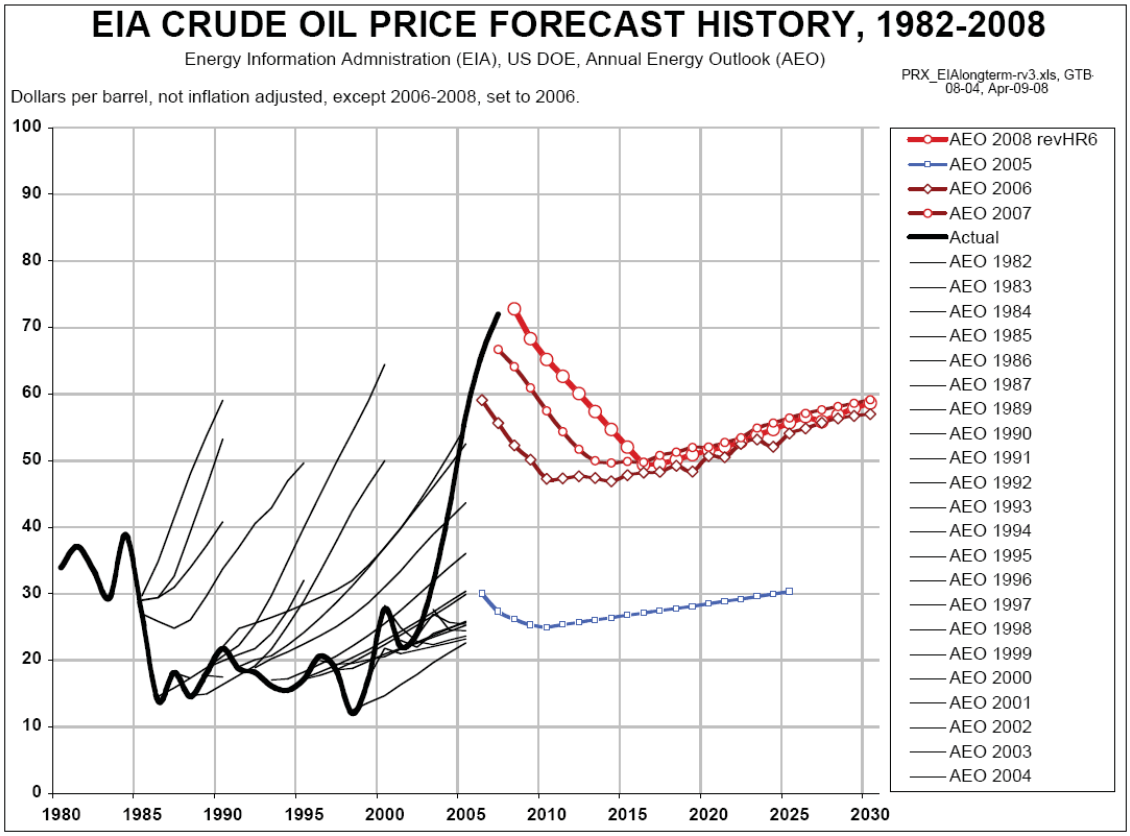

Fig. 5.15: Crude Oil Price Forecast History[388]

Regarding the extent of changes the oil price developments of the last years also triggers the turbulence. The price volatility calculated on a monthly basis is increasing since 2000 as visualised in figure 5.16 by the spotted curve. The years before a standard deviation of more than two US-dollars has been an exception, whereas since 2000 the most spots are above this value with an increasing tendency. This more and more volatile course of the price is another indication for a more turbulent environment and the petroleum companies have difficulties to handle the key parameter for their business.

[388] Hudson (2008)

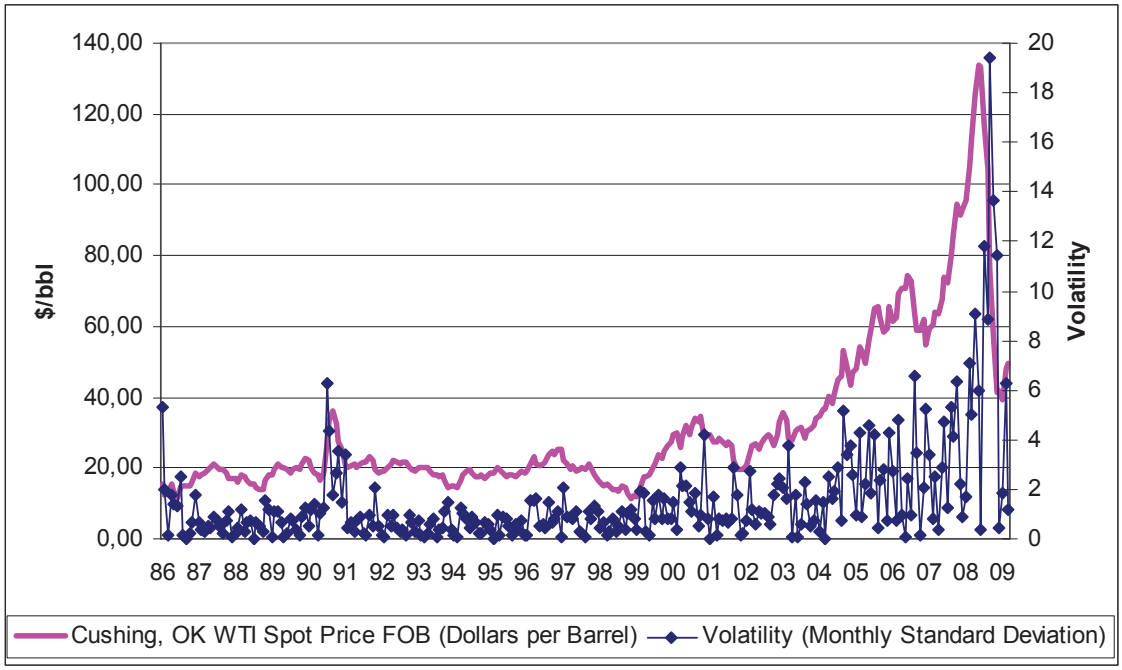

Fig. 5.16: Development of Oil Price Volatilities[389]

5.3.3 Availability of Resources and Opportunism of Partners

The resources of a company can be categorised in physical capital (technology, plants and equipment, geographic location and access to raw materials), human capital (training, experience, judgment, intelligence, relationships and insights of the employees) and organisational capital (reporting structure, planning, controlling and coordinating).[390] The scarcity of these resources, especially in combination with the opportunism of partners, is an indicator for a turbulent environment in the business too.

Regarding the human resources the capital is at risk due to the disadvantageous age structure in the exploration and production industry, especially considering the white collar engineers active in the market. The qualities mentioned above are partially dependent on experience in the business and the transfer of knowledge. In an ideal case a uniform distribution of the age structure is the best condition for avoiding gaps in this context. In reality the average age in the industry is 49 years, older than in the most other industries. On the other side the university enrolments in petroleum engineering and geosciences show, partially triggered by a negative public perception of the industry, a significant decreasing trend which will cause further shortages of talents in these areas in the future.[391] The expected

[389] data: EIA (2009)

[390] cf. Barney (1991), p. 101

[391] cf. Sampath/Robinson (2005), p. 2 f.

retirements in the next years combined with the shortage of newcomers will challenge recruitment to attract talents and the competition for the available graduates will increase.

In the context of physical capital resources the access to the raw materials in form of crude oil and gas represents the greatest challenge with increasing difficulties for an international oil company. Basically the availability of hydrocarbons has geophysical constraints, so that the cumulative world oil production can be graphed with a curve. The most important feature of the curve is the turning point at its maximum, which is called the Hubbert's peak. The peak represents the time at which the maximum production is achieved and the new findings are not able to compensate the production decline anymore.[392]

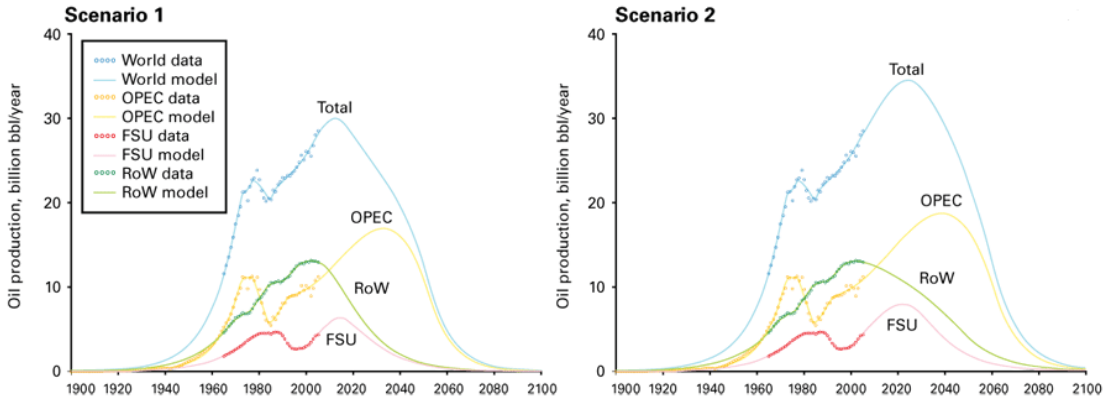

Fig. 5.17: Production Forecasts[393]

The curves can be constructed for the world production as well as for certain areas or countries (see fig. 5.17) and is based on mathematical modelling of a bell-shaped curve involving past and future production data. The Hubbert's bell curve assumes that the full production potential is always in use and is therefore not valid for missing demand or political interventions for example. The second condition for a meaningful modelling of oil production is an adequate estimation of the ultimate recoverable reserves. In figure 5.17 the curves are modelled for two different scenarios of ultimate oil recovery (2234 billion and 2734 billion barrel). The curves show the production of the OPEC, the countries of the former Soviet Union (FSU), the rest of the world (RoW) and the total world production. In the first scenario the total production will peak in 2012 and in the second case in 2024.[394] Although the peaks are expected in some years the turning point will come for sure and the resource base for all market participants will decrease. In the view of independent compa-

[392] see Deffeyes (2009)

[393] Mohr/Evans (2007), p. 50

[394] cf. Mohr/Evans (2007), p. 45 ff.

nies the peak comes into reach in countries, where the reserves are more accessible for them. Especially in the United States the peak was already reached in the seventies.[395]

The peak production rate comes along with a decreasing volume of new discoveries. The stable reserves in the last years are based on the definition of reserves also a matter of the oil price and new technologies and obscure the circumstance that new findings decline in volume and quantity (see fig. 5.18). The supergiant fields in the Middle East are older than 40 years and are conserved due to political reasons, but since then no fields with a similar extent were found. The volumes from successful exploration efforts peaked in the sixties and since the eighties the production is exceeding the discovery volumes more and more.

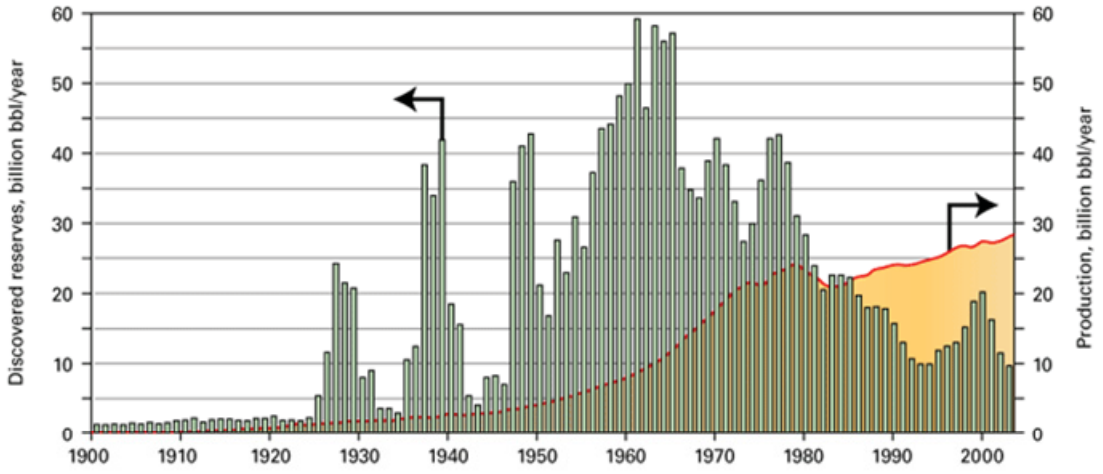

Fig. 5.18: Backdated Oil Discoveries[396]

The production of unconventional resources (heavy oil, oil sands, oil shale) as well as the practical limits of new technologies will not have a significant impact on the peak itself but rather dampen the decline rate.[397] This development is not stoppable and one of the primary goals of a petroleum company to replace their annual production by new reserves will come along with an intensification of the competition for reserves respectively constrains the resource availability. Focussing only on independent international oil companies the access to reserves is also determined by the ability to operate in host countries respectively to close a contract with them since they are mainly located in consuming countries with restricted reserves which cannot meet the demand. In the seventies 85 % of the reserves were in the control of international oil companies but the rise of national oil companies

[395] cf. Wells (2005), p. 20 ff.

[396] Wells (2005), p. 21

[397] cf. Wells (2005), p. 20 ff.

reduced the share to marginal 7 %. Since only this small fraction is left the access to it is accompanied by an intensified competition.[398]

The rise of national oil companies is also a consequence of the opportunism of partners, which are the host governments as the reserve owners. In the last years the term "petro-nationalism" was reinvented to describe the nationalistic behaviour of governments regarding the access to resources. The characteristics of this trend are a higher involvement of the state in the petroleum industry including the international expansions of national oil companies, the rise of royalties and taxes in contracts with international oil companies, the revisions of existing contracts or in the worst case the expropriation of assets.[399]

The focus on controlling the reserves is represented by the behaviour of the national oil companies. Some of them (Yemen Oil Company, Sudapet,…) are only the bureaucratic extension of the state and at most a minority partner in the operations. Others are compulsory partners (Qatar Petroleum, Libyan NOC, PDVSA,…) for international companies and hold a significant stake in ventures with them. Another group is composed of dominant domestic players (Saudi Aramco, Gazprom, NIOC,…), who are not dependent on foreign operators and only offers service contracts in exceptional cases. Relatively new are acquisitive national oil companies (Petrobras, Petronas, ONGC, CNOOC,…), who are also active abroad respectively overseas and even acquire foreign oil companies. Within this categorisation of company types a trend towards a higher state involvement and a more acquisitive behaviour of the national oil companies is recognisable.[400]

The reasons for the trends, especially indicated by the rise of the share of government take in the revenues in form of royalties and taxes in the last years, are the increasing oil prices, the commoditisation of technologies and political as well as social disenchantments. In case of high oil prices the governments try to get a higher share of the windfall profits and developed contractual systems which adapt the government take in case of price rises. It is also possible that existing contracts or laws are changed afterwards and the international oil companies have the choice to agree or to leave the country.[401] The most radical example for this type of behaviour is Venezuela, which invited international oil companies in a low price environment to invest in exploration by offering contracts with a relatively low government take since the conditions for producing the heavy oil there profitably are difficult. As a reaction of increasing prices a decade later the contracts were cancelled and joint ventures with a government ownership up to 80 %, represented by the national oil company

[398] cf. Jessen (2009), p. 24

[399] cf. Guzmán et al. (2006), p. 23

[400] cf. Hunter (2005), p. 2 f.

[401] cf. Guzmán et al. (2006), p. 27 f.

PDVSA, were dictated. Nearly all international companies accepted the unilateral change of the regulations.[402]

Technological advantages were in the former decades an important factor to gain access to foreign resources since national oil companies had a lack of advanced technologies which could be compensated by international companies. In the economically poor nineties technological leadership lost its meaning for the petroleum majors and the foundation of large service companies (Schlumberger, Halliburton,…) made technology available on the market as an commodity also purchasable for national oil companies. As a consequence an important reason for collaborating with international oil companies was of secondary importance. Finally the some states were disenchanted with the neo-liberal policies, which led to social inequality and social discontent and were answered by nationalistic tendencies especially in the economy again.[403]

5.3.4 Competitors and their Activities

The rivalry in an industrial sector is determined by the competition for market share and is a consequence of the market growth respectively shrinkage and the number of competitors in this market. The number of competitors is subsequently dependent on entry and exit barriers in the market.[404]

If the markets are confined as countries with petroleum reserves then not only attempts of independent companies to internationalise their operations respectively to stay in their core areas (see fig. 5.14) are triggers for the rivalry in a certain market. Also the international expansion strategies of the national oil companies imply the entry of new competitors in specific markets partially accompanied by the acquisition of other national or independent oil companies. Their focus on strategic interests and their access to cheap capital from the governments eclipse the profitability bias and give them the opportunity to bid very aggressive for properties or companies. Another constraint for independent companies is the preferred partnerships between national oil companies for political reasons which eliminate other collaboration opportunities for them.[405]

Regarding the market share of independent oil companies expressed as the share of the total hydrocarbon production more and more entry barriers are established within the rising petro-nationalism. Especially in the Middle East or partially in Africa the operation

[402] cf. Jessen (2009), p. 24 f.

[403] cf. Guzmán et al. (2006), p. 29 f.

[404] cf. Porter (1988), p. 43 ff.

[405] cf. Guzmán et al. (2006), p. 25 ff.

opportunities are restricted for the independents.[406] Consequently the market is innately limited to countries with a more liberal energy policy and in a global view oil production as an indicator for the market size is already stagnating or even shrinking according to the Hubbert's peak (see fig. 5.17). Especially the more accessible parts of the world for the independent companies outside of the OPEC are positioned near the peak on the curve or countries like the United States are already in the degeneration phase.

Even if actually the economic crisis have a major impact on the national budgets and consequently also on the investment activities respectively exploration efforts of national oil companies the long-term conditions represented by shrinking markets for independents will create a new level of competition.

5.3.5 General Threats

Based on a study and partially consistent with the concerns mentioned in the previous chapters (e. g. number of employees in chapter 5.2.3, availability of resources and opportunism of partners in chapter 5.3.3, competitors and their activities in chapter 5.3.) the strategic risk, to which the petroleum industry is exposed to actually, can be summarised as follows (see fig. 5.19 for the categorisation and impact assessment):[407]

- **Human Capital Deficit**: The necessary growth of the sector to overcome the future demand is significantly restricted by human capital constraints.
- **Worsening Fiscal Terms**: Mainly caused by political opportunism and a high price environment petro-nationalism is triggered and fiscal terms are a more comprising factor for the business.
- **Cost Controls**: The industry is not able to control the costs along the whole value chain and the cost inflation is skyrocketing in the last years.
- **Competition for Reserves**: National oil companies are new competitors, which close deals which are not publicly offered.
- **Political Constraints on Access to Reserves**: National oil companies control the majority of reserves and therefore also the world supply.
- **Uncertain Energy Policy**: Considerations neglecting the profitability of the business like supply security or environmental goals are in the focus of the policy and ignore the economic evaluation of the supply.

[406] cf. Hunter (2005), p. 1

[407] cf. Jessen (2008), 18 f.

- **Demand Shocks**: Demand shocks as a consequence of financial crisis would have significant impacts on the petroleum industry.
- **Climate Concerns**: The use of oil and gas as energy sources is associated with climate concerns, which may have a higher physical impact as known from the published conservative climate scenarios.
- **Supply Shocks**: Supply disruptions may cause price spikes and a worldwide recession, which would impact the competitive environment of petroleum companies.
- **Energy Conservation**: The high energy efficiency improvement potential would lead to lower energy intensities and possibly to the substitution of oil.

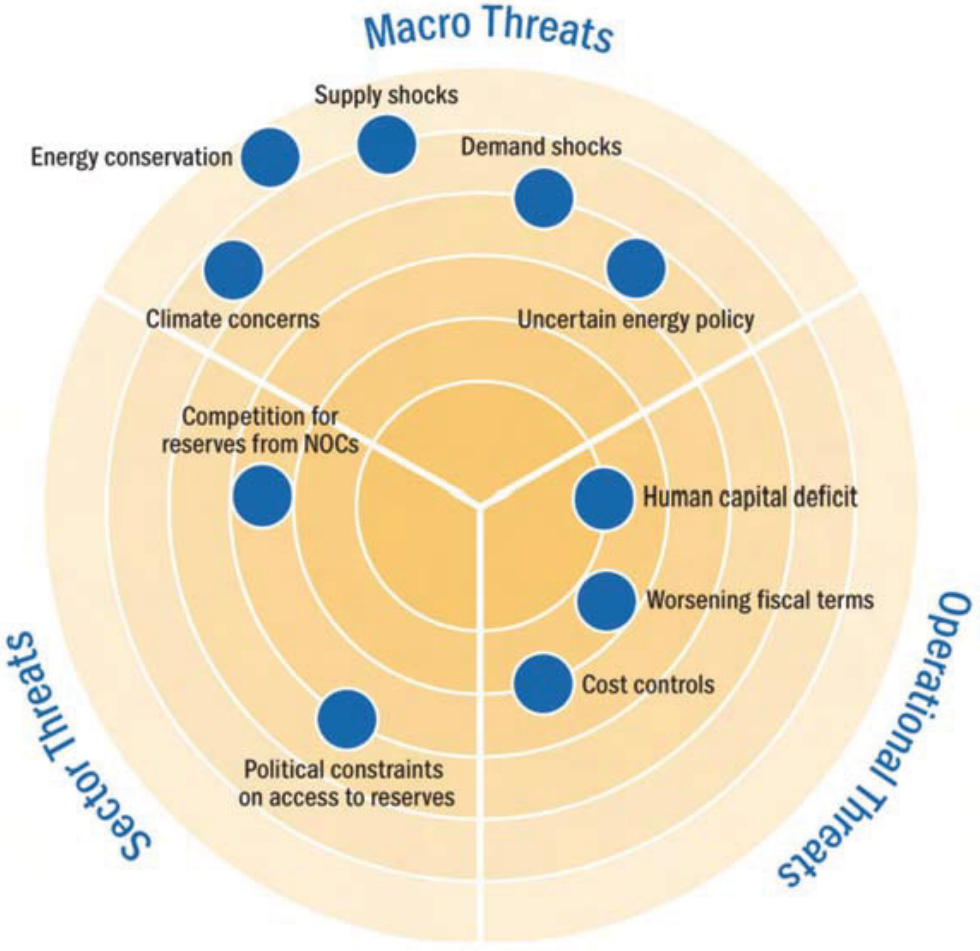

Fig. 5.19: Major Strategic Risks of the Petroleum Industry[408]

In figure 5.19 the strategic risks are categorised in macroeconomic, operational and sector related ones. Besides their potential impact is assessed by experts whereas the more signifi-

[408] Jessen (2008), p. 18

cant topics are indicated in the inner circles. The sequence of their importance corresponds to the sequence of the list above starting with the most significant risk respectively threat.

While the macroeconomic threats have an impact on the oil price based on the fundamental laws of supply and demand the oil price affects the magnitude of the operational and sector-related risks as already discussed in the previous chapters with limitations in regard of the human capital deficit. High oil prices in combination with petro-nationalistic tendencies cause the unfavourable change of the fiscal terms. The difficulties to control costs is also a matter of oil prices since the cost inflation is dependent on the demand for input factors, which is again a matter of the exploration activity correlating to the oil price. The other characteristics of petro-nationalism like competition from national oil companies respectively the politically restricted access to resources is as described above also an arising threat in a high price environment.

5.4 Implications for the Thesis

The success factors are essential for the future potential of a company and strategic risks may also endanger their preservation. The first task is to be conscious about what the success factors of a business are and then the concentration on them should be in the focus since they can be influenced by the management by definition. In contrast to the environmental conditions they are within the field of action of an enterprise and should be adapted to the requirements of the external state.

The consideration of the success factors of an industry is essential in the context strategic of risk management since the malfunction of the risk management would affect them too. Their preservation is therefore also an indicator for a working management system and a loss of the success factors may result in a crisis. Since a crisis is defined as the destruction of the structures of a system (e. g. an enterprise) in a way that the achievement of the targets is not possible and the result is not ambivalent anymore.[409] In other words the initial state of the system is not recoverable and the state is outside the area of (strategic) risk management. Consequently success factors as internal manageable factors are associated with strategic risk management since they are vulnerable to disregarded internal and external risks and may activate an irreversible crisis in case of their absence.

The oil price itself is not covered by the success factors of an upstream company because it is excluded by the definition due to the missing influence of the enterprise on the oil price developments. Nevertheless it is essential to identify the drivers and monitor the course of action since the oil price has a substantial impact on the firm's performance as illustrated in

[409] cf. Klügl (2005), p. 20, Gareis (1994), p. 22

the previous chapter. Although it would be disregardful to concentrate the business activities only on the oil price developments it should be in the focus of strategic risk management as the key impact factor which may also affect the success factors of the company respectively industry.

The interrelationships between the oil price and the aspects describing the business environment are highlighted in the last chapter. This is another evidence about the significant role of the oil price since not only the performance figures of an enterprise but also its business environment is triggered by it and the actual major risks are in the most cases also a consequence of changing prices.

6 Oil Price Scenario Monitoring with Fuzzy Logic

The previous chapter investigated the characteristics of the petroleum upstream industry and emphasised the uprising dynamic environmental conditions. These conditions have to be considered in strategic planning, whereas the conventional methods of the strategic analysis (e. g. analyses of the global environment, branch structure, competitors, internal strengths and weaknesses[410]) rely on information from the past or the actual situation. To anticipate trends and developments a future oriented perspective is a necessary complement and prognosis or the strategic early warning approach are used to cope with that problem.[411] The requirements for information to be suitable for the strategic planning process are its predictability to extend the response time and the adequateness of the forecast to assess the impact on the company's performance.[412]

The way the future oriented information is processed is dependent on the level of uncertainty. Single point forecasts are only adequate if the future is clear enough and probabilities should only be used if there are few and clear defined alternative outcomes. In case of true ambiguity it is seen as a failure to use probability distributions and additional tools have to be applied. In this situation uncertainty should not be reduced but managed.[413] In general various areas of business management are concerned by this type of uncertainty triggered by an increasing environmental dynamism. An empirical evidence for this development is the rising number of publications of the application of the scenario technique in the context of business management as a method able to cope with this level of uncertainty. Therefore the publication database of Scopus[414] is used to analyse the trend of the amount of publications over the time and should emphasise the meaning of the method for strategic planning in an uncertain environment.

The Scopus database finds articles from more than 18.000 peer-reviewed journals from more than 5.000 publishers to a specific topic. The main categories for the search are life, health, physical and social sciences. For the subsequent analysis the application of the scenario method in the category "Social Sciences and Humanity" and its subcategories are analysed. In figure 6.1 the absolute figures of publications are visualised. The first trend line covers the number of publications in the mentioned main category and the second in the subcategory "Business, Management and Accounting" to get a clearer focus. Finally the development in the context of "Strategic Planning" is represented, whereas the amount of

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[410] see Welge/Al-Laham (2001)

[411] cf. Welge/Al-Laham (2001), p. 289

[412] cf. Ansoff (1976), p. 133

[413] cf. Bratvold et al. (2002), p. 6 f.

[414] Scopus (2009)

articles is shown on the right axes in the graph. All three trends disclose a skyrocketing number of publications regarding the scenario topics since the early nineties in the considered time interval. In general nearly 3.000 publications about scenarios are available in 2008 and concerning strategic planning 20 publications give evidence for the increasing significance of the scenario technique in this context aligned with the rising dynamism.

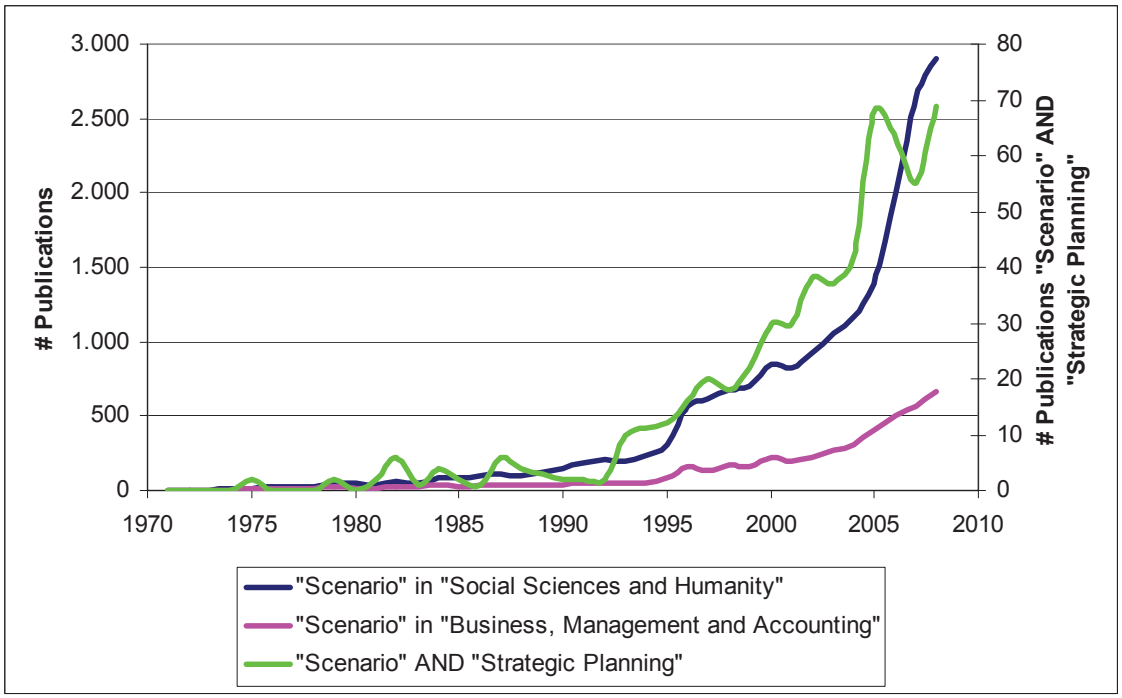


Fig. 6.1: Absolute Number of Publications in the Context of Scenarios[415]

Since the number of journals respectively articles in the database is also increasing with time an analysis of relative figures is necessary to support the statement of a rising significance. For this purpose the results in figure 6.1 are opposed to the total number of publications in the main category "Social Sciences and Humanity" as demonstrated in figure 6.2. The results of the second analysis with the Scopus database are indicated as a percentage in the graph, whereas the results for the share in "Strategic Planning" correspond to the secondary right axes again. Also the relative shares of publications confirm the trend of a growing relevance of the scenario method in general, in business, management and accounting as well as in the strategic planning approach. The interruption of the developments since the early nineties is not obvious in the relative analysis but rather a continuous trend over the considered decades is indicated. Due to the smaller number of publications in the field of strategic planning the volatilities are significantly higher but nevertheless the trend line has an upward slope.

[415] data: Scopus (2009)

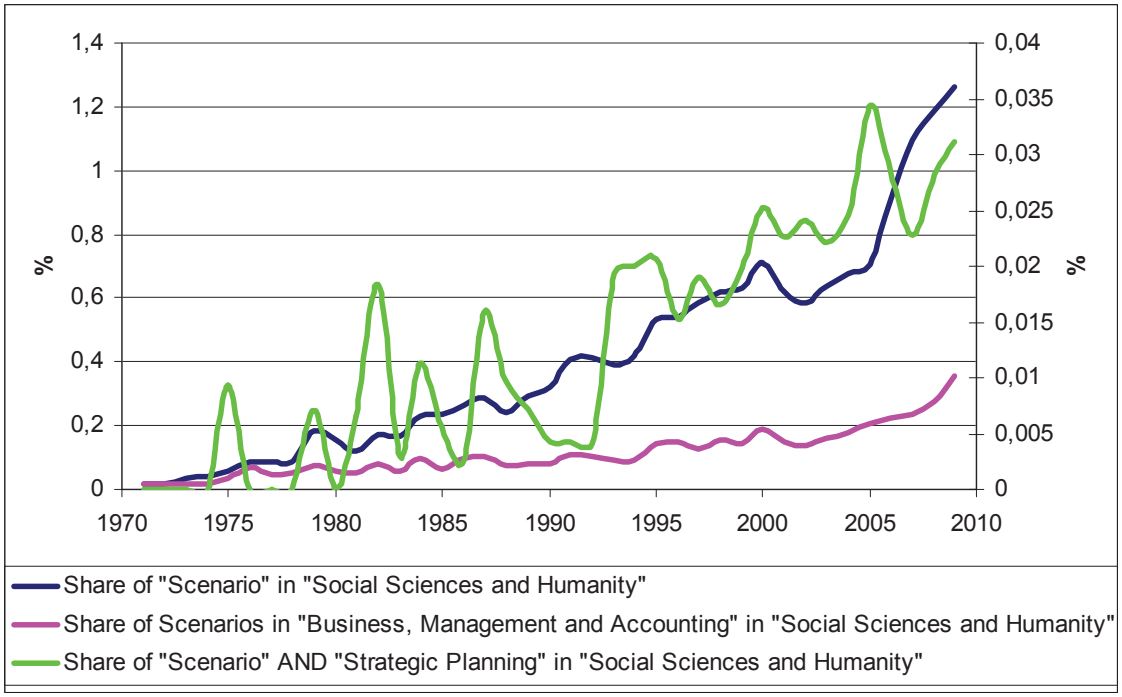


Fig. 6.2: Relative Number of Publications in the Context of Scenarios[416]

The oil price as main influencing factor for the petroleum industry (see chapter 5.2.3) faces uncertainties concerning its impact factors as well as its own potential impacts and can not be analysed by trend projections or model simulations. As a consequence the strategic planning should be based on alternative developments respectively scenarios too.[417] Therefore the scenario technique is the basis for the analysis of the oil price developments and the advanced processing of the corresponding information as an input for the strategic planning.

In the subsequent chapter the implementation of scenario monitoring with fuzzy models as an advancement of the scenario technique is described. Before the necessity of oil price scenario monitoring in the upstream industry is pointed out and different scenarios considering the oil price are analysed concerning their suitability. After the introduction to fuzzy systems the scenario of the HWWI is implemented as a fuzzy model exemplarily.

[416] data: Scopus (2009)

[417] cf. Kreilkamp (1987), p. 255

6.1 Scenario Monitoring of Oil Price Developments

The description of the business environment in chapter 5.3 discloses the existing turbulence in the upstream industry accompanied by a saturated market which creates a condition contrarily to a stable growth in a more or less certain future (compare chapter 4.4.1). The advanced competition for reserves is a second condition for dynamism and uncertainty which makes the use of prognosis like trend extrapolations worthless.[418] In the context of the oil price the empirical evidence of the pitfalls of using prognosis can be demonstrated by analysing the forecasts of well-known organisations historically. As already visualised in figure 5.15 the one-dimensional forecasts of the Energy Information Administration failed considerably. Another empirical evidence for the inapplicability of single point projections is shown in figure 6.3 where the forecasts of the US Department of Energy and the International Energy Workshop are averaged and missed the real developments significantly. Besides, also the trends of the futures market in 2003 turned out to be misleading considering the rising oil prices since that year. Against the background of these two empirical examples the demand for planning with multiple futures in the context of oil price developments is reasoned too. Since the oil price is highly dependent on several factors of the global environment which are exposed altogether to a certain extent of dynamism and interrelate to each other the complexity can only be handled by system thinking representing the network of factors.

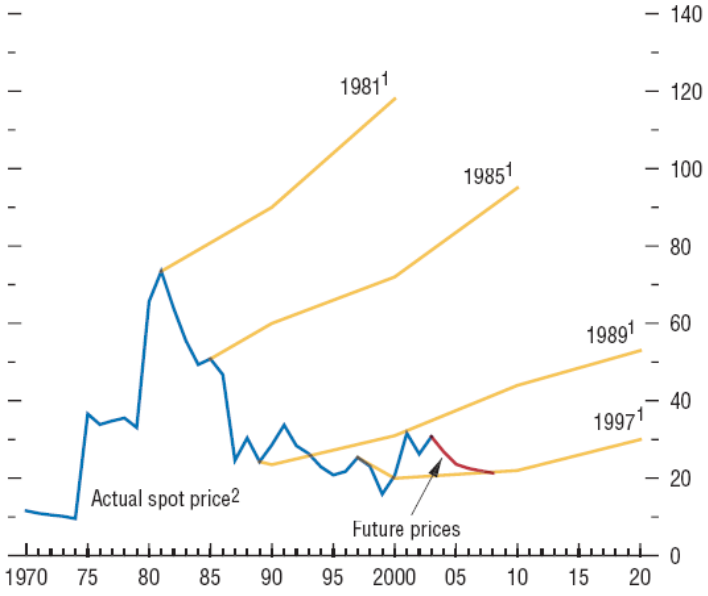
The conditions described above create a level of uncertainty in which no probabilities for certain states can be estimated and the influencing factors may change with time. Dependent on the period new technologies, political interventions or speculative market participants have influence on the oil price. For the given state of unpredictability the application of the scenario technique creating potential future pictures is recommendable.

Already before the first oil crises in 1973 the suitability of the application of scenarios was recognised in the petroleum industry for the purpose of preparing for changing oil prices. In the stable fifties and sixties the conventional strategic planning approach was reliable and in a not changing world prognostications worked with sufficient accurateness. On the other side prognostications were not able to anticipate the basic changes of the environment. In a more turbulent environment the task is not to improve the extrapolations or to employ better experts but to accept and understand the uncertainty. Especially if long planning horizons are required like in the petroleum industry the use of scenarios is adequate.[419] In the eighties and nineties several companies in the industry, especially the petroleum majors, started to adapt the scenario approach for their strategic planning processes instead of using single-point forecasts. This was a consequence of the increasing inaccuracy

[418] cf. Grant (2003), p. 493

[419] cf. Wack (1996), p. 395 ff.

of the forecasts which proved to lead to bad results of strategic decisions in some companies if for example the oil price assumptions were far away from reality. In this way the contingency planning based on assumptions for certain variables replaced the forecasts.[420]



Sources: Bloomberg Financial Markets, LP; Goldman Sachs (2002); and IMF staff estimates.
[1] Average of long-term forecasts prepared by the U.S. Department of Energy and the International Energy Workshop in 1981, 1985, 1989, and 1997, respectively.
[2] West Texas Intermediate petroleum spot price.

Fig. 6.3: IMF Analysis of Crude oil Forecast History[421]

After a scenario is created an adequate and continuous monitoring of the influencing factors in the course of the scenario management process is essential to get the desired information for the planning process. A poorly monitored fact is more dangerous than a wrong conclusion.[422] The monitoring phase focuses on the key factors of the scenario to get informed about the occurrence of a certain scenario path (see chapter 3.4.1). Monitoring stands for the observation and intensive search for signals already identified in the scenario creation, whereby no holistic methods are proposed in the literature. Recommendations for time intervals for observations in case of certain developments[423] or monitoring the key indicators to check the validity of the scenarios and their modification requirements[424] are examples for the application of the monitoring approach. The last application also points

[420] cf. Grant (2003), p. 506
[421] IMF (2003), p. 58
[422] cit. Valery, in Wack (1996), p. 432
[423] see Von Reibnitz (1991), p. 208 ff.
[424] see Fink/Siebe (2008), p. 75 f.

out that monitoring is also used to recognise if the right scenario is chosen. Another result of monitoring is the attempt to turn the uncertainty into risk by the subjective evaluation of probabilities based in the observed developments, but the identification of trends is more meaningful than the quantification of the possible occurrence of a scenario in a subjective manner.[425]

Based on the target of the monitoring to identify the most realistic oil price trend based on the development of the input factors, the requirements for a meaningful application are reflected on the nature of scenarios. First of all quantified results of the scenario monitoring (e. g. the oil price as output) will never be consistent with reality, since this is not the basic idea of the scenario technique where recognising trends is the main benefit. Further on the determination of the most realistic scenario path without a subjective influence is desirable. A further problem results from the qualitative or quantitative values for the input parameters and their link to the resulting scenario paths. Qualitative factors are difficult to classify (e. g. political tensions) or can only be determined bivalent (e. g. outbreak of a war or not outbreak of a war). Quantitative factors are easier to compare with the premises for different scenarios but are difficult to assign to a certain scenario path as a single value. Often the underlying quantitative premises are not consistent with reality and changing volatilities with time (e. g. the skyrocketing oil price volatilities since 2000) do not allow a comparison with the initial premises for the scenario. Also the determination of threshold values at which the occurrence of a scenario is probable is not suitable when neglecting the causal relationships between all influencing factors. Since scenarios are based on system thinking and the key factors can be described by a network in the most cases all factors have to be aggregated to assign the actual developments to a specific scenario path. In the end an excellent monitoring method also visualise the results to attain recognition and acceptance in the view of the deciders respectively user of the technique.

The limitation of the scenario monitoring is primarily the concentration on the factors involved in the scenario, so the result of the monitoring can only be as good as the underlying assumptions and the coverage of the selected factors for the scenario to monitor. The scanning as the search of information without a reference to an already identified signal (see tab. 4.1) cannot be replaced by the monitoring approach and it must be complemented by other methods to establish a holistic strategic early warning system. Although potential discontinuities may be considered in scenarios (see fig. 4.2), the majority of them only deals with trends. The risk of determining influencing factors in a long-term view like it is implemented in scenarios is, that the influencing factors are changing respectively discontinuities occur. For example the most oil price scenarios assume some trends of supply and demand development to give conclusions for the oil price and would not incorporate the

[425] see Gausemeier et al. (1996), p. 225 f.

excessive fluctuations due to market speculators in the last years. As a consequence no scenario was able to anticipate the third oil crises or at least the extent of the skyrocketing prices since a new trigger appeared in this context. To find a remedy for this development an additional search for weak signals is necessary. For example like suggested in chapter 5.2.2 respectively visualised in figure 5.5 it would have been possible to be prepared for the countermovement in form of the bursting bubble after the price peak in 2008 by finding analogies to other markets. Generally it is highly recommended to implement the concept of weak signals as a complementation to scenario monitoring to be protected against surprises. This requirement corresponds to the tasks of the first phase of strategic early warning systems like represented in figure 3.19.

6.2 Selected Energy and Oil Price Scenarios

In many petroleum companies scenarios were applied and proved to be successful especially in times of a highly volatile environment since it discloses alternative ways of action. The application of the scenario technique results in different possibilities of what might happen and prepares the companies for necessary measures to work with the potential future states.[426] Since the creation of professional scenarios is a very time consuming activity where a large team of experts is necessary to achieve meaningful results existing scenarios from independent organisations are used by oil companies without an installed scenario team and also for the thesis in hand.

In this chapter selected scenarios from different organisations and based on different methods are introduced to give insights in the interrelationships of influencing factors and different views of environmental changes. Dependent on the key influencing factors of the scenarios a differentiation can be done, whereas it is recommended to monitor scenarios of all types to check the consistencies respectively to get a holistic picture of potential key factors. The most scenarios like that of the Organisation for Economic Co-operation and Development (OECD), the Energy Information Administration (EIA) or the Hamburgisches Weltwirtschaftsinstitut (HWWI) are based on supply and demand. Others like that of the European Commission (EC) focus on the potential development of new technologies. Finally scenarios are available dependent on the energy policy like that of the World Energy Council (WEC) and that of the International Energy Agency (IEA), whereas the first one does not specify oil prices and is not introduced subsequently and in the second one the carbon dioxide regulations play a major role.

[426] cf. Boyle (2002), p. 15 f.

6.2.1 Supply-Demand-Driven Scenarios

The supply and demand driven scenarios cover factors regarding production and partially the influence of the OPEC on the production as well as the economic growth, price elasticity, energy intensities and others representing demand. Subsequently the scenarios of OECD, EIA and HWWI are discussed.

OECD Economic Outlook

The scenarios of the OECD[427] can be differentiated from others since they also consider short-term influences next to the long-term fundamental determinants of the market. The basic assumptions can be summarised as follows:

- The dependence on oil as an energy source will continue especially in the transport sector. The demand is increasing in North America and above all in the emerging non-OECD countries with a higher energy intensity and will even have a higher change in relation to the global gross domestic product (GDP).
- A further concentration of the oil reserves on the Middle East will result in a higher dependence on the OPEC accompanied by decreasing volumes of oil discovered outside the exporting countries.
- Oil prices tend to rise even if the market share of the OPEC is stable over the considered time horizon.
- In the case of an even higher GDP growth respectively income elasticity of demand, especially in China, the prices would increase significantly or OPEC is gaining market share and compensates the increasing demand.
- Supply and demand outside of the OPEC may respond to higher prices by technological progress and unconventional production, which would limit the power of the cartel again.
- High price volatilities and the threat of unexpected oil market disruptions would have a restricting influence on investments in exploration.
- Since the regional distribution of demand will change, bottlenecks in transport may cause an upward shift in prices.
- The current upward movement of prices will continue although it is uncertain how long the short-term influences increasing the prices would endure.
- A changing monetary policy would weaken the impact of oil prices on inflation.

[427] OECD Economic Outlook No. 76 (2004), Chapter IV

- Since the oil price increase is primarily caused on the demand side the shock may have only a moderate impact on the output of OECD countries.
- A fiscal policy targeting on a high tax share in product prices would reduce the oil intensity and would not support the reduction of oil dependency.

In a long-term view the oil market is characterised by a decreasing oil intensity of production (oil consumption per unit of output) in OECD countries causing the demand growth to stagnate. Oil is used more efficiently respectively partially replaced by alternative energy sources. Nevertheless in a global view the rise in demand will continue and the oil dependence will be maintained. The reserves to production ratio representing the years of supply left at current production rates will be stable also due to the definition of reserves, whereas the reserve base is determined by the economic viability and the technological progress too and therefore assumed to be stable although the physical volumes discovered will decrease. Nevertheless the reserves will be concentrated more and more in the Middle East, where investments in exploration may not be sufficient in the future. Another influencing factor is the extent at which the OPEC will demonstrate their power in regard of their low production cost opportunities. The incentive to use their power is dependent on the price elasticity of demand and supply outside the OPEC where a low elasticity may provoke production cuts.

The assumptions result in a baseline scenario and six other paths deviating from that (see tab. 6.1). The baseline scenario is based on the assumptions described before and considers an oil price increase of about 1 % per year on average from 2004 to 2030 up to 35 US-Dollars per barrel, whereas the market shares of OPEC and non-OPEC production is stable with an initial value of 38 %. Besides a constant moderate increase of the demand is expected and in general supply and demand are in a long-term equilibrium. The different price extrapolations resulting from different scenario paths are reasoned by higher GDP growths, different income and price elasticity of demand as wells as non-OPEC supply elasticity. The first two deviations due to higher growth respectively higher income elasticity would result in higher oil prices in comparison to the baseline scenario of 4,5 respectively 13,2 US-Dollars per barrel. In contrary the potential changes of the price elasticity of demand and non-OPEC supply in the next two scenarios have only a marginal impact on the oil price development. The last two scenarios as a combination of the first three ones would produce the highest price increases.

Besides the long-term projections also short-term influences deviating from the market fundamentals are mentioned in the study. These are a stronger anticipation of growing demand, a low flexibility on the supply side, low oil inventories, transportation bottlenecks, regional supply imbalances, geopolitical tensions and speculation on the oil markets. Summarised the fundamental key factors determined in this scenario are the supply-demand-

balance in general expressed by the oil intensity, the OPEC market share, the economic growth, the price elasticity on the supply and demand side and the income elasticity of the economies.

Tab. 6.1: Oil Price Assumptions for Selected Supply and Demand Scenarios[428]

	A. Oil price in constant 2000 dollars (fixed OPEC market share target - 38%)				B. OPEC target price band +/- 10% from baseline 2030	
	2004	2010	2020	2030	OPEC Supply (Mbd)	OPEC Market share (percentage points)
1. Higher growth						
OECD (+1/2%)	0.2	0.6	1.0	1.4	0.6	0.0
China (+1%)	0.1	0.3	0.7	1.3	0.5	0.0
Rest of the world (+1/2%)	0.2	0.5	1.1	1.9	0.8	0.0
World	0.4	1.5	3.0	4.6	4.5	1.5
2. Higher income elasticities						
OECD (+0.2)	0.7	1.9	3.1	4.1	2.6	0.6
OECD and China (+0.2)	0.9	2.6	4.5	6.5	9.6	3.9
World (+0.2 for ROW)	1.4	4.6	8.7	13.2	29.0	11.7
3. Lower price elasticities of demand						
OECD (+0.2)	0.0	0.0	0.2	0.4	0.2	0.0
China (+0.2)	0.0	0.0	0.0	0.1	0.0	0.0
Rest of the world (+0.2)	0.0	0.0	0.1	0.4	0.2	0.0
World	0.0	0.0	0.5	1.2	0.5	0.0
4. Different non-OPEC price elasticities of supply						
Higher (+0.2)	0.0	-0.1	-0.3	-0.6	0.3	0.0
Lower (-0.2)	0.0	-0.1	0.4	0.9	-0.5	0.0
5. Higher growth and income elasticities in non-OECD countries[b]						
China	0.3	1.1	2.6	4.8	5.0	1.8
World excluding OECD	1.1	4.0	8.7	14.9	34.4	13.6
6. Higher growth and income elasticities and lower price elasticities of demand[b]						
China	0.3	1.1	2.8	5.3	6.3	2.5
Rest of the world	0.8	3.1	7.3	13.2	24.9	10.3
World excluding OECD	1.2	4.5	10.9	20.1	38.9	15.1

a) Assumptions in the left column are also shown as deviations from baseline. Since price elasticities are negative a positive change implies a lower elasticity (in absolute terms).

b) Scenarios 5 and 6 are simulated as combinations of scenarios 1, 2 and 3 where relevant, for the country or region concerned.

Note: Rest of the World is defined as the total world less China and the OECD.
Source: OECD calculations.

World Energy and Economic Outlook (EIA)

Also the scenario of the EIA[429] defined a reference case and by variations of the values for the key factors two other paths for low respectively high oil prices are created. The refer-

[428] OECD Economic Outlook No. 76 (2004), p. 10

[429] EIA (2007)

ence case assumes that the legal and political conditions are unchanged over the years and a significant increase of worldwide demand for energy, especially in the non-OECD countries. The dependency on oil respectively the first position of oil in the energy mix will remain but decrease moderately, especially because of the dependency in the transportation sector. Nevertheless the rising oil prices will dampen demand growth after 2015 to a moderate extent until 2030. Also the gas consumption increases and due to higher oil prices the coal demand is represented by the largest growth. The assumptions for economic growth are based on many relevant macroeconomic indicators and mentioned as the most important ones for the future energy demand. Based on the reference assumptions two scenarios for different oil price developments were created and the impacts are analysed (see fig. 6.4).

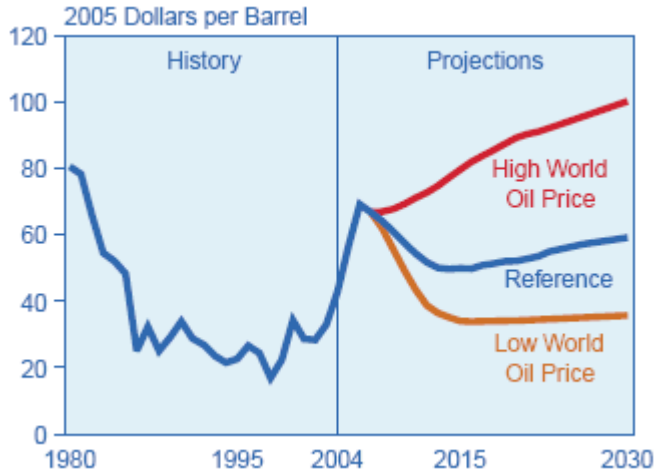


Fig. 6.4: World Oil Price Scenarios[430]

In 2030 the oil prices for the reference, the high oil price respectively the low oil price case are 59, 100 and 36 US-Dollars per barrel. Although there are substantial price differences in the three scenarios the energy demand is relatively stable for the considered time horizon, only the shares in the energy mix are changed significantly. While the global energy demand is projected to grow continuously nearly independent of the oil prices the oil consumption is about 30 % higher in the low oil price case than in the high oil price case (fig. 6.5). In the high oil price case also the gas consumption is lower than in the reference case in contrast to the consumption of coal, renewable and nuclear energy. In the low oil price case the reverse trend is obvious, whereas especially the transport sector is very price elastic as shown in figure 6.6.

[430] EIA (2007), p. 13

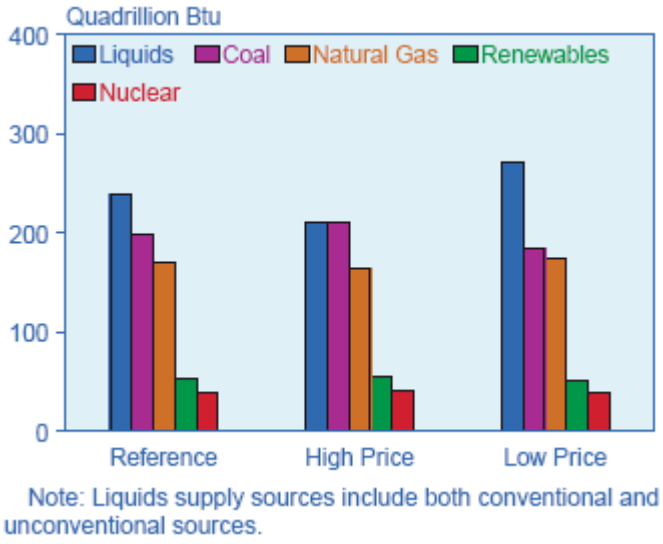


Fig. 6.5: Energy Mix for Different Oil Price Assumptions[431]

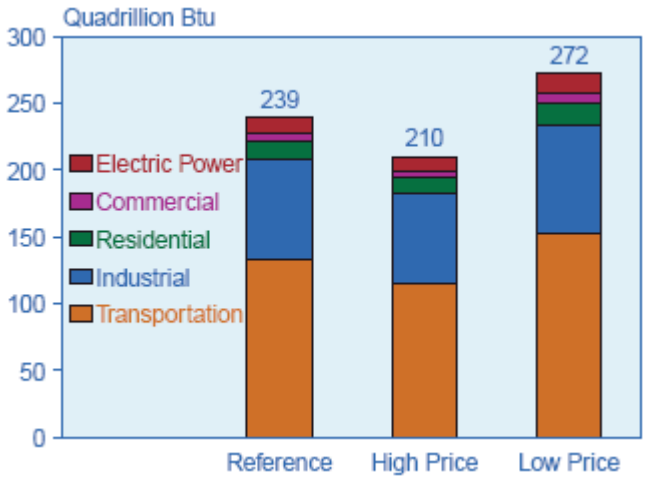


Fig. 6.6: Sector Related Oil Consumption for Different Oil Price Assumptions[432]

Concerning the influence of the oil price scenarios on the GDP only short-term impacts are expected to a greater extent since the economies will be able to adjust themselves to the situation until 2030. In comparison to the reference case the GDP growth will peak at 0,7 % above the reference growth in the low oil price case respectively at -1,1 % below the reference growth in the high oil price case in 2014 but both deviations will converge to the reference projection until 2030 again.

[431] EIA (2007), p. 13

[432] EIA (2007), p. 15

In the context of oil production the reserves will be 15 % smaller in the high oil price case compared to the reference case which results in higher production costs and a smaller than desired production rate of the OPEC producers. In a low price environment the reserves will be 15 % larger in contrast to the reference case accompanied by higher OPEC production quotas. In all cases the work of fundamental market influences is assumed neglecting disruptions on the supply side. In non-OPEC regions a moderate increase of conventional and a substantial increase of unconventional production is assumed until 2030, whereas the unconventional production is also a matter of oil prices and intensified with higher prices and reversely.

Recapitulating the assumptions for the future developments are based primarily on demand. The impacts of the different oil prices are analysed regarding economic growth, energy mix and production in OPEC and non-OPEC areas.

Energierohstoffe (HWWI)

HWWI[433] created scenarios which are also based on the basic laws of supply and demand as visualised in figure 6.7. The demand is described by the energy intensity dependent on the technical progress and the consumption determined by the amount of goods produced in the economies. The supply is a matter of reserves which are extended by new findings and reduced by the oil consumption. The reserve base and the consumption are the determinants for the reserve range representing the years of production left when dividing the actual production respectively consumption by the total amount of reserves. Based on the sketched mechanism a base scenario to 2030 is created and five deviating scenario paths influenced by variations of the key factors are simulated.

The assumptions for the scenario creation are that after partially being influenced by short-term disruptions the oil price is triggered by the described fundamentals resulting in a long-term trend. In a long-term perspective the demand is as already mentioned a result of the growth of the goods production, the technical progress and also the oil price. Neglecting the changes of the other two parameters the demand for oil is proportional to the production of the economies and the energy intensity expressed by dividing the energy use by the production is constant. Therefore for determining the demand a forecast of the global production is necessary. In this context it is expected that the energy intensity will decrease due to a higher efficiency by technological improvements. If the price for fossil energy sources increases for 10 % a decrease of demand of 2,5 % but an increase of the demand for alternative energy sources of the same extent is assumed.

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[433] HWWI (2005)

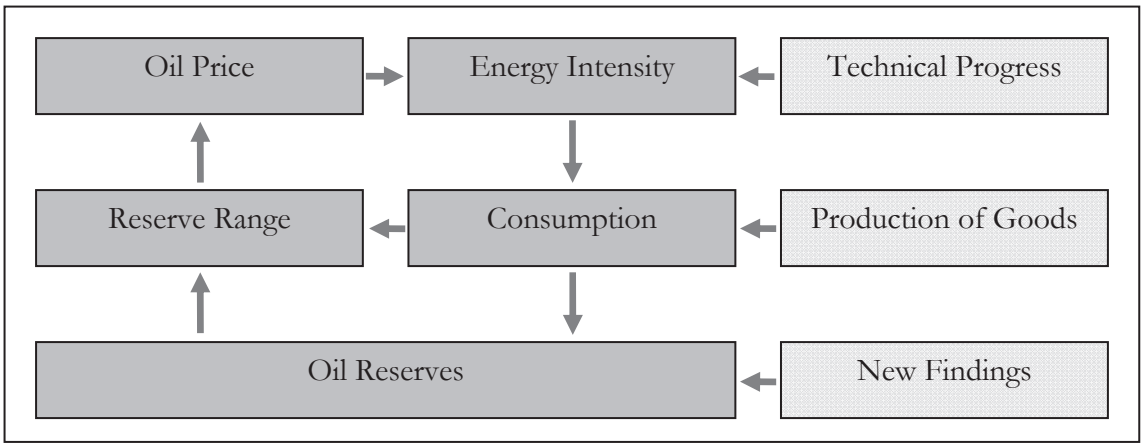

Fig. 6.7: Basic Mechanisms for Oil Price Projections[434]

Considering oil reserves a decline is a consequence of the consumption and additions are achieved by exploration activities. Basically the exploration activities are dependent on the oil price but there is no clear correlation between new discoveries and the oil price. Therefore the new oil findings are prognosticated with a trend and assumed to be reduced by 20 % until 2030 corresponding to a 0,5 % share of new discovered to the total reserves in contrast to 2,4 % in 2003. On the other hand the gas field discoveries are expected to be stable in the next two decades. These assumptions are aligned to the peak oil theory.

The oil prices are not a consequence of the production costs but of the long-term availability of reserves expressed by the range in years. If the range is reduced by 10 % the price increases for 7,5 %. Also the substitution effect is considered in form of the adaption of the prices of competing energy sources. The production policy of OPEC is neglected in the basic assumptions and considered by a specific scenario path described subsequently.

The different scenarios are modifications of the base scenario (see tab. 6.2). In the base scenario the world production will double until 2030 with an average annual growth of 2,8 % and the energy demand will have a weaker growth due to higher prices and the technical progress. The oil share in the energy mix will decrease to 33 % but due to an increasing demand and smaller new discoveries the reserve range of oil will decrease to 22 years (about 40 in 2003). The oil prices for the single scenarios are indicated in the table.

[434] on the basis of HWWI (2005), p. 24

Tab. 6.2: Nominal Oil Price Development of Alternative Scenarios[435]

Scenario	Initial Price ($/bbl)	2010 ($/bbl)	2020 ($/bbl)	2030 ($/bbl)
Base Scenario	38	50	75	120
Intensified Energy Savings	38	49	70	107
Halving of New Findings	38	52	85	154
Intensified Oil Price Reaction	38	51	80	135
Intensified Energy Savings in Northern America	38	49	71	113
Higher Growth in Asia	38	51	82	145

The first scenario with deviating assumptions considers the case of a more efficient use of energy caused by political changes of innovations. As a consequence the energy demand increases only by 51,2 % (instead of 75,1 % in the base scenario) until 2030, whereas primarily fossil energy is saved. Since the range of the reserves declines more moderate the oil price is also lower in the course of the considered time frame.

The halving of the new findings of fossil energy sources implies the decline of the reserve range to 15 years in 2030. The halving is regarded as the lower limit of reserve reduction and the oil price would be the highest of all scenarios with 154 US-Dollars per barrel.

Intensified price reactions stand for a higher price elasticity on the supply side, whereas for a 1 % decline in reserves the price would rise for 1 % in this scenario in contrast to 0,75 % in the base scenario. The consequence is a decreasing demand which expands the reserve range moderately until 2030 and triggers the substitution by alternative sources.

A political change towards energy savings in Northern America would offer a great potential especially for the oil intensity. The lower demand would dampen the oil and gas price rise and not create incentives to switch to renewable energy.

The last scenario regards the economic growth of Asia, which is 2 % higher as in the base scenario. Consequently the significant increase in energy demand causes steep price rises.

Since the mentioned key factors respectively trends only considers long-term trends also short-term influences on the oil price are mentioned in the analysis, which are not involved in the scenarios above and may cause substantial deviations from the projections. These may be disruptions in the oil supply, whereas a drop out of 10 % of the world production is assumed to skyrocket the oil price by 80 %. In this case a substitution of oil as energy source is expected and it lasts about six years until the return to the long-term trend is

[435] on the basis of HWWI (2005), p. 37

achieved. A shock caused on the demand side, for example by a rise of 10 %, would also cause a price increase of 80 % in the applied simulation model. Also in this case it would last years until the supply in balance with the demand again and this time range is determining the price recovery.

The scenarios of the HWWI are relying on a system of key parameters, which represent energy supply and demand in a very fundamental way to gain conclusions for the long-term oil price developments. The key factors considered are energy intensity, reserve range, energy consumption as well as the reserve base.

6.2.2 Technology-Driven Scenarios

Although in all scenarios discussed above technology plays a role too, the scenario in this chapter focuses on future developments which are primarily driven by potential technological changes in contrast of having only an indirect influence.

World Energy Technology Outlook (EC)

The scenarios of the EC[436] in the "World Energy Technology Outlook - 2050" cover next to a reference case scenarios for a carbon constraint world and a world using hydrogen commercially, both dependent on future technological developments.

The reference case as a projection of existing trends assumes only moderate interventions of the policy concerning climate issues. The total energy demand will double until 2050 with a 70 % share of fossil fuels, although driven by policy and due to higher prices for energy the energy will be used more efficiently which is compensated by the economic growth and the accompanied additional goods production. The regional distribution of energy consumption will change in favour of the developing countries, which will need two thirds of the energy in 2050. The conventional oil production will peak in 2025 and the unconventional part as well as the gas production will increase over the whole time period considered. The electricity production will be four times higher in 2050 with a higher share of coal and later on with an increasing use of renewables and nuclear power. Concerning carbon dioxide emissions the comeback of coal will compensate the use of renewables so that they grow proportionally to the energy demand. For this case an oil price of 111 US-Dollars per barrel is assumed in 2050.

In a carbon constraint world a carbon dioxide emission target of 500 volume parts per million in the atmosphere should be achieved by corresponding political interventions until

[436] EC (2006)

2050. This target is achieved earlier in developed countries and with a delay in developing and merging countries. Especially in the European Union the emissions should be the half of those in 1990 to achieve this aim, whereas especially after 2030 substantial savings can be achieved. In the energy mix non-fossil fuels will increases their share, whereas renewables and nuclear power will cover 20 % of the energy demand in 2050 and will especially be used more frequently in the electricity generation. Due to new carbon dioxide capture and storage technologies the cumulative storage capacity until 2050 will be five times the annual emissions of today. The trends of this scenario result in an oil price of 90 US-Dollars per barrel due to the lower demand caused by the higher carbon value which creates a gap between producer and end-user prices.

Finally the hydrogen scenario is based on the carbon constraint case with the consideration of the commercial use of hydrogen technologies for end-users. Although the total energy demand is only moderately lower than in the reference case the energy mix changes significantly. The consumption of fossil energy sources will only account for 60 % of the total demand, whereas especially the share of coal as a carbon dioxide intensive source will decrease to the half. Especially between 2030 and 2050 the share of renewables and nuclear power will increase driven by the high value of carbon emissions. Concerning the electricity generation it is assumed in this case that more than the half of the plants will be able to capture and store carbon. The commercial use of hydrogen is possible not until 2030 when the costs are reduced due to technology developments and hydrogen is primarily used as fuel in the transport sector by 30 % of the passenger cars in form of fuel cells, hybrid engines or hydrogen internal combustion engines. The assumed oil price in 2050 is 100 US-Dollars per barrel in this scenario also caused by a reduced demand and a slightly higher carbon value as in the reference projection.

In regard of the oil production due to better technologies the recovery rate will be increased and the ultimate recoverable reserve base will be extended from 2700 gigabarrels today to 3500 gigabarrels in 2050. The reference case considers partially also constraints to the access to resources as a consequence of the policy in the Middle East. The modelling of the oil prices mentioned above for each scenario is based on the market fundamentals as well as the reserve and production figures. The latter ones are calculated for each producing country starting with the cumulative discoveries as a function of the recoverable reserves and the exploration efforts, whereas the reserves are dependent on the technological available recovery rate and the oil price. The recovery rate is assumed to rise from about 35 % to 50 % in 2050. The reserve changes are calculated by subtracting the cumulative production from the discoveries in a time period. The oil production is determined by the decreasing reserve to production ratio in non-OPEC states and by the balance of supply and demand in the OPEC. The world oil prices are in a short-term view dependent on the

OPEC capacities and in a long-term view on the reserve to production ratio which reasons the increase in the later decades of the time horizon (see fig. 6.8).

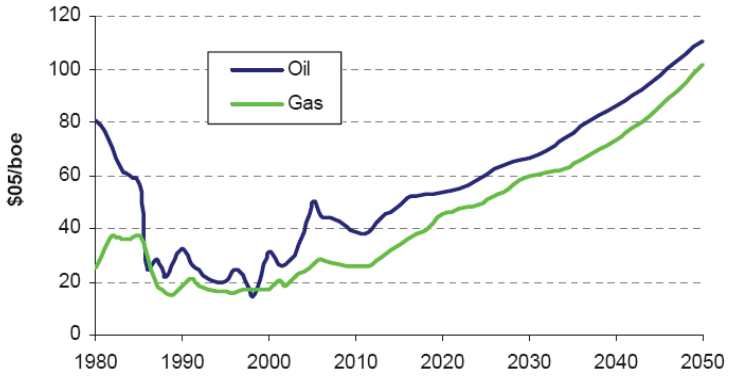

Fig. 6.8: Oil and Gas Prices in the Reference Case[437]

Summarised the extent of oil price rise is a consequence of the fundamental market parameters demand and supply. The demand is driven by the development of alternative technologies and the value of carbon as determinants of substitution. The supply is dependent on the reserve availability affected by production, new discoveries, technology and also the oil price in a long-term perspective.

6.2.3 Policy-Driven Scenarios

Finally a scenario is introduced which is driven by the political interventions determining the value of carbon and therefore based on different projections of the extent of carbon dioxide equivalent emissions in 2030.

World Energy Outlook (IEA)

The IEA[438] publishes an annual world energy outlook including scenarios for different greenhouse gas emission targets and also covering the consequences for the oil prices. This is achieved by different policy mechanisms focussing on emission reduction targets in OECD countries. The available mechanisms are cap-and-trade systems, sectoral agreements or national policies and measures. Cap-and-trade systems are able to meet the targets with a great certainty since the caps are set at the desired level of emissions and the available amount is traded at a price representing the scarcity. The consequence is a better eco-

[437] EC (2006), p. 29

[438] IEA (2008)

nomic efficiency and lower global costs for reducing emissions. An ideal trading system considers all sources of emissions which is not implemented yet. Sectoral agreements are defined as international commitments of certain countries to reduce the emissions of specific sectors (e. g. steel sector) for a fixed amount in a certain period. The agreements are applied if emission caps would produce higher transaction costs, are more difficult to negotiate or if the reduction potential of a specific sector is not capitalised. When applying the first two mechanisms there are another gaps left which can be addressed by national policies or measures. They are aligned with the specificities of the local environment and all aspects of energy and carbon efficiency respectively all sectors can be in the focus (e. g. smaller emitters like in the building sector). On a national level the energy policy can be influenced by the fiscal policy (taxes, incentives,…) and practical measures to create sectoral standards are introduced.

The basic assumptions for the reference scenario are:

- There are no changes to the actual climate policy.
- The world population will grow at 1 % on average per year until 2030.
- The gross domestic product as indicator for the energy demand will increase by 3,3 % on average with a higher growth in non-OECD countries, especially in China, India and the Middle East.
- The oil price will increase to 100 US-Dollars (real in 2007 Dollars) per barrel until 2015 and to 120 US-Dollars in 2030 (200 US-Dollars in nominal terms). The reasons are the projections for physical delivery and futures contracts in a short-term view and the supply costs and demand outlook in a long-term view.
- The energy efficiency is increasing steadily over the considered period and new technologies on the supply-side (e. g. carbon storage and capture) are applied at a small extent.
- The global energy demand will grow at 1,6 % per year until 2030 dampened by higher energy prices and a slower economic growth.
- The energy mix will consist of 80 % fossil fuels at the end of the time horizon with the highest growth for coal and a sustained dominance of oil.
- China and India will consume more than the half of the total primary energy.
- After the aggregated energy demand of the residential, services and agricultural sector the industry sector will become a larger consumer than the transport sector. Concerning the end-use of energy the electricity consumptions will grow fastest.

- The production of fossil fuels increase only in non-OECD countries and the dependence on imported oil and gas will rise significantly on the consumer side.

The scenarios deviating from the reference case are called 450 policy scenario respectively 550 policy scenario indicating the target for the reduction of greenhouse gas emissions (450 respectively 550 parts per million). Both scenarios consider cap-and-trade systems in the power-generation and industry sectors of the OECD countries with significant higher reductions after 2020 in the 450 scenario. Besides the OECD and other major economies conclude sectoral agreements for their steel, cement, vehicle- and aircraft-manufacturing sectors encouraging the use of more efficient technologies. It is also assumed in both scenarios that national policies and measures will cover the buildings sector in OECD countries, the building, power generation and industry sectors in other major economies and in all sectors of the remaining countries.

The consequences of the two scenarios can be summarised as follows:

- In the 550 scenario the greenhouse gases emissions peak in 2020 and the carbon dioxide emissions in 2025. Both types of emissions are 19 % lower than in the reference case.
- The price of carbon is 90 US-Dollars per tonne of carbon dioxide in the 550 scenario leading to changes in the energy mix. The share of alternative energy sources will increase at the cost of fossil fuels and the total energy consumption is 9 % lower than in the reference projection in 2030.
- In the 550 scenario the oil demand rises at a lower extent especially due to savings in the transport sector. Therefore the oil price will be lower and account for 100 US-Dollars per barrel in 2030.
- In the 450 scenario stronger political interventions lead to a sharp fall of emissions after 2020. The carbon price is assumed to be 180 US-Dollars per tonne of carbon dioxide. Alternative sources will cover 40 % of the electricity generation and energy related carbon dioxide emissions will already peak in 2020. The oil price is also assumed to level out at 100 US-Dollars per barrel in the 450 scenario.

The scenarios of the IEA can only be differentiated by the extent of political interventions in the climate policy. The influencing factors on the oil price are primarily driven by supply (including cost considerations) and demand, whereas the latter one is the link to the varying assumptions of the scenarios.

6.2.4 Recommendations

In the chapters 6.2.1 to 6.2.3 different energy and oil price scenarios are introduced based on different aspects and the underlying impact factors. Each of the scenarios is characterised by the perspective restricted by the considered factors and as a consequence advantages and disadvantages arise. Therefore the concluding paragraphs should give recommendations for the suitability of scenarios to represent the oil price developments as a basis for the monitoring. To cover a larger spectrum of the environmental factors a combined use of more than one scenario is recommended to check consistencies or deviating results.

The scenarios of the OECD are characterised by only small differences between the resulting oil prices and therefore of limited usability for the purpose to confront the decider with potential alternative developments of the oil price. They are not very flexible and consider only a small number of interrelationships between the influencing factors. Besides the OECD does not publish scenarios periodically and the available scenario of the year 2004 involves premises which deviate significantly from the actual state. Nevertheless the basic indicators and their causal relationships are represented even if the oil price specifications only differ marginally and an implementation by a fuzzy model can be considered.

The EIA scenarios analyses primarily the impact of the oil price on other parameters of the environment and it is not meaningful to monitor the consequences of the developments. Consequently using these scenarios is also not recommendable for the targeted purpose.

The HWWI created scenarios which are based on prognosis and are calculated by a simulation model. The deviating oil prices result form singular impacts which are analysed separately and therefore the system thinking is not applied at its full potential except for the model representing the basic mechanisms. Nevertheless the scenarios cover the market fundamentals in a clear and suitable way and should be able to identify the basic trends if no discontinuities occur. The use of the scenarios to monitor the basics of the oil market is highly recommended if also complementary scenarios involving other impacts are used. Unfortunately the scenarios are created only one-time but the mechanisms should have a long-term validity.

The scenarios of the EC deliver an interesting view of potential changes if new technologies will entry the market. Nevertheless the technological discontinuities are considered to occur in the next decades and general trends of the actual oil price developments cannot be derived. Therefore the scenarios can only be used complementary to other ones which illustrate the market fundamentals.

Also the scenarios of the IEA play only a complementary role. In general it is an interesting and useful approach to analyse the impacts of the climate policies on the oil price by considering the consequences on the demand side but the oil price is also influenced by other factors also mentioned in the study. Besides an advantage of the IEA scenarios is an annual

update and a disadvantage the specification of only two different oil prices for the three scenarios whereas the difference between them is only moderate.

Concluding the HWWI scenario and the used mechanisms is the most suitable scenario to analyse the oil market fundamentals and is also implemented by the fuzzy monitoring approach exemplarily in chapter 6.4. Complementary the impact of technological and political changes can be analysed by the scenarios of the EC and the IEA and also suitability of the application of the OECD scenarios should be of evaluated. The other scenarios (EIA) are not recommended in the available form. It is also necessary to search for new or modified existing scenarios which are available on the market respectively provided by certain organisations.

6.3 Application of Fuzzy Logic for Scenario Monitoring

Subsequently the fuzzy logic is contrasted to the classical binary logic and the characteristics of a fuzzy system are discussed in theory. Thereafter a scenario representing the interrelationships of fundamental oil market parameters is chosen to illustrate the implementation for the purpose targeted at in this thesis.

6.3.1 Introduction to Fuzzy Logic

The basic idea of fuzzy sets, the theoretical fundament of fuzzy logic, is that classes of objects cannot be assigned definitely to one set. While for example animals can be assigned relatively clear to a set with the binary logic (dogs, horses, birds,…) in the most cases, it is already more difficult to classify objects like starfishes or bacteria. Classes of objects which cannot be assigned definitely to one set are called fuzzy sets and are very significant for the human thinking, especially concerning cognition, communication of information and abstractions. The reasons are fuzzy criteria which define the membership to a certain group respectively set. Each individual has different perceptions concerning the classes of tall men or beautiful women for example and uses no binary logic for the classification itself.[439]

The theory of fuzzy sets is applied for different objectives, whereas in the context of business management above all the modelling of uncertainty as well as the reduction of complexity are relevant. Concerning uncertainty the stochastic and linguistic uncertainty is distinguished. The stochastic uncertainty is basically discussed in the probability theory, whereas probabilities of occurrence are assigned to a potential event. A precondition for it is again the binary character of the occurrence or non-occurrence (condition true or false).

[439] cf. Zadeh (1965), p. 338 f.

In regard of "events" like acceptable safety or attractive projects for example no probabilities for their occurrence can be determined, in this case fuzzy sets can be used. The linguistic uncertainty focuses on the content of words or sentences (e. g. stable currency, hot day,…), which must be taken in a context to recognise their factual meaning. While in the interpersonal communication the context is represented sufficient in the most cases in the electronically processing of knowledge definitions by content are necessary. This translation for the data processing can also be achieved by the application of fuzzy sets. Another objective of the fuzzy logic is the reduction of the complexity. Since humans have a limited capacity in the reception and processing of information and therefore difficulties with handling complex systems real situations are often represented by models to simplify the complexity. To achieve a close approximation to reality the models are extended with more and more details and are consequently more and more complex. With the help of fuzzy sets linguistic variables can be embedded into the models and the data surplus can be limited respectively the complexity is reduced.[440]

Therefore fuzzy sets try to blur the crisp boundary values of the binary logic. As an example the class "high oil price rise" can be defined in a way that all values above an annual increase of 30 % fulfil the criteria for the membership in this class. So corresponding to the conventional set theory the values 29,9 % and 30,1 % have a totally different relevance for the model. Although the first value is near the limit the value "false" or "0" is assigned to it corresponding to the defined membership function $\mu(x)$ and the second only marginal higher value will be "true" or "1" and therefore member of the class "high oil price rise" (see fig. 6.9, left graph). The advantage of fuzzy sets is that also class memberships between 0 and 1 are allowed (see fig. 6.9, right graph). As a consequence an oil price rise of 29,9 % will also be considered like the rise of 30,1 % in the model but represented as a less "high price rise". In the figure the blurred transition of the membership function on the right side to the class "high oil price rise" demonstrates this behaviour. As an example even an oil prise rise of 22,5 % is a member of the defined class of „high oil price rise" with a value of 0,25.[441]

[440] cf. Zimmermann (1999), p. 22 f.

[441] cf. Kahlert/Frank (1993), p. 9 f.

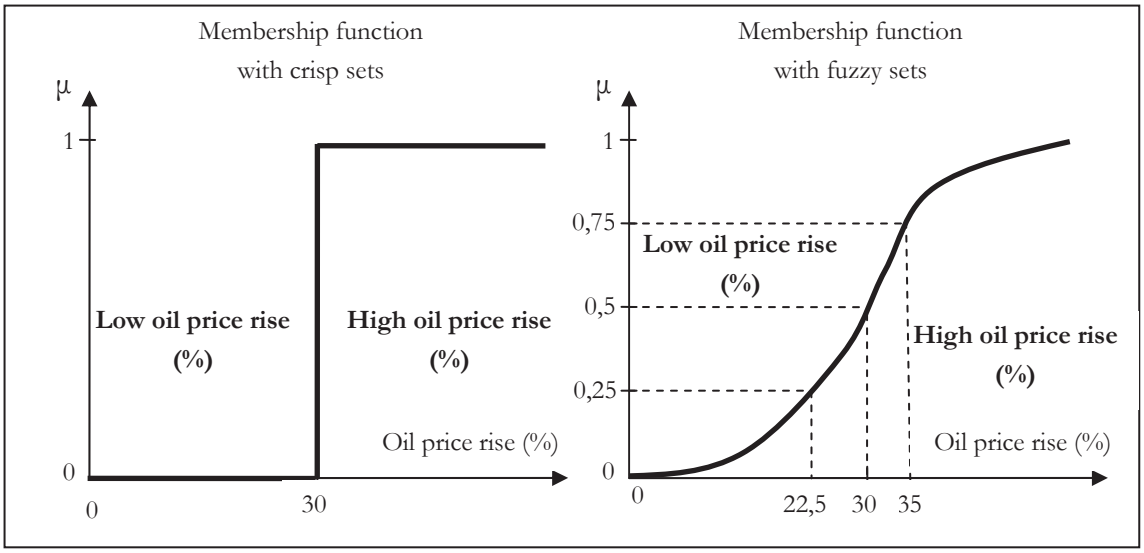

Fig. 6.9: Modelling of Crisp (Left Graph) and Fuzzy Sets (Right Graph)[442]

A fuzzy set is defined by the basic set $X = \{x_1,\ldots,x_n\}$ of degrees of membership assigned to the elements which are represented in the membership function $\mu_A : X \rightarrow [0; 1]$ by values between 0 and 1. So an element can be member of more than one fuzzy set whereas the sum of the degrees of membership has not to be one. The membership functions can be described in different ways, whereas the characteristic functions for the graphical representation can be determined by oneself (e. g. trapezoid or triangular form), by analytical functions (e. g. Gaussian curve or cosine half cycle) or by discrete pairs of values ("Singletons"). For the practical application it is sufficient in the most cases to select a trapezoid or triangular membership function with a varying tolerance and impact range.[443]

If the fuzzy logic is applied to a specific problem a connection of the fuzzy sets by operators is required. If the mathematical basic operators "AND" and "OR" are considered they can be transferred from the classical binary set theory to the fuzzy sets. The "AND" relation corresponds to the average of the two intersecting areas beneath the membership functions and is described mathematically by the MIN-operator (minimum norm):

$$\mu_{A\cap B}(x_i) := \min\{\mu_A(x_i); \mu_B(x_i)\}$$

The "OR"-relation corresponds to the connection of fuzzy sets implemented by the MAX-operator (maximum-conorm):

$$\mu_{A\cup B}(x_i) := \max\{\mu_A(x_i); \mu_B(x_i)\}$$

[442] on the basis of Kahlert/Frank (1993), p. 9

[443] cf. Kahlert/Frank (1993), p. 10 ff.

Figure 6.10 visualises the results of application of the two mentioned connectives as an area in which the resulting fuzzy sets are contained. In detail the membership functions for the classes medium and high oil price rise are combined with each other and triangular functions are assumed. Also other norms are applicable for the connection, if for example in the case of a fulfilled condition the degree of membership should be exactly one, but in the most applications the use of the MIN- and MAX-operators is adequate.[444]

Fuzzy sets can be described by different classes of an attribute (e. g. oil price rise) and subsequently by the formulation of rules used for fuzzy conclusions, whereas various attributes are connected to allow a causal conclusion to an additional attribute. These inference rules are represented by "IF" (premise) - "THEN" (conclusion) - conditions and the output describe the third attribute. On the example of the oil price rise the condition may be: "IF the demand increases significantly AND the oil production decreases THEN there is a high oil price rise". The possible classes of the linguistic variables demand (increases slightly, medium, strong,…) and oil production (decreases slightly, medium, strong,…) would be the input and the output the oil price development (low, medium, high rise,…). In this way by the combination of several rules conclusions for the oil price development are made available.[445]

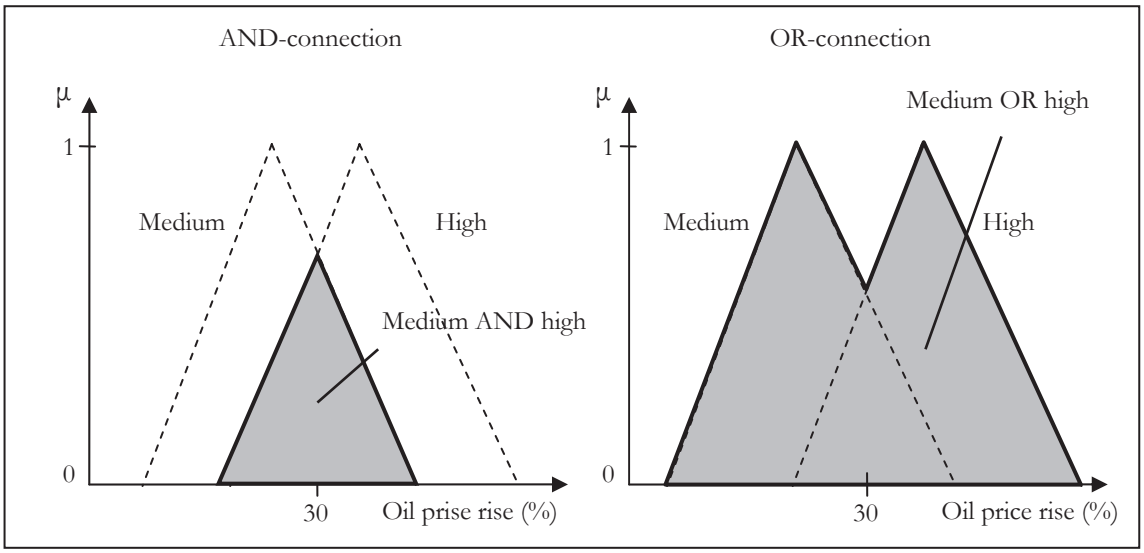

Fig. 6.10: Connection of Fuzzy Sets[446]

[444] cf. Kahlert/Frank (1993), p. 22 ff.

[445] cf. Bojadziev/Bojadziev (1997), p. 128 ff.

[446] on the basis of Kahlert/Frank (1993), p. 22 f.

The application of fuzzy systems covers basically three steps:[447]

1. **Fuzzification**: The specifications respectively the fuzzy sets and the membership functions are defined for the linguistic variables and based on these the input values are converted to fuzzy values.
2. **Inference**: After the determination of the rule base, composed of several IF-THEN-rules connected with logical operators like AND and OR, the inference results with the specific input of the fuzzified input variables in conclusions which are available as fuzzy linguistic output variable.
3. **Defuzzification**: The resulting fuzzy output set is transformed through the membership functions and the help of mathematical methods in crisp values again. These values can be used for the further processing for decisions or for control systems in technical applications.

The process of a fuzzy-ruled system is demonstrated in figure 6.11 on the example of the oil price topic to gain a better understanding. At the beginning the crisp values for the oil production and demand are fuzzified by linguistic variables. In the considered case the oil production has a significant membership in the classes low and medium and the demand a strong membership in the fuzzy set "high" as well as lower fraction in the set "medium". With these fuzzified values by the help of the rule base conclusions for the oil price development are made. The two rules of this simplified example would be:

- IF the oil production is on a medium level AND the demand is medium THEN the oil price rise is medium.
- IF the oil production is on a low level AND the demand is high THEN the oil price rise is high.

Via the MIN-operator the minimal membership of the two variables in a single condition of the two mentioned is projected on the oil price change. The result is a lower membership in the class "medium" and a higher fraction in the class "high". If the two rules are connected with the MAX-operator then the resulting areas beneath the triangular functions are combined and by mathematical methods[448] (e. g. centre-of-gravity-method) exact values can be calculated again.

[447] cf. Mayer et al. (1993), p. 70 ff.

[448] see Kahlert/Frank (1993), p. 89 ff.

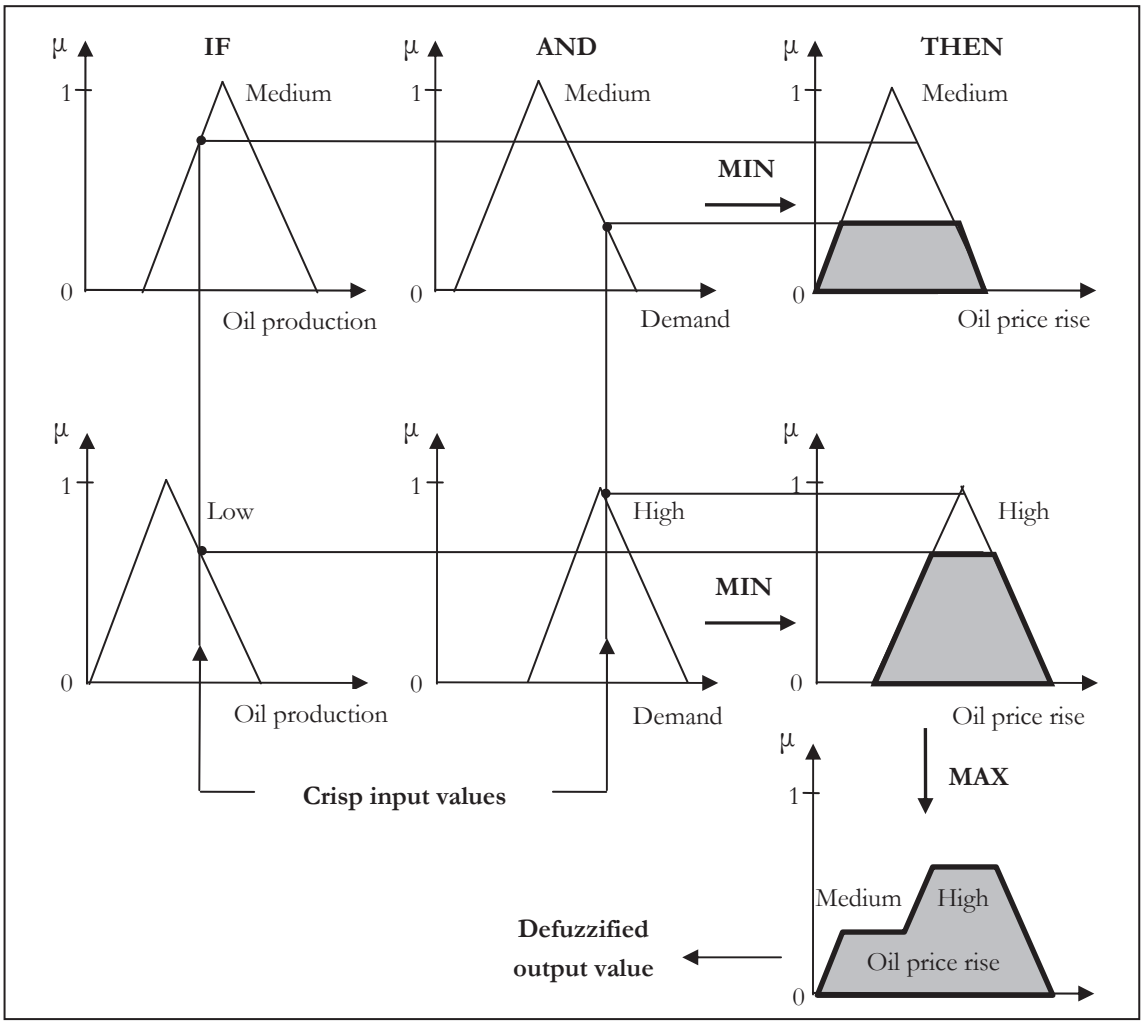

Fig. 6.11: Exemplary Fuzzy System with Two Rules[449]

Regarding the requirements for scenario monitoring an application of fuzzy sets for this purpose has various advantages. As shown in figure 6.11 the graphical output visualises the membership in certain classes (in this case medium respectively high oil price rise) which is used in the context of scenario monitoring to express the membership in different scenario paths. Since scenarios will never be consistent with real figures in this way trends are visualised and the defuzzified value can be neglected. This way the most realistic scenario paths are the result and by repeating the monitoring approach by time intensifying or inconsistent trends can be recognised. Nevertheless the memberships are also quantified, not by probability values, but the determination of the expected developments based on the actual data is also by definition an alternative to turn uncertainty into risk. Other advantages are the possible consideration of qualitative inputs as well as the possibility to modify the input that the effect of higher volatilities of the values can be dampened. By the formulation of

[449] on the basis of Nauck et al. (1994), p. 250

the fuzzy rules causal relationships between the parameters are created corresponding to the theory of system thinking. Thereby not the monitoring of the changes of single values lead to conclusions for the potential scenario paths but the whole underlying system including the interrelationships is considered respectively processed for the output and intuitive components are reduced to a minimum. Finally the method results in an adequate visualisation of the realistic scenario paths which is another convenience leading to a recommendation of this method.

6.3.2 Exemplary Oil Price Scenario Monitoring

To demonstrate the application of fuzzy sets in the context of scenario monitoring the scenarios of HWWI[450] considering the fundamental oil market mechanisms are implemented based on the theory discussed before. The target of creating a fuzzy model based on the scenarios is to fulfil the requirements to represent the conditions of the underlying scenarios and to visualise trends sensitive to changes of the influencing parameters. If the requirements are met the scenario monitoring should result in conclusions whose quality and validity are as good as the selected scenario to monitor. To implement the fuzzy model a software is necessary, in this exemplary application the Fuzzy Control Manager (FCM, version 1.5.4, TransferTech GmbH) is used. The actual and historical real data for the variables is taken from the "Historical Data Workbook"[451] published by British Petroleum (BP) with the exception of the gross domestic product development, which is taken from another online source.[452]

The procedure of describing a scenario in a fuzzy model starts with the definition of the input and output variables. These are combined with the rules which transform the input values into output values. Besides, the specifications of the values are needed from the scenario description to determine the membership functions and their limits. After the model is created real input data is needed for the monitoring, whereas also the use of prognosticated data is recommended for early warning reasons if available.

Constructing an adequate model is an iterative process, whereas tests are needed to guarantee the sensitivity, plausibility and validity of the model. For this purpose the software offers graphical representations of the output values for varying values along the whole input range. The graphs disclose if the output is sensitive to input changes and if the output changes are plausible respectively consistent with the assumed conclusions. Although the long-term validity of a scenario is basically no precondition, since the assumed premises

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[450] see HWWI (2005) respectively chapter 6.2.1

[451] BP (2009)

[452] ERS (2009)

change with time and should only be valid for the considered future time horizon, a test with historical time series may result in the conclusion that the basic assumptions have long-term validity. Especially if the sensitivity and the plausibility are not given the model has to be modified until satisfying results can be achieved and the underlying scenario is represented adequately.

These are measures to improve the model but it has to be considered that there are no general guidelines available in the literature how to implement the scenario monitoring and at which conditions the model is valid respectively which mathematical tests have to be applied to assure a required quality. Per se it is not possible to evaluate the results of the scenario monitoring by tests due to the constructive character of the underlying scenarios.

Modelling of the Input Parameters

The scenario of HWWI is constructed step by step with the fuzzy software subsequently. The influencing factors regarding the selected example on the oil price are the gross domestic product, the primary energy demand, the oil demand, the gas demand and the range of reserves. The reserve range is the result of dividing the proved reserves by the actual annual oil production indicated in the workbook of British Petroleum. The values of the different parameters are quantified in the scenario descriptions of HWWI for the six potential paths until 2030. To have the opportunity to compare the actual trends with those in the scenarios the annual changes describing the development of the considered variable in the scenario path has to be available. If only the value for the end point in 2030 is given it has to be broken down in annual changes from the actual date to the end date. The HWWI scenario already indicates the annual changes, otherwise they have to be calculated by the following formula:

$$\text{Annual change [\%]} = 100 \times ((\text{End value}/\text{Initial value})^{1/\text{Years}}-1)$$

After all values for the annual changes are calculated a categorisation regarding their extent is done dependent on how much classes of linguistic variables are used. Here for all variables three classes for a low, medium or high increase are used since all are expected to rise until 2030. These classes must be represented by membership functions, which are a combination of one triangular and two trapezoidal functions (see fig. 6.12). The medium class is visualised as a triangular since small changes of the input value should already have an impact on the output. The classes low and high use a trapezoid function since the membership is intensified if the actual values are significantly deviating values and for example a substantially rising oil demand should be regarded as a full member of the "high" class instead of loosing importance due to the triangular downward slope. There are basically no rules for the determination of the functions, they should fulfil the targeted requirements for the fuzzification and be modelled with a logical procedure. The exemplary application uses

the extreme values of the different scenario paths to determine the edges of the low and high trapezoidal functions and the mean value between them for the peak of the triangular of the medium class.

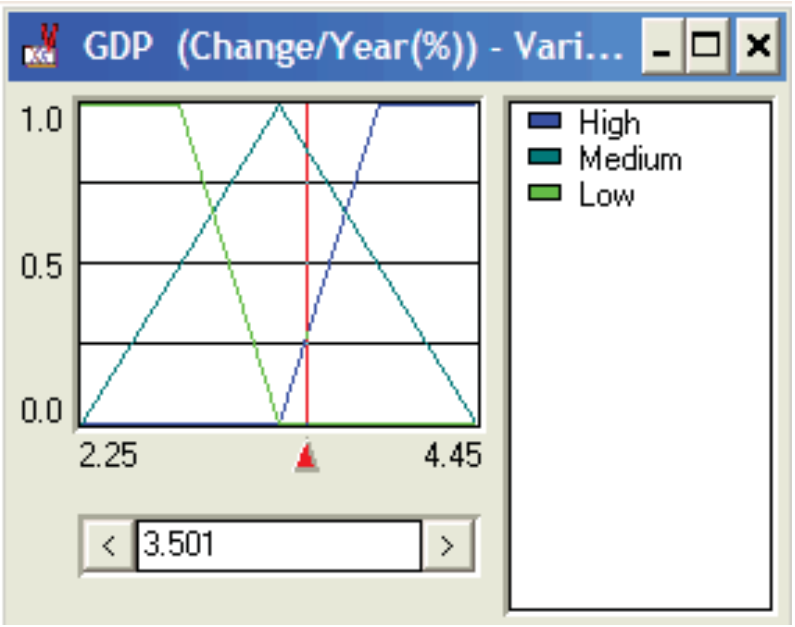


Fig. 6.12: Modelling of Input Parameter (Gross Domestic Product) by Triangular and Trapezoidal Functions

To create a sensitive model where also small changes affect the degrees of membership the functions of the extreme classes overlap the function of the medium respectively the medium class overlaps the other two over the whole range visualised. This range is determined by adding the distance from the extreme values to the mean value on each side that there is also a possibility of representing real values outside the range fixed by the scenario values. Since the variable values often fluctuate and are outside the considered range (e. g. a gross domestic product change lower than 2,25 %) the trapezoidal form guarantees their consideration by a full membership in one of the extreme classes range (e. g. a gross domestic product change lower than 2,25 % would be a full member of the "low" class).

The modelling is repeated for all input parameters in a similar way. After defining the linguistic variables respectively classes, the ranges and membership functions the quantified (or also qualitative) input is entered (e. g. a gross domestic product growth of 3,5 % in figure 6.12) to fuzzify the values and process them further.

Modelling of the Output Parameter

The modelling of the output parameter (see fig. 6.13), here the oil price change, is implemented similar to the input parameters. To monitor the key variable three scenarios are considered described by a low, medium and high oil price change. Also for the output parameter the data ranges are adapted from the scenario description and transformed to annual changes. The extreme values from the paths with lowest and the highest expected oil price changes are represented as the edges of the trapezoidal functions and the mean value is the peak of the medium price scenario. If the input values would deviate significantly from the assumed developments the oil price change may be outside the sketched range, but by the use of trapezoids the result would be the full membership to one of the two extreme scenarios. Another possibility is the representation of the extreme scenarios by triangular functions, whereas in the described case no membership to a certain scenario path would be indicated. In this way the consistence of the underlying scenario with the real development can be checked and the validity of the premises can be challenged.

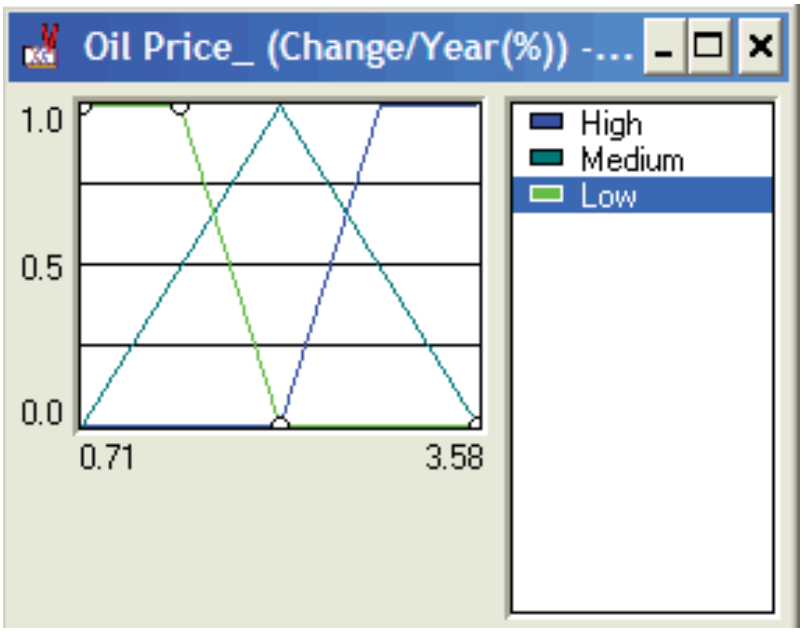


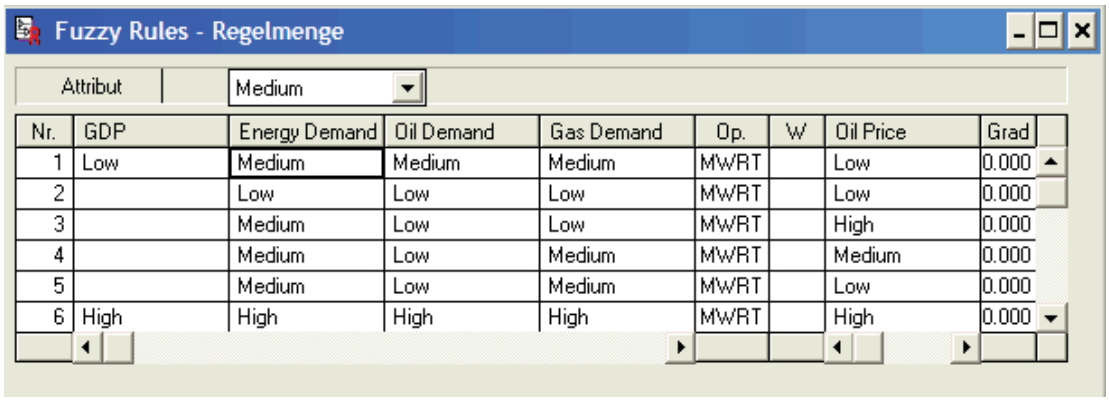
Fig. 6.13: Modelling of Output Parameter (Oil Price) by Triangular and Trapezoidal Functions

Based on the model the expected scenario would be visualised but also the defuzzification of the resulting memberships to a crisp value is dependent on it. Before an output in form of membership values or crisp values is available the input parameters have to be linked to the output parameter by the rule base.

Determination of the Rule Base

The rule base (see fig. 6.14) consists of the conditions determining the membership to the functions of the oil price scenarios based on the input parameters. The linkage describes the underlying system of variables respectively the developments resulting in a specific scenario. The IF-THEN-conditions consider which linguistic variable would lead in combination with the values of other variables to a certain end result regarding the different oil price scenarios.

The operators used (see chapter 6.3.1) combine the values of the variables to conclude to the value of the output parameter. Considering figure 6.10 some shortcomings of the AND-connection respectively the MIN-operator are disclosed, especially if more than two parameters are considered for the conclusion and there is a possibility that there is no membership in the classes of at least one parameter. In this case the result will also be a missing membership in the output class, which will not be representative for the actual problem. The OR-connection respectively the MAX-operator would result in the reverse case where the full membership in one class of only one variable may cause the full membership in one output class. Besides the OR-connection is not suitable for logical reasons for the given task and would neglect the system interrelationships. The software offers therefore a mean-value-operator, which makes use of the arithmetic mean value of the memberships in the different classes and considers all input parameters adequately as a consequence.



Nr.	GDP	Energy Demand	Oil Demand	Gas Demand	Op.	W	Oil Price	Grad
1	Low	Medium	Medium	Medium	MWRT		Low	0.000
2		Low	Low	Low	MWRT		Low	0.000
3		Medium	Low	Low	MWRT		High	0.000
4		Medium	Low	Medium	MWRT		Medium	0.000
5		Medium	Low	Medium	MWRT		Low	0.000
6	High	High	High	High	MWRT		High	0.000

Fig. 6.14: Extract from the Rule Base

The rule base in figure 6.14 shows the combinations of conditions leading to a certain oil price scenario. If for example the input value is at least partially a member of the classes low for the gross domestic, medium for the energy demand, medium for the oil demand, medium for the gas demand and high for the reserve range (not illustrated) then at least a partial membership in the low oil price function is existing. As already mentioned an operator using the mean values of the input variables is used. There is also the possibility to

weight the impact of the single rules respectively conditions by a value between 0 and 1. Also the degree of the fulfilment of the single rules can be read out from the rule base, which is not demonstrated in the figure. The links between the input values and the rule base as well as the output parameter complete the initial model, which is implemented by drawing the connecting lines in the software programme.

Testing of the Model with Real Data

Since the model is based on scenarios which are rather dependent on assumed premises instead of describing the reality the validity of the fuzzy model to monitor the scenarios cannot be investigated. Nevertheless the numerous assumptions for the description of the scenarios like data ranges, membership functions or conditions demand the optimisation of the initial model to represent the changes best. For this purpose the plausibility and the sensitivity should be tested and the model modified until a satisfying result is available. The plausibility is given if the assumptions are represented by the results that for example a higher oil demand results in higher oil prices. The sensitivity is a measure for the extent of the change of the output parameter if an input parameter is changed for a specified extent.

The applied fuzzy software offers for this purpose a tool simulating the result in dependence of two chosen input factors. The result is a three dimensional surface disclosing the direction and extent of changes if the values for the input variables are simulated in equidistant steps (see fig. 6.15). The surface shows a plausible interrelationship between the influencing factors gross domestic product and the reserve range and the output in form of the oil price change. The higher the production of the economies and the lower the reserve range the higher the oil price rise will be. It is also recognisable that the sensitivity is only high in the transition zone between the two planes for both variables. This indicates that values are analysed which are outside the range covered by the "medium" membership function of both. Nevertheless the changing values would affect the oil price and the model ensures the reaction of the output on input variations.

After the optimisation of the model the result for the real input data for 2008 is visualised in figure 6.16. The grey areas below the membership functions indicate the degrees of membership in each scenario. Based on the input data of 2008 a lot of conditions are fulfilled at least partially so that the result is exceptionally well distributed and the medium respectively the low oil price change environment is more realistic concerning the results. The area distribution is also the basis for the calculation of the defuzzified value which is an oil price rise of 2.049 % in this case but should not be taken into account as a specification.

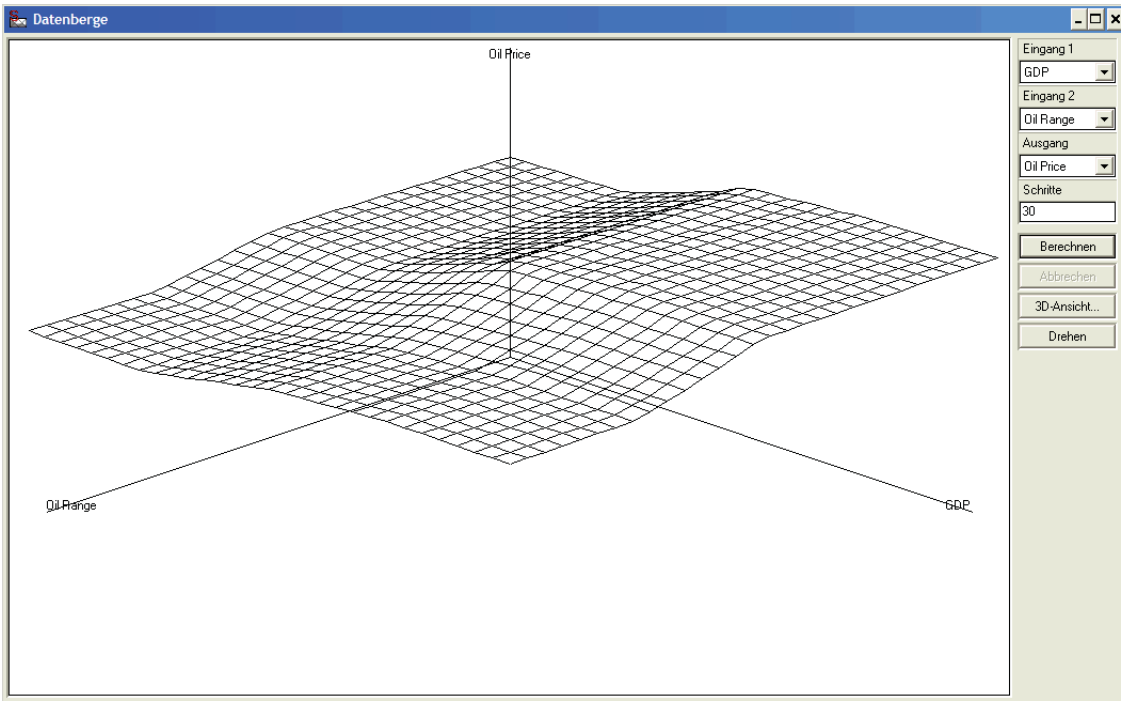


Fig. 6.15: Oil Price for Varying Input Variables

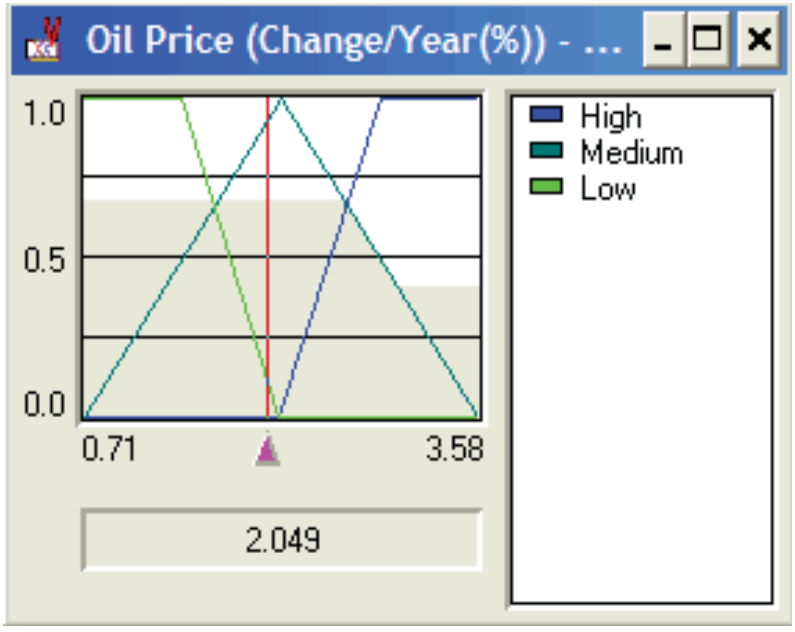


Fig. 6.16: Result of Fuzzy Monitoring Model for 2008

As already mentioned due to the assumed premises representing the actual and expected future environment a time series analysis gives neither evidence about the quality of the scenario nor of that of the fuzzy monitoring model. Nevertheless scenarios based on fundamental factors may have long-term validity which is also analysed. Figure 6.17 compares

the real oil price changes with the results of the fuzzy model using the real input data from 1980 to 2008.

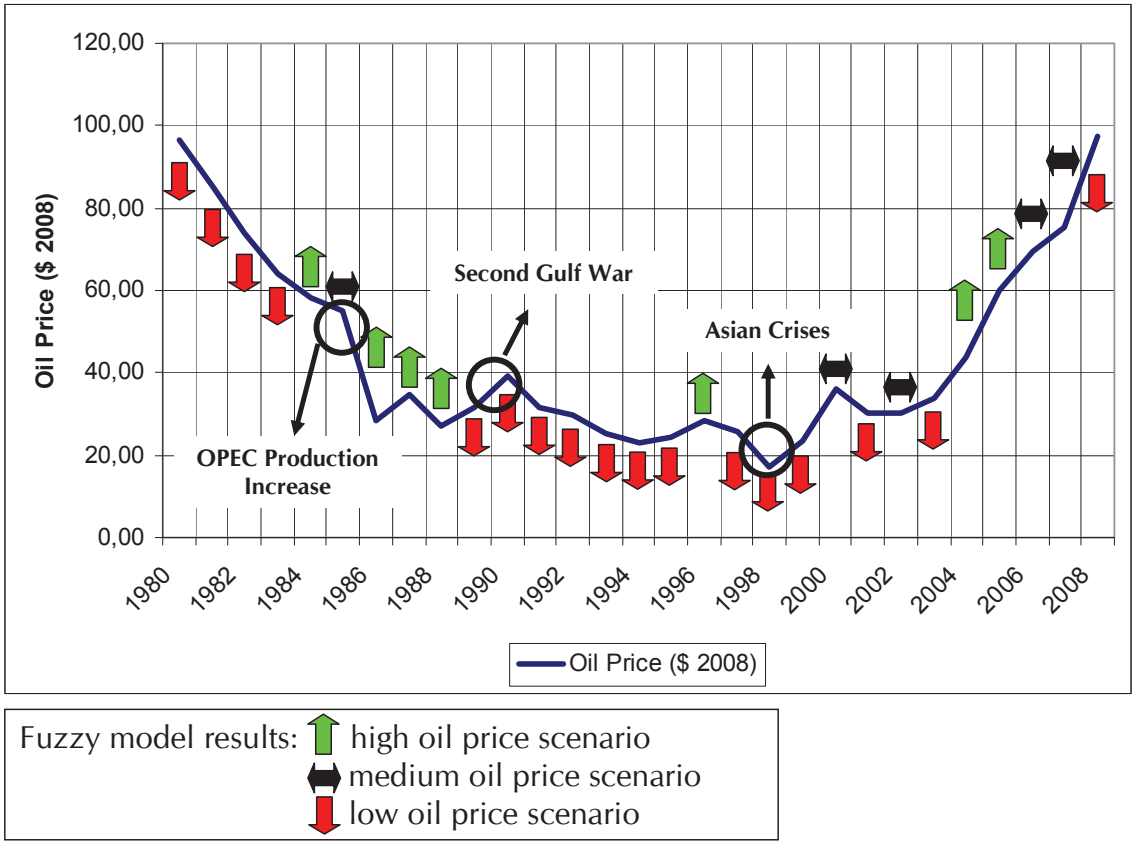


Fig. 6.17: Comparison of Fuzzy Model Results and Real Oil Price Changes

For the most data points the tendency is the same as calculated by the fuzzy model or the monitoring is even able to forecast one year in advance like it is mostly the case until 1994, then the changes and reactions of the oil price on the influencing factors were obviously faster. Some conflicting results are obvious for the years 1988, 1999/2000, 2003 and after 2004. This gives also evidence that the fuzzy model is only able to monitor the factors of the underlying scenario and not disregarded factors or discontinuities. Except in 1988 all other deviations can be explained by discontinuities which interrelate at most indirectly with the considered factors or the changes were very surprising. The oil prices in 1999 and 2000 were dictated by the production cuts of the OPEC, 2003 the Iraqi war began and the oil price developments since 2004 were substantially influenced by market speculation independent of the physical scarcity of crude oil. Although the percentage-wise changes have another dimension the basic trends can be represented by the fuzzy monitoring model but with the requirement of paying attention to the fact that the represented market mechanisms are not valid in each period.

6.3.3 General Applicability of Scenario Monitoring with Fuzzy Logic

The described generic characteristics of the fuzzy monitoring approach allow the applications of the method not only for oil price scenarios as a complementation of the strategic early warning system. The parameters for the input and output are interchangeable to an unlimited extent. If the constraints (neglecting of factors not in the model or inability to detect discontinuities) of the method are considered it is applicable for all scenarios independent of the availability of quantitative or qualitative impact factors. The induction from the applicability in the context of the oil price to the general applicability for various scenarios is allowable if the conditions of repeatability/reproducibility, inter-subjectivity, controllability and completeness of the observations are given[453] (see also chapter 2.1).

Regarding the requirement that the observations have to be repeatable respectively reproducible the available fuzzy model ensures by using the same input data and by representing the paths of the underlying scenario the calculation of all output values can be repeated and reproduced for an unlimited number of trials. If the mechanisms determining the rule base as well as the data ranges and the membership functions are unchanged every input value can be computed for several times.

The inter-subjectivity can be achieved by visualising and interpreting the results and/or the procedure for other observers who can reconstruct them and come to the same conclusions for the potential scenario developments under the specified assumptions. By using the software and therefore a tool for the visualisation the observation is made available to an unlimited number of observers.

The controllability of the procedure is given by the documentation of the influencing factors in the model respectively the software tool. Consequently it can also be observed what changes deviating assumptions, input factors and their weighting, input values and so on will produce in the trial. The factors determining the output values are visualised in the model and based on the scenarios to monitor.

Finally the completeness of the aspects influencing the given observation situation should be documented. This requirement demands the analysis of factors influencing the real specifications of the values monitored. Are the results of the monitoring not aligned to the real trends other influences not considered in the scenario or discontinuities have to be documented. On the example of the oil price the significant deviations were for example the consequences of discontinuities like unexpected production cuts, wars or excessive market manipulation. These circumstances but also the input data leading to a certain result if the monitored trend is realistic have to be monitored.

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[453] cf. Weber (2004), p. 49 f.

If other scenarios are monitored by the method the procedure described in chapter 6.3.2 is generally applicable. The prerequisite is a proper description of the underlying scenario including the influencing factors and the interrelationships between them determining the outcome in form of different scenario paths. In an ideal case the quantified values may, if the premises are adequate, result in a more precise result. Qualitative values should at least disclose meaningful trends if the scenario is of good quality. Recapitulating the exchangeability of all factors in the model and the acknowledgement of all limitations of the method guarantees the general applicability for various scenarios.

7 Conclusions

In the concluding chapter the contents of the thesis are summarised and the results are represented separately. Besides the benefits of the results in the context of strategic risk management are described and recommendations for their application in the strategic management are given. Finally prospects for further research to fill remaining gaps are listed.

7.1 Summary and Results

Recapitulating the introducing chapter discloses the situation of the petroleum upstream industry and shows the demand for strategic risk management. The theoretical basics cover the underlying field of decision theory, whereas especially the prescriptive theory represents a key background for the thesis. The deductive and inductive epistemology is chosen for the scientific approach, which is discussed in the chapter too.

The subsequent theoretical part starts with insights to strategic management, which is the approach in which the risk consideration should be integrated. For this purpose terms are defined, the scientific development is investigated, the theories including process and content are analysed and the application in different environments is discussed. Following the basics of risk management are introduced starting again with the definitions of risk and risk management before the development and the necessity is explained. Additionally the holistic process of risk management completes the chapter. Concluding the two disciplines are consolidated to draw conclusions for risk management in a strategic context, the definitions are derived and the necessity explained. Finally the corresponding concepts of strategic early warning in general and the strategic issue analysis are discussed.

Complementing to the previous chapter the most significant methods and instruments applied in the concepts are described with a special focus on the scenario technique. Since the scenario technique is a powerful method but not able to cover all requirements of strategic early warning also other complementing methods and instruments found in the literature for this purpose are mentioned.

With the objective to deduce the findings of the theoretical part for the petroleum upstream industry the characteristics of the sector are surveyed subsequently. Starting at the investigation of the strategic success factors the meaning of the oil price for the economies and especially for the businesses is examined. Based on the theoretical operationalisation of a business environment the turbulence in the petroleum industry is analysed to reason the demand for strategic risk management.

In the previous chapter after reasoning the adequateness of the scenario technique as a method applicable for the given conditions the monitoring of the existing scenarios by fuzzy models is recommended to answer the key research question. The application and the corresponding procedure are demonstrated by an example and the general applicability of fuzzy systems for the purpose of scenario monitoring is induced.

The results of the thesis aligned with the research questions are summarised in table 7.1.

Tab. 7.1: Summary of Results Aligned with Research Questions

Research Questions	**Results**
Which methods are suitable in the strategic risk management to anticipate strategic risks based on oil price developments in time?	
Which environmental conditions reason the demand for strategic risk management?	• Classification of strategic risk management • Discussion of relevant environmental conditions
Which methods and instruments are applied within strategic early warning?	• Discussion of relevant methods and instruments, especially the scenario technique
How the petroleum upstream industry can be characterised?	• Identification of success factors • Description of key impact factors • Description of business environment
Which method of strategic risk management is suitable to overcome the uncertainty under the given conditions?	• Deduction of demand for the given environmental conditions • Discussion of scenario technique • Discussion of sector related scenarios
How scenarios can be monitored in time?	• Discussion of fuzzy models • Application of fuzzy models for scenario monitoring • Induction of general applicability

7.2 Utilisation in the Strategic Risk Management

The output of the applied method of fuzzy-based monitoring of oil price scenarios are degrees of membership to a certain scenario path determined by the underlying scenarios. Thereby trends for further oil price developments can be identified and by a repetitive application of the method the intensification or the refusal of the trends can be checked. The

early warning effect respectively the ability to anticipate the oil price developments in time result from the ability of a real time monitoring with a sophisticated method which corresponds with the demand for the speed of decisions instead of waiting for complete information as a basis of competitive advantages. By the use of input parameters which can be forecasted with a reasonable certainty or are characterised as early warning indicators the effect can be intensified and the time for actions can even be extended.

The anticipation of oil price developments can be used for the evaluation of long-term projects and its revisions over time. The main focus is on strategic decisions, whereas the method represents an aid for the evaluation of strategy alternatives, the monitoring of the premises of the existing strategy is based on and for the improvement of the scenario selection for the strategic management process. The original function of scenarios (see chap. 4.1.5) to match the scenarios to the strategy options is improved by the fact that not only potential scenarios are considered to find for instance robust strategies, but there is also a determination of the most realistic trends available by the degrees of membership. In table 7.2 the strategy alternatives are opposed to the three oil price scenarios, whereas the degrees of membership indicate that the medium price scenario is the most realistic one, some indicators would also support a high price environment and a low price is not realistic for the given situation. The adequateness of a strategy alternative for a certain scenario is indicated by the crosses in the matrix and based on that the best strategy can be chosen.

Tab. 7.2: Opposition of Scenarios and Strategy Alternatives

Scenario	Degree of Membership	Strategy Alternative A	Strategy Alternative B	Strategy Alternative C	Strategy Alternative D	Strategy Alternative E	...
Low Oil Price	0,00	X	X		X		
Medium Oil Price	0,38	X		X	X	X	X
High Oil Price	0,26			X			X

Based on the risk definition originating from the decision theory a risk is a determined uncertainty, whereas the determination is conventionally done by probabilities. By using fuzzy sets to determine realistic scenario paths no probabilities are given but a determination by the degrees of membership. In the context of the risk evaluation (see chap. 3.2.3) it is mathematically not allowed to multiply the resulting values with the impact to gain the risk expected value for example. Nevertheless the degrees of membership are only marginally confronted by subjectivity in the case if qualitative values are estimated by experts or missing data is estimated. In all other cases objectivity is given and the degrees of membership may for instance be opposed to the impacts (on sales turnover, earnings,…) at least in a

risk map and a risk prioritisation is the result. The ability to determine the uncertainty allows the conclusion that uncertainty can be transformed to risk by definition thereby.

7.3 Concluding Prospects

The concluding considerations are related to prospects for further research in the context of the subject of the thesis. Taking into account that the application of the method is performed for the first time not all complementing gaps can be filled by the thesis.

First of all, the inductive conclusion that the method is applicable in general for scenario monitoring should be substantiated by applying it for several scenarios to offer comparisons for the scientific community. Especially for cases where the scenarios are not completely described or rather complex the creation of a plausible and sensitive fuzzy model may challenge the appliers. Also working with qualitative input parameters would create a new problem where subjectivity is involved and the quality of the output has to be analysed.

The result of the thesis includes a recommendation for the application of the method in the strategic risk management. For this purpose no empirical values are available actually. Not until the method is applied for several scenarios by several companies for a longer time horizon an empirical study of the benefits of the application should be performed. This would not only concern the ability to anticipate risks earlier but also if the deciders accept the method for the input creation for their decisions respectively rely on it.

Once more it should be emphasised that the scenario monitoring is only as good as the underlying scenarios. Consequently a further research focus would be to introduce a method to check the suitability of scenarios including the evaluation of their plausibility and their basic premises by confronting them with reality. For a special case like the oil price development it might also be helpful to create own scenarios adapted to the special purpose. Besides it is essential to survey continuously the providers for new available scenarios which are more sophisticated, up-to-date and incorporating new influencing factors.

Since the monitoring is per definition the search of information in regard of an already identified signal it is obvious that all other signals not considered in the underlying scenario are neglected. Consequently not all requirements of a holistic strategic early warning system are fulfilled and not all phases of that are implemented. This fact would represent a significant initial point for the creation of a holistic system complementing the approach introduced by the thesis. The key focus might concern the scanning activities, the identification of new weak signals, the recognition of potential discontinuities, the evaluation of the impact including the impact on the success factors of the business and the processing of the information for the implementation phase to name a few examples.

Concerning the implementation of the fuzzy monitoring by a software tool also improvements are possible. The software market offers primarily older version which are sufficient for basic applications but often user friendliness or the compatibility with conventional Microsoft software tools like MS Excel are missing. Another improvement potential is the integration of indicators for the quality of the fuzzy model and its sensitivity to the input parameters besides the surface template. In this context the aggregation of risks resulting from several impact factors respectively of scenarios and its implementation in fuzzy models is also a potential field of research.

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Appendix

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Success Factors of E&P Companies Questionnaire

Instructions

Part 1: Success

In this first part we ask you to define success, to carry out a self-assessment and to specify success factors.

Part 2: Company Characteristics

The second section is designed to characterise your company. The questions refer to the status and not to the future. Each question should be answered by one mark.

Part 3: Strategic Management

The strategic management section indicates future plans as well as tools and systems you use to implement the strategy.

Part 4: Company Data

The company data is necessary to categorise the companies. Since some data refer to an annual result, the year 2003 should be considered. An alternative for answering the questions of this section is to send us the annual report of 2003, which would be very helpful anyway.

Part 5: Comments

At the end we ask you to give me feedback or to comment on the survey.

Definitions

Success Factor:	Factors ensuring successful competitive performance for the company.
Key Performance Indicator:	Quantifiable measurements that reflect the success factors of an organisation.

Please consider that even an incomplete questionnaire is able to improve the quality of the analysis.

Thank you very much for your assistance!

Contact Data

Name of Company: _____
Location of E&P Headquarters: _____
Name of Respondent: _____
Position/Title of Respondent: _____
Telephone Number: _____
E-Mail Address: _____

☐ Yes, I want to receive the results of the study (E-Mail Address needed!).

1. Success

1.1 How do you define success for an E&P company?

_____

_____

1.2 Which indicators would you use to measure success?

_____

_____

1.3 Is your company successful according to your definition?

Not Successful		↔		Very Successful
☐	☐	☐	☐	☐

1.4 If you define success as specified below, how do you assess your company?

	Not Successful		↔		Very Successful
High Recovery	☐	☐	☐	☐	☐
Reserve Replacement	☐	☐	☐	☐	☐
Production Growth	☐	☐	☐	☐	☐
Exploration Success	☐	☐	☐	☐	☐
Cost Reduction	☐	☐	☐	☐	☐
Low Tax Regimes	☐	☐	☐	☐	☐
Balanced Risk	☐	☐	☐	☐	☐
Core Competences	☐	☐	☐	☐	☐
Attract and retain Talents	☐	☐	☐	☐	☐
Entrepreneurship of Staff	☐	☐	☐	☐	☐
Stakeholder Satisfaction	☐	☐	☐	☐	☐
Employee Satisfaction	☐	☐	☐	☐	☐
“Getting the Deal”	☐	☐	☐	☐	☐
Good Contacts	☐	☐	☐	☐	☐
Good Reputation	☐	☐	☐	☐	☐
Shareholder Return	☐	☐	☐	☐	☐
Earnings Growth	☐	☐	☐	☐	☐
Value Growth	☐	☐	☐	☐	☐
Return on average Capital Employed	☐	☐	☐	☐	☐

1.5 How do you ensure success?

Please fill in the three most important success factors.

1._____

2._____

3._____

1.6 Which key performance indicators correspond to the success factors above?

1._____

2._____

3._____

1.7 Please rank the following categories from 1 to 7 according to their importance.

Rank	
☐	Financial Power
☐	Quality of Acreage
☐	Technology
☐	Staff Competence
☐	Culture
☐	Stakeholder
☐	Organisation

1.8 Which success factors are significant concerning the categories above?

_____

_____

_____

2. Company Characteristics

2.1 Where are your areas of activity?

OPEC Countries	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
OECD Countries	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Political risky Countries	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
North America	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
South/Central America	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Africa	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Oceania	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Former Soviet Union	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
North Sea	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Rest of Europe	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Middle East	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Rest of Asia	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%

2.2 How do you replace reserves?

Exploration	↔	Acquisition
☐	☐ ☐ ☐ ☐	☐

2.3 Do you concentrate on core areas or diversity?

Core Areas	↔	Diversity
☐	☐ ☐ ☐ ☐	☐

2.4 To which extent is your production from offshore?

☐ 0% ☐ 0-15% ☐ 15-30% ☐ 30-45% ☐ 45-60% ☐ 60-75% ☐ >75%

2.5 How mature is your asset base?

New	☐ <20%	☐ 20-40%	☐ 40-60%	☐ 60-80%	☐ >80%
Growth	☐ <20%	☐ 20-40%	☐ 40-60%	☐ 60-80%	☐ >80%
Mature	☐ <20%	☐ 20-40%	☐ 40-60%	☐ 60-80%	☐ >80%

2.6 Which fraction of your total production is gas?

☐ <15% ☐ 15-30% ☐ 30-45% ☐ 45-60% ☐ 60-75% ☐ >75%

2.7 Which fraction of your technology used is developed by the company itself?

☐ 0% ☐ 0-15% ☐ 15-30% ☐ 30-45% ☐ 45-60% ☐ 60-75% ☐ >75%

2.8 Has your company established technological core competences?

No	↔	Technology Leader
☐	☐ ☐ ☐ ☐	☐

2.9 To which extent do you cooperate with universities or public research institutions concerning technological projects?

No Cooperation	↔	Permanent Partnership
☐	☐ ☐ ☐ ☐	☐

2.10 How would you describe the impact of new technologies on the success rate of your exploration projects?

No Impact	↔	High Impact
☐	☐ ☐ ☐ ☐	☐

2.11 How would you describe the impact of new technologies on the lead time of your development projects?

No Impact	↔	High Impact
☐	☐ ☐ ☐ ☐	☐

2.12 How many years of professional expertise do your engineers, geologists and geophysicists have on average?

☐ <10 ☐ 10-15 ☐ 15-20 ☐ 20-25 ☐ >25

2.13 What is the fraction of engineers, geologists and geophysicists of the total white collar staff?

☐ <15% ☐ 15-30% ☐ 30-45% ☐ 45-60% ☐ 60-75% ☐ >75%

2.14 Which fraction of leading positions is recruited externally?

☐ 0% ☐ 0-15% ☐ 15-30% ☐ 30-45% ☐ 45-60% ☐ 60-75% ☐ >75%

2.15 Considering key staff, do you implement a long-term personnel development strategy or do you act dependent on the personnel market?

Long-term	↔	Personnel Market
☐ ☐ ☐ ☐ ☐		

2.16 What is the relative number of female employees in the management?

☐ 0% ☐ 0-5% ☐ 5-10% ☐ 10-15% ☐ 15-20% ☐ 20-25% ☐ >25%

2.17 To which sum of money is your middle management allowed to make own decisions (in 1000$)?

☐ <50 ☐ 50-250 ☐ 250-500 ☐ 500-1000 ☐ 1000-5000 ☐ >5000

2.18 Which answer represents your health/safety/environment policy best?

☐ Proactive, we work on Problems that we still find
☐ Calculative, we have Systems in Place to manage all Hazards
☐ Reactive, we do a lot every Time we have an Accident

2.19 How many incidents per million hours worked do you have on average, contractors excluded?

☐ <3 ☐ 3-6 ☐ 6-9 ☐ 9-12 ☐ 12-15 ☐ >15

2.20 Do you focus rather on shareholder or stakeholder satisfaction?

Shareholder	↔	Stakeholder
☐ ☐ ☐ ☐ ☐		

2.21 Do you measure the satisfaction of your employees?

☐ Never
☐ Now and then
☐ Periodically and systematically

2.22 Do you measure the satisfaction of your customers?

☐ Never
☐ Now and then
☐ Periodically and systematically

2.23 Is your staff's salary linked to the profit of the company?

No Link	↔	Full Link
☐ ☐ ☐ ☐ ☐		

2.24 Which answer describes your company structure best?

- ☐ Centralised, controlled fully by Headquarters
- ☐ Centralised, organised from Headquarters, some Input from other Units
- ☐ Decentralised, Guidelines from Headquarters, primary Input from other Units
- ☐ Decentralised, independent Units

2.25 To which extent is your organisational structure able to ensure flexibility regarding the business demands?

Stiff		↔		Flexible
☐	☐	☐	☐	☐

2.26 Are you willing to finance impact projects by debt capital?

No		↔		Yes
☐	☐	☐	☐	☐

2.27 How important is cost leadership for your company?

Unimportant		↔		Important
☐	☐	☐	☐	☐

2.28 Does your finance base allow you to participate in auction processes?

- ☐ Yes
- ☐ No

2.29 Do you accept lower hurdle rates due to strategic reasons?

- ☐ Yes
- ☐ No

2.30 Are you primarily an operator or a non-operator in your joint ventures?

Non-operator		↔		Operator
☐	☐	☐	☐	☐

2.31 Under which contracts do you operate?

Concession Contracts	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Production Share Contracts	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%
Service Contracts	☐ 0%	☐ 0-20%	☐ 20-40%	☐ 40-60%	☐ >60%

3. Strategic Management

3.1 Please define your strategy by indicating the tendency between the two poles.

	↔					
Growth	☐	☐	☐	☐	☐	Harvesting
High Risk	☐	☐	☐	☐	☐	Low Risk
Short-term Profitability	☐	☐	☐	☐	☐	Long-term Profitability
Exploration	☐	☐	☐	☐	☐	Acquisition
Strategic Alliances	☐	☐	☐	☐	☐	Independence
Core Areas	☐	☐	☐	☐	☐	Diversity
Value Growth	☐	☐	☐	☐	☐	Earnings Growth
Niche Business	☐	☐	☐	☐	☐	Global Player
Aggressive Exploitation	☐	☐	☐	☐	☐	Reserve Life Increase
Financial Reserves	☐	☐	☐	☐	☐	Investments
Core Business (Vertical Int.)	☐	☐	☐	☐	☐	Diversification (Horizontal)
Oil Production	☐	☐	☐	☐	☐	Gas Production
Onshore	☐	☐	☐	☐	☐	Offshore
Technology Follower	☐	☐	☐	☐	☐	Technology Leader

3.2 Which key performance indicators are part of your strategy statement and what are the target values for the year 2004?

KPI	Target Value 2004
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

3.3 Which management systems and tools are integrated in your company and which leverage effect do they have on strategic success? (Examples: Management by Objectives, Knowledge Management, Balanced Scorecard)

	Management System/Tool	No Impact	↔		High Impact
1.	_____	☐	☐	☐	☐
2.	_____	☐	☐	☐	☐
3.	_____	☐	☐	☐	☐
4.	_____	☐	☐	☐	☐
5.	_____	☐	☐	☐	☐
6.	_____	☐	☐	☐	☐
7.	_____	☐	☐	☐	☐

4. Company Data 2003 (alternatively: Annual Report)

4.1 Type of Company:	☐ Exploration	☐ Production	☐ E & P	☐ Integrated
	☐ Private		☐ State controlled	
	☐ Quoted on the Stock Exchange			
4.2 Turnover (million $, only E&P):	☐ <50 ☐ 50-100	☐ 100-500 ☐ 500-1000	☐ 1000-5000 ☐ 5000-10000	☐ 10000-20000 ☐ >20000
4.3 Employees (only E&P):	☐ <100 ☐ 100-500	☐ 500-1000 ☐ 1000-5000	☐ 5000-10000 ☐ 10000-30000	☐ 30000-50000 ☐ >50000
4.4 Years in Business:	☐ <10	☐ 10-30	☐ 30-50	☐ >50
4.5 Return on average Capital employed:	☐ <0% ☐ 0-5%	☐ 5-10% ☐ 10-15%	☐ 15-20% ☐ 20-25%	☐ 25-30% ☐ >30%
4.6 Shareholder Return:	☐ <0% ☐ 0-20%	☐ 20-40% ☐ 40-60%	☐ 60-80% ☐ 80-100%	☐ 100-120% ☐ >120%
4.7 Daily Production (Mboe):	☐ <10 ☐ 10-20	☐ 20-30 ☐ 30-50	☐ 50-100 ☐ 100-300	☐ 300-1000 ☐ >1000
4.8 Production Growth:	☐ <-20% ☐ -20-0%	☐ 0-20% ☐ 20-40%	☐ 40-80% ☐ 80-120%	☐ 120-200% ☐ >200%
4.9 Proved Reserves (MMboe):	☐ <20 ☐ 20-50	☐ 50-100 ☐ 100-300	☐ 300-1000 ☐ 1000-5000	☐ 5000-15000 ☐ >15000
4.10 Reserve Replacement Rate (3 Years Average):	☐ <50% ☐ 50-75%	☐ 75-100% ☐ 100-125%	☐ 125-150% ☐ 150-200%	☐ 200-250% ☐ >250%

5. Comments

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