Innovation in shipping by using scenarios

André Kroneberg

April, 2000

Dr. Ing. Thesis
Department of Marine Design
Faculty of Marine Technology
Norwegian University of Science and Technology

"All who claim to foretell or forecast the future are inevitably liars, for the future is not written anywhere – it is still to be constructed. This is fortunate, for without this uncertainty, human activity would loose its degree of freedom and its meaning – the hope of a desired future. If the future were totally foreseeable and certain, the present would become unliveable. Certainty is death."

(Godet, 1990, p.731)

Preface

This thesis represents a milestone for me and marks the end of an exciting but challenging period in my life. I would not have made it without all the support and help I have received from friends and colleagues during my work.

First, I would like to thank Professor Stian Erichsen, my advisor on this thesis, for his valuable comments and guidance.

Financial funding has been provided by MARINTEK and The Research Council of Norway. The Research Council of Norway also provided me with a travel grant for the six months I spent with Stanford Research Institute Consulting, California. In California, a number of people contributed with exciting views and ideas. It is not an exaggeration to say that the main foundations for the thesis were laid here.

Through MARINTEK, I could test out the scenario-based guidelines for innovation in practice. I would particularly like to thank Atle Minsaas for his encouragement and support and Torbjørn Landmark and Eivind Dale for a fruitful co-operation.

I would like to thank all participants in the three scenario processes (MARINTEK, Statoil Driftstjenester and Wallenius Wilhelmsen Lines) with whom I have had the pleasure of working together with. Practical experience from these projects has contributed in assessing the theoretical basis of the thesis.

I appreciate the valuable comments and questions given by the Approval Committee. These contributions have influenced the final product.

I would also like to thank friends and colleagues at Barber Marine Consultants. I have been working for Barber Marine Consultants the last 12 months engaged in interesting shipping projects related to business development, logistics and scenario planning.

Finally, I would like to thank my wife for her support and understanding during this period.

Oslo, April 11, 2000

André Kroneberg

Summary

In the following, a short summary of the thesis is given with a basis in the following chronological points:

- Background and main goal of the thesis.
- Theoretical foundations – Innovation.
- Theoretical foundations – Scenarios.
- Practical implications.
- Conclusion, results and further work.

Background and main goal of the thesis

Chapter 1 gives a short introduction to the thesis and address the background and main goal of the thesis.

My experience from working in shipping over the last five years indicates that shipping companies are mainly concerned with day to day operations and that little effort is put into pursuing innovation in a systematic manner. It is my conviction that using scenarios may improve innovation and thereby strengthen the competitive force in shipping.

The importance of using scenarios in shipping is further underlined by the increasingly changing conditions in the business environment. General globalisation, emergence of new integrative information technology systems, stricter environmental regulations, alliances and mergers, individualisation of end customer and new types of service providers (e.g. 4PLs) are only some of the driving forces that companies are faced with when planning for the future.

With a basis in the background of the thesis outlined above, the main goal of the thesis is to show how innovation in shipping may be guided by using scenarios. In order to realise the goal, I develop and test guidelines for using scenarios to improve innovation. By following the guidelines, a company may explore, evaluate and implement innovations.

Theoretical foundations – Innovation

Chapter 2 provides a theoretical basis for understanding innovation.

Innovation is defined as the development or adoption of new services resulting in competitive advantages. New services are considered to be for instance real time tracking of cargo and processing of raw materials during transport from shipper to receiver. Usually, what has been mentioned as new services has to be based on the development/adoption of new products and/or by co-operating with other actors in the transport chains.

Products are broadly defined as physical objects (e.g. main engine) or technologies (e.g. technologies for combustion processes, or technologies for communication processes) or methods (e.g. new methods for ship maintenance and training of crew). Co-operative forms are classified according to whether the co-operation is horizontal (e.g. carrier-carrier) or vertical (e.g. carrier-trucker). Further, three forms of co-operation are identified as market, alliance and integration with corresponding governance mechanisms termed as price, trust and authority. The price mechanism is commonly used in commodity shipping. Authority may be associated with a tight co-operation (possibly through ownership) between a shipper and a carrier. Trust may be used to govern a co-operation between companies during an innovation process.

By discussing several models of innovation, it is concluded that the innovation process is presently viewed as a complex and dynamic interplay between different actors in a business network. Stable relations between actors are viewed as a precondition for initiating and accomplishing an innovation process.

In the adoption of new products, five aspects of an innovation are important for a decision to adopt:

1. Relative advantages (e.g. increased efficiency and flexibility).
2. Compatibility (e.g. technological and cultural compatibility with existing systems and organisation).
3. Complexity (e.g. number of interconnections in a system).
4. Trialability (e.g. possibility of small scale tests).
5. Observability (e.g. number of users at a given time).

Theoretical foundations – Scenarios

Chapter 3 provides a theoretical basis in order to understand scenarios and presents the scenario-based guidelines for innovation.

The history of scenarios is reviewed showing how scenarios have been used in the past and how scenarios are used today. Scenarios have evolved from being used as military tools, to develop government policies, and finally to support business strategies. Today, there is a trend towards qualitative descriptions of the future (i.e. scenarios), possibly as a result of the fact that qualitative descriptions of the future are quicker to develop and are usually perceived as more realistic images of the future.

Benefits of scenarios are discussed in order to show how scenarios may guide innovation. Scenarios treat uncertainty regarding how the future might develop by analysing how key drivers of change may lead to a future structurally different from the situation today. Scenarios may contribute in exploring directions for innovation by expanding our experience-based mental models. Further, scenarios may contribute in evaluating identified directions for innovation by testing them against a range of plausible futures (referred to as a “map of the future”). Finally, scenarios point to key indicators to be monitored. By monitoring these indicators, a company may track the migration of business towards a specific scenario or combination of scenarios. In this way, the scenarios may guide the implementation of innovations.

A representative technique for developing scenarios is presented and complemented by discussing additional contributions from the scenario field of research. The technique is based on a six step process as illustrated in Figure 3-2.

The scenario-based guidelines for innovation indicate five major steps as illustrated in Figure 3-4. The guidelines are not described in detail at a prescriptive level. The reason for this is that the individual companies should be able to tailor the guidelines according to their needs.

Practical implications

Chapter 4 reports from how the scenario-based guidelines have been applied in practice by three different companies: MARINTEK, Statoil Driftstjenester and Wallenius Wilhelmsen Lines.

The methodology used and underlying the empirical work is described and discussed in section 4.1. Basically, each of the three case descriptions given in section 4.2 – 4.4 are read, commented upon and approved by a leading company representative in order to assure correctness of the findings reported in the thesis. Further, minutes of meeting (read and commented upon by all scenario team members), final company approved reports/presentations, interviews with participants and notes taken during the execution of the process contribute to assure the validity of the findings.

The three cases are described according to the following structure:

1. Introduction:
   - Company profile.
   - Conditions leading to interest in scenarios.
   - Goals of scenario process and time horizon for scenarios.
   - Time for accomplishing the scenario process.
   - Organisational slack available for the scenario process.
   - Scenario team.
2. Development of scenarios (step 1 in the scenario-based guidelines for innovation, refer Figure 3-4):
   - The practical execution and results of each step are described.
3. Exploration, evaluation and implementation of innovations (step 2-5 in the scenario-based guidelines for innovation, refer Figure 3-4):
   - The practical execution and results of each step are described.
4. Evaluation of the scenario-based guidelines for innovation:
   - Advantages and disadvantages based on feedback during the execution of the process and interviews with participants shortly after the termination of the process.

General problems related to implementation of innovations triggered by scenario discussions are identified as: the possibility of a game-like atmosphere, the timing of the implementation and the need for concretising certain types of services (e.g. how many vessels should be chartered?). These problems are discussed in section 4.5 with a basis in the three case studies.

Conclusion, results and further work

Chapter 5 concludes the thesis by assessing how the goals of the thesis are met and by assessing the applicability of the scenario-based guidelines for innovation.

Both the theoretical and practical results of the thesis confirm that scenarios may be used to guide innovation in shipping. More specifically, the three cases confirm that scenarios may be used to guide exploration, evaluation and implementation of innovations in shipping.

However, more time is needed in order to asses how monitoring of key indicators may guide the implementation of innovations. The effects of monitoring has not been documented well enough for any of the three cases as these effects only will be measurable over a longer term.

Finally, further work is needed to identify ways of combining scenario techniques with quantitative techniques in order to reveal quantifiable consequences of scenarios when needed.

Table of Contents

List of Figures

List of Tables

1 Introduction

In Chapter 1 the reader is introduced to the background and importance of the thesis. Goals of the thesis, major definitions and limitations are given in order to serve as a framework for the rest of the chapters. Further, I put forward a set of conditions and requirements which have to be met in order to develop and use scenarios for innovation. These conditions and requirements will be addressed throughout the thesis. Finally, the structure of the thesis is explained and illustrated in order to prepare the reader for the following chapters.

1.1 Background

The thesis has its origin in the strategic activities of the Short Sea Shipping Program, launched by The Research Council of Norway. The Short Sea Shipping Program outlines three strategic activities:

1. Analytical methodologies for design and operation of integrated logistical systems.
2. Technology development, external conditions and strategic choices:
    - Market behaviour and competition.
    - Innovation in short sea shipping.
    - Future scenarios for the markets of transportation in Europe.
3. Development in transportation and changes in the economic geography of Europe.

My work is triggered by the second point of the second activity: Innovation in short sea shipping. Although, the thesis will address shipping in general, I feel it is appropriate to underline the importance of innovation in short sea shipping.

1.1.1 Innovation in short sea shipping

Short sea shipping has always played a vital role in Norway due to the long coastline and the demographic distribution.

Norway is a long country, cut through by numerous fjords and gulfs. The coastline is 2.650 kilometres, but including fjords and gulfs the coastline reaches incredible 21.465 kilometres (Statistisk Sentralbyrå 1998a). The major Norwegian cities, such as Oslo, Bergen, Trondheim, Stavanger, Tromsø and Kristiansand are all located along the coastline.

In addition to the favourable geographic and demographic conditions for short sea shipping, Norway is experiencing an increasing amount of goods being transported.

In the time period 1970 – 1990, the Norwegian domestic transport increased 27% from 14.895 million ton-kilometres to 18.941 million ton-kilometres, and in the period 1990-1997 the domestic transport increased another 12%, from 18.941 million ton-kilometres to 21.300 million ton-kilometres (Statistisk Sentralbyrå 1998b).

For the last three decades, however, short sea shipping has lost market shares and experienced increased competition from other transport modes, and in particular from the road transport, as illustrated in Figure 1-1.

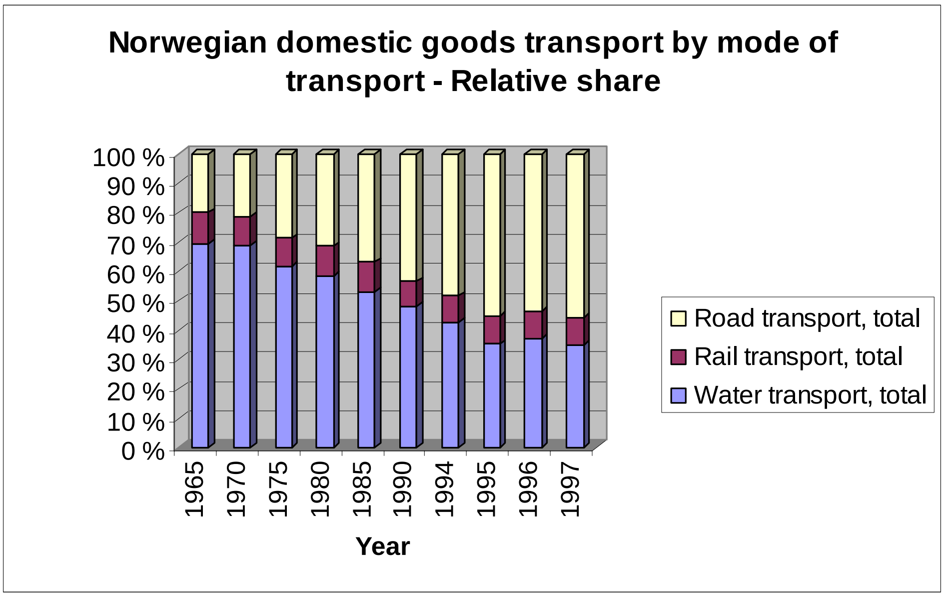


Figure 1-1 Norwegian domestic goods transport by mode of transport - Relative share (Statistisk Sentralbyrå 1998b)

During the last thirty years, short sea shipping has lost considerable market shares to road transport in the transport of Norwegian domestic goods.

In European short sea shipping, the tendency is the same. Between 1990 and 1997, short sea shipping grew by 23% in ton-kilometres, while the road transport experienced a 26% growth in ton-kilometres (European Commission 1999).

What are the reasons behind this development in the transport patterns? Why does road transport continue to gain market shares at the cost of sea transport? Obviously, the road network has improved over the last thirty years. However, this is only a necessary, but not a sufficient condition for the success experienced by road transport. More important are the requirements and needs of the customers (e.g. shippers), related to transport time, frequency, flexibility and cost.

It is difficult for short sea shipping to avoid a longer transport time in comparison to road transport, partly because of the additional loading and unloading in ports, but also because of a generally low frequency of sailing adding to the total transport time. Further, the flexibility offered by road transport is very hard to match. The reason for this is that a trailer has a considerably lower cargo capacity than a ship, and may therefore transport smaller shipments, at shorter notice, and door to door without additional loading/unloading. A ship requires considerable cargo in order to obtain a sufficient utilisation of her capacity. In addition, the sender and receiver of the cargo are usually not located in the loading and unloading ports, meaning that a door to door transport, without additional loading/unloading, is not possible.

Due to weak performance in transport time, low frequency of service and poor flexibility, short sea shipping has to offer relatively low freight rates in order to attract cargo. However, as companies' attention is shifting to speed and time-based competition in the 1990s (Carter et al. 1995), logistical systems are subject to massive interest and cost is no longer the only important criterion for selecting transporting solutions.

Through innovation, a short sea carrier may gain competitive advantages related to cost reductions and value added services (Figure 1-2).

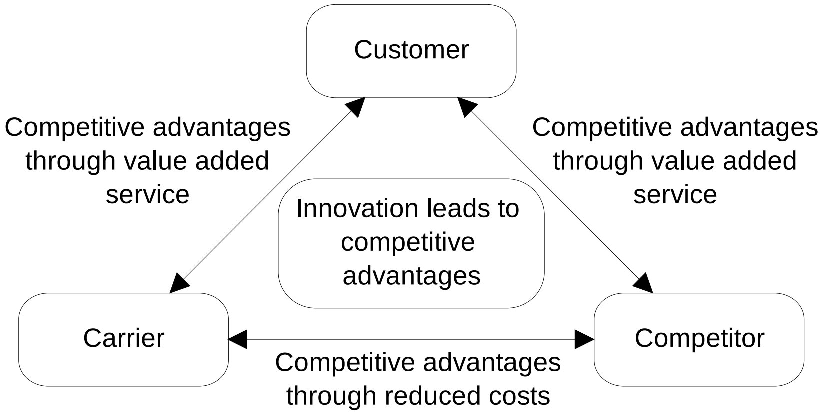


Figure 1-2 Innovation leads to competitive advantages

Through innovations a short sea carrier may gain competitive advantages related to cost reductions and value added service. The figure is inspired by the "three C's" (Company, Customer, Competitor) (Ohmae 1983) and Porter's (1980) generic strategies (cost leadership and differentiation) for creating a defendable position in an industry over the long run.

The Research Council of Norway (NFR) underlines the importance of innovation in shipping and particularly for short sea shipping competing with road and rail (Norges Forskningsråd – Industri og energi, 1996). Both technological and organisational challenges are pointed out by NFR. The European Commission (1999) argues that short sea shipping needs to attract volumes through better logistics organisation, service level frequency, regularity, networking and one-stop shops (i.e. single point of contact) for the management and pricing of the whole transport chain from door-to-door as in road transport.

Although innovation may lead to competitive advantages (Figure 1-2), these advantages will not last forever. At regular intervals, companies will have to undertake innovation in order to maintain competitiveness. Today, some authors actually claim that the ability to innovate is the only competitive advantage a company may possess in the long run.

Furthermore, the development, adoption and implementation of innovations have to be triggered by considerations related to the future. The reason for this is that it will usually take considerable time from the decision to develop or adopt an innovation, until the innovation is implemented and in operation.

However, the future is characterised by uncertainty. Uncertainties may be related to customer needs, competitor actions, political regulations and development of new technologies. The treatment of uncertainties related to the future in an innovation process poses a challenge with respect to the goals of this thesis. No innovation literature surveyed during my work addresses such uncertainties in a structured way, and to an acceptable level. In chapter 3, however, I show how scenarios may be used to take uncertainties into account in an innovation process.

1.2 Goals

My experience from working in shipping over the last five years indicates that shipping companies are mainly concerned with day to day operations and that little effort is put into pursuing innovation in a systematic manner. It is my conviction that using scenarios may improve innovation and thereby strengthen the competitive force in shipping.

The importance of using scenarios in shipping is further underlined by the increasingly changing conditions in the business environment. General globalisation, emergence of new integrative information technology systems, stricter environmental regulations, alliances and mergers, individualisation of end customer and new types of service providers (e.g. 4PLs) are only some of the driving forces that companies are faced with when planning for the future.

Realising the above, it is easy to understand the need for a structured way of treating uncertainty. Further, the treatment of uncertainty should guide innovation, in order for a company to adapt to changing conditions and prosper in new competitive arenas.

With a basis in the above and the discussion in section 1.1, my main goal is to:

Show how innovation in shipping may be guided by using scenarios.

I will develop and test guidelines for using scenarios to undertake innovation. By following these guidelines, a company may explore, evaluate and implement innovations.

In this way, the innovation I write about is a kind of *forced innovation*, where forced innovation is defined as a set of structured activities undertaken in order to develop or adopt innovations in order to gain competitive advantages.

1.3 Definitions and limitations

In this section, major definitions and limitations are given.

1.3.1 Definitions

Throughout the thesis, important words and expressions are defined the first time they are used. In this section, however, my major definitions are given in order to serve as a framework for the thesis.

Innovation:

Innovation is defined as the development, or adoption of new services resulting in competitive advantages.

Although the goal of this thesis is not to identify and discuss specific new services, but rather to develop and test guidelines for using scenarios to undertake innovation, it may be appropriate to mention what is considered to be “services”. New services are considered to be, e.g.:

- Real time tracking of cargo.
- Processing of raw materials during transport from shipper to receiver.
- Extension of core sea transport to also include inland distribution to end customer.
- Higher frequency on established routes.

Usually, what has been mentioned as new services has to be based on the development/adoption of new products and/or by co-operating with other actors in the transport chains. Products are broadly defined as physical objects (e.g. main engine) or technologies (e.g. technologies for combustion processes, or technologies for communication processes) or methods (e.g. new methods for ship maintenance and training of crew). In a transport chain perspective, there are two basic forms of co-operation: horizontal co-operation (e.g. carrier-carrier) and vertical co-operation (e.g. carrier-trucker).

Consider the example where a carrier wishes to extend his/her core sea transport service to also include inland distribution to the end customer. In order to develop and eventually offer this new service, the carrier may need to co-operate closer with terminals, truckers and the receiver. At the same time, these actors may need to invest in common information and communication technologies in order to integrate and optimise the cargo flow in the transport chain.

Short sea shipping:

Short sea shipping is defined as intra-continental freight of unit loads by sea.

Although the thesis will address shipping in general, I feel it is appropriate to give a definition of short sea shipping as the term is used several times throughout the thesis.

Traditionally, short sea shipping has been associated with freight of cargo from one port to another. In 1964, however, Skipsteknisk Forskningsinstitutt (the forerunner for MARINTEK) held a conference regarding rationalisation of loading and unloading processes. In this conference several of the speakers (Erichsen 1964, Heirung 1964) underlined the importance of viewing shipping as a link in an integrated transport chain.

In the last decade, the term has been subject to a massive interest from both industry and academia in Europe due to a declared policy from the European Union to shift freight of cargo from road to sea (European Commission 1999). Congested roads and the resulting negative economic and environmental effects, largely trigger this policy (Østvik et al. 1998). OECD estimates the cost of congestion at 2% of GNP in industrialised nations, or more than 120 billion ECU for the EU (Donnelly and Mazières 1999). In the past few years, three "European Research Roundtable Conferences on Short sea Shipping" have been held (Wijnolst et al. 1993b 1995, Peeters and Wergeland 1997), all underlining the importance of integrating short sea shipping into intermodal transport chains and networks.

Based on the above discussion, I will view shipping in an intermodal perspective, trying to gain increased knowledge and understanding of the different actors' roles and relations in the transport chain.

In the definition of short sea shipping given above, the concept of unit loads is applied. Unit loads are defined as containers, trailers, swap-bodies and pallets. It is primarily in the unit load segment that the competitive position of short sea shipping is weak compared to road transport. In the bulk segment, the low value of the cargo does not normally justify any other transport mode than by sea. The unit load segment of short sea shipping is also the fastest growing segment. The statistics provided by 15 European ports show that the transport of containerised cargo rose by 44%, from 1993 to 1997 (European Commission 1999). The markets for short sea shipping and road transport are partly separate, as there is a considerable difference between the average distances of a ton carried by short sea shipping (1385 kilometres) and by road (100 kilometres). However, short sea shipping can still be competitive within a considerable market segment, a segment that could increase if transport users could be attracted to using short sea shipping for shorter distances (European Commission 1999).

Scenarios:

Scenarios are defined as structurally different stories about how the future might develop.

Fahey and Randall (1997b) argue that scenarios provide vividly contrasting narrative descriptions of how several uncertain aspects of the future might evolve. Their understanding of scenarios is fairly representative for the bulk of scenario thinkers.

In Table 1-1, I highlight the basic ideas behind scenarios based on my own understanding of and experience with scenarios.

Scenarios are:	Scenarios are not:
Structurally different stories about how the future might develop	Prediction of the future with a certain probability
Acknowledgement of an uncertain future	Extrapolation of existing trends
Acknowledgement of intuition	Exclusively analytical considerations
An active attitude towards the future	A passive attitude towards the future
Strategic tools	Operational tools

Table 1-1 Defining scenarios

1.3.2 Limitations

In the limited time period available for writing the thesis, it is impossible to cover all relevant aspects of the given subject. The thesis has to be limited.

The major definitions given in the previous section contribute in limiting the thesis. In addition, I would like to inform about limitations concerning the theoretical and practical basis of the thesis.

Theoretical basis:

The innovation process is a complex and dynamic interplay between different actors and institutions involving many different activities and resources. In order to understand innovation processes, an overview of relevant innovation theory is needed.

Further, in order to understand how certain properties of scenarios may guide innovation, an overview of relevant scenario theory is given.

Practical basis:

Three different companies have tested the guidelines in practice:

- MARINTEK.
- Statoil Driftstjenester.
- Wallenius Wilhelmsen Lines.

Time limitations and other practical circumstances made it very difficult to seek co-operation with additional parties.

1.4 Conditions and requirements for developing and using scenarios

In the following, I put forward a set of *necessary* and *sufficient conditions* and *requirements*, which have to be met in order to develop and use scenarios for the guidance of innovation. Erichsen and Selvig (1991) inspired the classification and development of these conditions and requirements.

Necessary conditions must be present, but do not warrant the development of scenarios. If sufficient conditions are present, the applicability of scenarios is secured, provided that the necessary conditions are met.

The following *necessary conditions* are identified:

- The future is uncertain.
- Organisational slack is present.

The first of the necessary conditions states that the future has to be uncertain in order to develop scenarios. Otherwise, one should develop new services optimised to fit the requirements of a known future. Some may argue that this is a given condition, that uncertainty is the only certainty about the future. This understanding of the future is also reflected in the quotation given by Godet (1990) on page i. However, I choose to include this condition in order to emphasise that different aspects of the future may be associated with different degrees of uncertainty. One could argue that a carrier with all his/her tonnage tied up in a 20 year charter party faces less uncertainty than a carrier operating in a spot commodity market with eroding profitability due to less cargo availability and new entrants. Thus, when I claim that the future has to be uncertain in order to develop scenarios, I am referring to a certain degree of uncertainty influencing strategic choices with respect to innovation.

The second of the necessary conditions states that in order to develop scenarios, organisational slack is needed. Organisational slack is defined as available time, financial and competency resources.

The following *sufficient conditions* are identified:

- Forced innovation is wanted.
- Strategic decisions have to be taken, but not within a limited time period.

These two conditions are closely related to each other.

The first of the sufficient conditions states that a company has to request forced innovation in order to develop scenarios. The scenarios are supposed to guide exploration, evaluation and implementation of innovations.

Further, forced innovation usually implies that some kind of strategic decisions have to be taken. Examples of such decisions are:

- Should we purchase a new vessel or not?
- Should we develop a strategic alliance with company X or not?

Scenarios should not be used for operational decisions, which need to be taken on a day to day basis. It is not necessary to develop scenarios in order to decide whether to purchase round-headed or flat-headed screws!

In addition, the second condition states that scenarios may not be used for time-critical decisions. Normally, it takes several months to develop a good set of scenarios[1].

If both necessary and sufficient conditions are present, scenarios should be developed in order to guide innovation. In order to be of use, however, scenarios should satisfy a set of *requirements*:

- The minimum number of scenarios to be developed is two, and the maximum number is five.
- The time horizon of the scenarios should correspond to the time horizon of the consequences of the strategic decision to be taken.
- The scenarios should embrace the extreme points of plausible futures relevant for the strategic decisions.

The first requirement states that there is no need to develop just one scenario, as this would imply that the future is certain. The minimum number of scenarios to be developed is therefore two. I will argue that a maximum number of scenarios should be set to five. Normally, two to five scenarios are developed and learning and problem-solving experiments show that the amount of information that can be held in the short-time memory appears to be seven, plus or minus two (Miller 1956).

The second of the requirements states that the scenarios ought to cover the full time-span relevant to the strategic decisions. If the scenarios are to guide the strategic decisions they will, obviously, have to address the time-span relevant to the strategic decisions.

The third requirement states that the scenarios need to embrace the extreme points of plausible futures relevant for the strategic decisions. This is important in order for the scenarios to capture the major uncertainties related to how the business environment may change and how these changes may affect the outcome of the strategic decisions.

[1] Some consultants actually develop scenarios during a day or two, but these “stunt” scenarios are not used for major strategic decisions.

Conditions and *requirements* are to be further discussed and tested throughout the thesis.

1.5 The structure of the thesis

The thesis consists of five main chapters and two appendixes. Chapter 1 gives an introduction to the thesis. Chapter 2 provides a theoretical basis in order to understand innovation. Chapter 3 provides a theoretical basis in order to understand scenarios and develops guidelines for using scenarios to guide innovation. Chapter 4 reports from how the guidelines have been applied in practice. Chapter 5 concludes the thesis by assessing how the goals of the thesis are met and by concluding the applicability of the scenario-based guidelines for innovation. Appendix A contains a paper presented at the RINA Design and Operation of Containerships Conference, London, 1999. Appendix B contains a paper presented at the 7th International Marine Design Conference, Korea, 2000. The two papers are part of the thesis and examples of how my work has been communicated to the public.

The structure and main content of the thesis are shown in Figure 1-3.

1 Introduction
Gives a short introduction to the thesis regarding:
- Background
- Goals
- Definitions and limitations
- Conditions and requirements for developing and using scenarios
- Structure

2 Theoretical foundations – Innovation
Deals with a theoretical basis for understanding innovation, like:
- Definitions, characteristics and classifications of innovations
- Models of the innovation process
    - New products
    - New forms of co-operation

3 Theoretical foundations – Scenarios
Deals with a theoretical basis for understanding innovation, and includes:
- History of scenarios
- Scenario benefits
- Scenario techniques
- Scenario-based guidelines for innovation

4 Practical implications
Reports from how the guidelines have been applied in practice, by:
- MARINTEK
- Statoil Driftstjenester
- Wallenius Wilhelmsen Lines

5 Conclusion
Revisits the goal and concludes the applicability of the guidelines.

Appendix A/B
Give examples of how my work has been opened up for the public.

Figure 1-3 The Structure and main content of the thesis

1.6 Conclusions of chapter 1

The thesis has its origin in the strategic activities of the Short Sea Shipping Program, launched by The Research Council of Norway. Short sea shipping has lost considerable market shares to road transport in the transport of Norwegian domestic goods. In European short sea shipping the tendency is the same. Innovation may lead to competitive advantages and may contribute in strengthening the competitive position of short sea shipping.

The main goal of the thesis is to show how innovation in shipping may be guided by using scenarios. I will develop and test scenario-based guidelines for innovation in shipping.

Major definitions and limitations are given. Innovation is defined as the development, or adoption of new services (e.g. real time tracking of cargo) resulting in competitive advantages. Short sea shipping is defined as intra-continental freight of unit loads by sea. Scenarios are defined as structurally different stories about how the future might develop. Several theoretical treatments of the subject are looked into, due to the complexity of innovation. Time limitations and other practical circumstances make it impossible to have more than three companies testing the guidelines in practice.

A set of necessary and sufficient conditions must be present in order to develop scenarios for innovation. In addition, the scenarios should satisfy a set of requirements in order to be of use.

The structure of the thesis is shown in Figure 1-3.

2 Theoretical foundations – Innovation

Chapter 2 discusses several theoretical contributions in order to understand innovation.

First, several definitions, classifications and characteristics of innovation are reviewed in order to focus and constrain the rest of the chapter. Thereafter, models describing the development and adoption of new products are discussed. A classification of different forms of co-operation is given, together with a model describing the process of developing and entering into a new co-operation.

2.1 Definitions, classifications and characteristics of innovation

The goal of this section is to review some definitions, classifications and characteristics of innovation in order to focus and constrain the rest of the chapter. First, innovations are defined in terms of new products, new processes and new forms of co-operation. Thereafter, development, adoption, imitation and implementation of innovations are discussed. Evolutionary innovations are contrasted to revolutionary innovations and some of the uncertainties associated with innovations are discussed.

2.1.1 Products, processes and co-operative forms

Most people associate the concept of innovation with something *new*. This *new* is often referred to as new products, new processes or new co-operative forms (Solberg and Danielsen 1992, Nås et al. 1994, Nærings- og energidepartementet 1996).

In shipping, examples of product innovations are the steam engine and the diesel engine allowing the transition from sail to steam to diesel. Another product innovation was the container causing the shift from break bulk stowage of cargo to containerisation. Other product innovations may be related to new technologies, such as advances in information technology enabling a better integration of actors and activities in a transport chain, or new loading/unloading technology speeding up port operations. In a broader context, product innovations may be related to new methods and routines for ship operation, maintenance and training of crew.

New processes are most commonly associated with improvements in the production process of a product. Examples of process innovations are welding robots allowing more efficient welding than traditional manual welding techniques. Process innovations are typical for a production company (e.g. a shipyard), and not for actors in a transport chain which are discussed in this thesis. Therefore, process innovations will not be further discussed.

New forms of co-operation are related to co-operations between actors in a transport chain. Examples of new co-operative forms may be pooling of cargo in order to obtain scale economies, or a joint venture aiming to serve a specific market.

2.1.2 Development, adoption, imitation and implementation of innovations

Rogers (1983) defines innovation in this way:

> "*An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption*"
>
> (Rogers 1983, p.11)

Rogers' definition stresses the individual's perception of newness, as opposed to some sort of objective newness (Ferguson 1995). An innovation may therefore be new to an individual, a company, an industry, a nation or the whole world. This implies that innovations need not only to be related to the development of new products or new co-operative forms from "scratch". For a company, adoption of new products or new co-operative forms from other companies, or industries, can be considered an innovation. Ferguson (1995) supports this view by arguing that the adoption of new technologies is an innovative process that involves elements of creativity. The difference between adopting a new technology and developing a new technology is a question of degree. In both cases, external information is learned by the company and further developed for company-specific use.

In addition to viewing the development and adoption processes as involving innovative activities, Dosi (1988a) also relates imitation to innovation, as he defines innovation in this way:

> "*… the search for, and discovery experimentation, development, imitation, and adoption of new products*"
>
> (Dosi 1988a, p. 222)

Further, Dosi (1988b) argues that:

> "*In general, it must be noticed that the partly tacit nature of innovative knowledge and its characteristics of partial private appropriability makes imitation, as well as innovation, a creative process, which involves search, which is not wholly distinct from the search for "new" development, and which is economically expensive – sometimes even more expensive than the original innovation…*"
>
> (Dosi 1988b, p. 1140)

The discussion above suggests that innovations may be related to development, imitation and adoption processes all involving elements of creativity and discovery. In the rest of the thesis, however, I do not look specifically into the imitation process, as this process is not wholly distinct from the development and adoption processes (Dosi 1988a, 1988b).

Finally, some contributors view the innovation process as a commercialisation, or implementation process. Nås et al. (1994) argue that an innovation is fulfilled when a new or changed product is being introduced in the market. A similar view on innovation is taken by Teece (1986) and McKelvey (1993), defining innovators to be those companies that are first to commercialise a new product or process in the market. In this way, the *use* of the innovation is considered, relating the innovation to its market introduction. I consider implementation of innovations as taking place after the development/adoption/imitation process.

An example of a successfully implemented innovation in shipping is the container. The container was implemented in American coastal trades in 1956-57. In 1966, Sea-Land established the first transatlantic container route and by the early 1970s, all major transatlantic routes were covered by container services. Short sea transport in Europe became influenced by the transatlantic container traffic, and approximately 13 million TEUs (Twenty-foot Equivalent Unit) were loaded and discharged by short sea vessels in 1994 (Zachcial 1996, Trondsen 1998).

An example of a failed implementation of an innovation in merchant shipping is nuclear propulsion. In January 1955, Skipsteknisk Forskningsinstitutt (SFI – the forerunner for MARINTEK) hired the naval architect Jens Wilhelmsen jr. in order to undertake a technological/economic analysis of the introduction of nuclear reactors in different ship classes and trades. The final report, published in 1956, concluded that a nuclear powered oil tanker would have a high building cost, but that under certain circumstances it might be able to compete with a conventional ship regarding earning capability. However, In the 1960s, as the oil price went down, diesel engines became more efficient and gas turbines were introduced, the nuclear powered ships were not able to compete. Nuclear powered merchant ships never became profitable. Nuclear powered military ships, however, numbered up to a total of nearly 1000 in 1994 (Listog 1997).

2.1.3 Evolutionary and revolutionary innovations

The effects of innovations are hard to measure. There is no single, simple dimensionality to innovation (Kline and Rosenberg 1986). In a wide sense, innovation may be compared to economical terms as *utility* or *welfare* that are subjective, not comparable and not directly measurable. However, this does not mean that every aspect of innovation is impossible to measure. In case of new products, they are often measurable in the company's product range and sales (Nås et al. 1994).

Due to the fact that there is no generally agreed way of measuring an innovation’s importance or impact, there is a tendency to identify innovation with innovations of a highly visible sort – electric power, automobiles, aeroplanes and television. However, Kline and Rosenberg (1986) argue that one must not forget that many improvements are of a less visible and even, in many cases, an almost invisible sort – for example minor modifications in the design of a machine that will enable it to serve certain highly specific end-users better, or that make it easier and therefore cheaper to manufacture. The subsequent improvements in an innovation after its first introduction may be economically more important, than the innovation in its original form.

Based on the above discussion, it seems natural to characterise innovations by their degree of newness and the degree of changes that innovation implies. In the innovation literature, the terms *minor, smaller*, and *evolutionary* are used as opposed to *major*, *radical* and *revolutionary*, when discussing innovations.

Examples of major innovations in shipping are the container, the specialised car-carrier and the hydrofoil boat.

Some companies are very effective in high-risk, radical innovation. These innovations may give radical improvements, or generate entirely new products, in productions- and sales processes, as a fundament for new activity. Other companies may be effective in small, cumulative and evolutionary changes that give incremental improvements in existing products, productions- and sales processes (Nærings- og energidepartementet

1996). Both types of innovation are important. The control of costs is important to remain competitive in the short run, and the movement to radically improved services is often necessary to survival in the long time (Kline and Rosenberg 1986).

For new technological products, Dosi (1982) explains, in rather general terms, the role of *continuity* and *discontinuity* in technological change. In his model, continuos changes are related to progress along a *technological trajectory* defined by a *technological paradigm*, while discontinuities are associated with the emergence of a new paradigm. A technological paradigm[2] is defined in accordance with the epistemological definition as an “outlook”, a set of procedures, a definition of the “relevant” problems and of the specific knowledge related to their solution. In addition each technological paradigm defines its own concept of “progress” based on its specific technological and economic trade-offs. A technological trajectory is then interpreted as the direction of advance within a technological paradigm. By using this terminology, *minor*, *smaller*, and *evolutionary* innovations may be related to progress along a technological trajectory, while *major*, *radical* and *revolutionary* innovations may be related to the emergence of a new technological paradigm.

In shipping, a shift of technological paradigms may be related to the shift from sail to steam for propulsion of ships. The shift may be illustrated by S-curves, as shown in Figure 2-1.

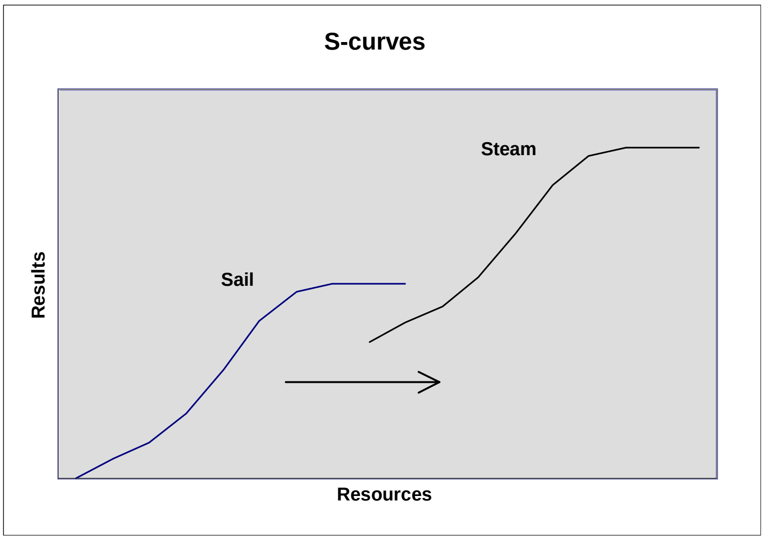


Figure 2-1 S-curves in shipping

The transition between two technological paradigms in shipping, sail and steam, is visualised by the use of S-curves.

Wijnolst (1995) argues that the improvement in efficiency of the sailing ships, as from around the year 1600, starts with the Dutch Fluit. The Dutch Fluit was a ship of 160 tonnes, which could be sailed by a 7 men crew (compared to 30 for traditional ships). The ship also had a favourable length to breadth ratio, giving good sailing performance and vertical sides that facilitated the stowage of cargo. The S-curve ends with the clipper, a ship that created a whole new market for itself, due to a significant increase in speed. The ultimate effort of the ship owners, who did not believe in steam engines onboard ships, was the construction of the 7-mast *Thomas W. Lawson*. This ship was built in 1902, but tipped over in a storm in 1907, while at anchor in a harbour, due to instability.

The steam engine was invented in 1712, and after experiments at the end of the 18th century, it was put on boats to drive paddle wheels around 1820. The boats were used on canals and rivers and had significant advantages over sailing ships, which could not operate in narrow waterways. In 1830, the invention of a surface condenser solved the problem of freshwater for the boilers and the steamship became an economically feasible solution for sea transport. Two further advances, the iron hull and the screw propeller, strengthened the steamship paradigm even further (Wijnolst 1995). In 1880, steamships carried more than half of the world sea-borne trade (Weyergang-Nielsen 1994).

S-curves illustrate how results improve as resources are invested in the development of new technology. For the steam paradigm, results may be related to higher speed, faster port operation and more reliable transport than sailing ships. Resources may be related to investments (time and money) in developing the new steam technologies, e.g. the surface condenser. In the first phase (1712-1830) improvements were small and slow. In the second phase of the paradigm (1830-1900) major improvements were made in shorter time, due to increasing market acceptability and accumulation of knowledge and experience related to steam technology. In this period, further improvements in sailships started to decline, and a limit was reached at the turn of the century with the mentioned clipper ships. In addition, Wijnolst et al. (1993a) argue that the opening of the Suez-canal in 1869 accelerated the transition from sail to steam even further.

Although Dosi (1982) related his paradigms to technological development, I believe it is possible to use his framework in a non-technological context as well. Introduction of

[2] Technological paradigms are developed as a parallel to, and based upon scientific paradigms as introduced by Thomas Kuhn (1962).

new co-operative forms may also be described by using the concepts of paradigms and trajectories.

In the following, I will give an example of a paradigm shift of co-operative forms in shipping. In the 1960s, producers (e.g. shippers) were mainly focused on improving internal resources and activities in order to serve their customers in a better way. In the 1970s and 1980s, organised co-operation with suppliers was in focus due to stricter quality requirements and the need for more flexibility in terms of product volumes, specifications and delivery times. In the 1990s, strategic alliances between shippers and their suppliers (including transport suppliers) are increasingly more common (Persson and Virum 1995). For a carrier this means that as the shippers' transport chains are getting increasingly integrated, the possibilities for long-term contracts and co-operation will increase. One could argue that the old paradigm characterised by port to port operations is being replaced by a new paradigm characterised by door to door operations and the emergence of integrated transport chains.

2.1.4 Uncertainty in innovation

Kline and Rosenberg (1986) argue that the central dimension that organises innovation, if there is one, is uncertainty. Innovation implies creating the new, and the new contains elements that we do not comprehend at the beginning and about what we are uncertain.

I will argue that in order to increase the probability of success, companies need to have an opinion of the future. The reason for this is that it will usually take considerable time from the decision to develop or adopt an innovation, until the innovation is implemented and in operation. However, as the future can not be predicted, companies are faced with a number of challenging uncertainties, as they plan their future transport service.

Uncertainties are related to changes in the business environment. On a micro level, customer needs are always changing. In the 1960s and 1970s cost leadership was a common strategy (Porter 1980, Carter et al. 1995). The *cost* of transport activities was in focus. Carter et al. (1995) argue that during the 1980s, many companies realised the importance of *quality* as a source of a competitive advantage. However, in the 1990s, attention is shifting to *speed* and time-based competition. In addition to changes in customer needs, companies may experience uncertainty related to competitors, suppliers, substitutes and entrants as proposed by Porter (1980). On a broader macro level, uncertainties may be related to the rapid emergence of information technology and the Internet, changes in the oil price sparked by OPEC, or conflicts in the Middle East, the Asian financial crisis, and international regulations concerning environmental requirements. A structured approach for discussing uncertainties at micro and macro levels is given in chapter 3.

2.2 Developing new products

There have been a number of attempts in recent years to impose some sort of conceptual order on the innovation process, with the purpose of understanding it better (Kline and Rosenberg 1986). In this section, I look into three models of innovation addressing the development of new products.

First, *the linear model of innovation* and *the chain-linked model of innovation* are discussed. Thereafter, a rather new model of the innovation process, *the network model of innovation*, is discussed. Finally, the three models are compared and discussed in order to uncover similarities and possible shortcomings. Aiming for a complete picture of the innovation process, identified shortcomings are further addressed and discussed.

2.2.1 The linear model of innovation

The generally accepted model of innovation since World War II has been what a few authors have called the linear model. In this model, one does research; research then leads to development, development to production, and production to marketing (Kline and Rosenberg 1986). A sketch of this model is given in Figure 2-2.

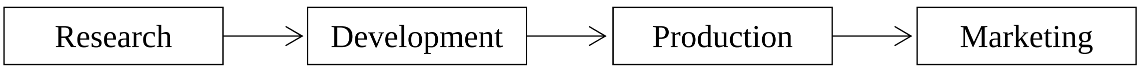


Figure 2-2 The linear model of innovation (Kline and Rosenberg 1986)

The innovation process is triggered by research and does not have any feedback paths from the market or within the process.

In the following, I give some critical comments regarding the model.

Firstly, I would like to question the linearity of the model. The linearity of the model is obvious, as no feedback paths within the process are assumed. However, feedback is important as the development of new products is an iterative process. Decisions taken early in the process are normally based on rather limited information on requirements and restrictions, but as the process proceeds towards a product solution, more information will be available and support for making decisions will improve. It may therefore be necessary to go back in the process in order to redo some decisions. I will argue that feedback paths from the market and within the different activities in the process, are essential in order to ensure a market success for a product.

Secondly, the model does not acknowledge a company's organisational slack needed in order to undertake innovation. Organisational slack will influence the process of innovation. A carrier with limited financial resources and little technological knowledge, may, for example, not develop a new loading and unloading technology from "scratch". If the carrier does not co-operate with other carriers and/or actors in the transport chain in order to increase organisational slack, an adoption process of existing technology would seem more likely.

Thirdly, the process is triggered by research. Not many companies have their own research departments, meaning that external research institutions are needed in order to innovate. Research is, however, not necessarily a triggering condition in every innovation process. Need and not research triggered the development of the specialised car carrier in the early 1960s. Bulk carriers could not efficiently handle the increasing export of small Japanese cars, and a conversion of bulk carriers to car carriers emerged, gradually leading the way to the first pure car carriers (Nilsen 1999). In addition, minor innovations, such as smaller improvements in existing technology, may be based on experience, knowledge and skills already present within the company.

Finally, the model does not seem to treat uncertainties related to future changes in the business environment. Before making a decision to develop or adopt and implement an innovation, a carrier should address the robustness of his/her decision. For example, how will a decision to invest in development of one large container feeder vessel play out, as opposed to an investment in two smaller vessels, if the shippers are increasingly demanding smaller shipments at a higher frequency?

I would argue that the linear model of innovation is better suited for describing large and long-lasting, national, or international, research efforts with extensive financial and organisational resources, rather than innovation undertaken by companies in order to gain new competitive advantages, normally within a restricted time period given by requirements for the pay-back period of the investments.

The national research and development efforts on nuclear powered merchant ships in Norway may be described by using the linear model of innovation, although the designs never went into production and marketing. Substantial research and development efforts were undertaken and co-ordinated by an external research institution. It seems as if "Nuclear optimism" in the 1950s and 1960s guided the process, rather than short-term commercial requirements.

2.2.2 The chain-linked model of the innovation process

Kline and Rosenberg (1986) developed the chain-linked model as an alternative to the linear model, described in the previous section. In the following, I will present and review the model and its assumptions.

The chain-linked model is shown in Figure 2-3.

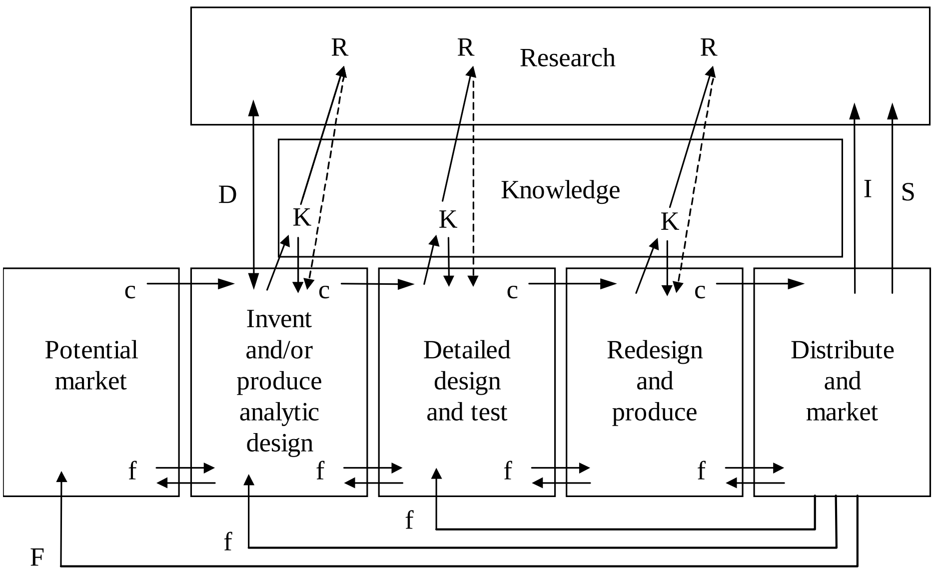


Figure 2-3 The chain linked model of innovation (Kline and Rosenberg 1986)

A potential marked need leads to an invention and/or production of an analytic design. Detailed design and testing then follows before redesigning and production, and finally distribution and marketing. Several feedback paths from the market and within the process are indicated. Knowledge and research are accessed if necessary.

The central chain of innovation ("c") is triggered by a potential market need. The marked need leads to what the authors refer to as an *invention* and/or a production of an *analytic design*. *Invention* is interpreted as a significant departure from past practice.

Analytic design differs from inventions as it is either a routine consisting of analysing various arrangements of existing components, a modification of designs already within the state of the art, or an improvement to accomplish old tasks more effectively. In this way, an analytic design is the complete opposite of an invention based on non-existing components. Detailed design and testing then follows based on market feedback. The product is, if necessary, redesigned before production and, finally, distribution and marketing.

The model is certainly not linear, as several paths of iteration are indicated. Feedback paths from the market (“F”, “f”), and feedback paths within the innovation process (“f”) provide input for evaluations and further progress. There are links to knowledge (”K”) and research (“D”, “KR”) all along the central chain of innovation (“c”). Long-range generic research for backup of innovations, financed by the market, is also indicated (“S”). Finally, innovations and new products support science and research by providing new tools and instruments (“I”).

With a basis in this model, Kline and Rosenberg (1986) claim that arguments about the importance of “market pull” versus “technology push” are artificial. The argument is that a perceived market need will be filled only if the technical problems can be solved, and a perceived performance gain will be put into use only if there is a realisable market use.

In my opinion, the chain-linked model is a significant improvement from the linear model. The importance of feedback within the process and from the market is acknowledged. However, I miss a discussion on how a company’s organisational slack is taken into account together with the market feedback, in order to focus and constrain directions for innovation. In addition, possible changes in the business environment should be addressed in order to develop robust directions for innovation.

I will also argue that the model treats the access to knowledge and research too simplistic. How does a company gain access to relevant external knowledge, not already present in the company? Does the company use its relations to customers and suppliers, attend conferences and subscribe to relevant journals? If research is needed, very few companies have their own research department, leaving the companies to rely on external research institutions. Knowledge seems to be easy available, lying alongside the central chain of innovation, ready to be used whenever needed. It seems as if Kline and Rosenberg (1986) treat knowledge as a generic commodity, which is one of the key assumptions in neo-classical theory. By using a neo-classical perspective, however, knowledge needs to have a number of certain attributes, as identified by Smith (1997, p. 20):

- *It is generic*. An item of knowledge, or a particular advance in knowledge, can be applied widely among firms and perhaps among industries.
- *It is codified*. Transmitability implies that knowledge is written or otherwise recorded in fairly complete usable forms.
- *It is costlessly accessible*. Transmission costs are negligible, or firms do not face differential cost barriers in accessing knowledge or bringing it into production.
- *It is context independent*. Firms have equal capabilities in transforming such knowledge into different service capabilities.

Obviously, in the real world, these attributes are not common. Transaction cost economics, discussed in section 2.5.2, suggests that the transfer of knowledge requires investments beyond single economic investments, creating transaction costs. In addition, network theory, discussed in section 2.3.3 and 2.5.4, argues that access to knowledge will depend largely upon the relations a company has with other companies in a business network.

In the following, the chain-linked model of innovation is related to shipping. Normally, yards and equipment vendors develop and produce new products. A carrier or a shipbroker may often communicate a potential market need for new products to a yard or an equipment vendor. In a survey carried out by Ying (1989), 18 Norwegian shipping companies answered a set of questions regarding product development orientation. The sources of business ideas were found to be (the respondents could choose more than one alternative):

- Customers (61%)
- The company's own force (56%)
- Consultants/brokers (28%)

Wijnolst (1995) argues that carriers and shipbrokers operate in the transport market, enabling them to see opportunities for new ship concepts. Although the discussions regarding "market pull" and "technology push" are artificial according to Kline and Rosenberg (1986), I will argue, in concert with Wijnolst (1995), that innovations in shipping, at least major innovations, are characterised by a stronger market pull than technology push. The carrier operates on a day to day basis in the transport market and should therefore easily be aware of potential improvements in the transport chains. A technology push may also be hindered due to risk-averse yards. As the yard is asked to deliver a bid for building a new ship, normally in competition with other yards, the yard does not want to spend a lot of engineering hours on a design it is not certain to build. The yard may therefore choose to use a well tested design. In this way the yard may act as an obstacle to innovative ship designs. However, this is a general observation and it is my experience that some yards are eager to develop new and innovative designs in co-operation with the carrier.

2.2.3 The network model of innovation

The "Industrial network approach" is the outcome of a fairly broad research program which originated in the mid-1970s at the University of Uppsala in Sweden. It deals primarily with the functioning of business markets.

In this research program, empirical studies show that business organisations often operate in environments which include a limited number of identifiable organisational entities, or actors. Relationships that develop between the actors are generally continuos over time, rather than being composed of discrete transactions, and the web of relationships is referred to as a network (Mattson 1987, Håkansson and Snehota 1989, Fossen 1996). These empirical findings contradict the neo-classical assumptions regarding relationships in the business environment. In a neo-classical market view, the actors' competitive rather than complementary activities are stressed and organisations are not assumed to be related to each other in a network, instead organisations are supposed to exist in an atomistic structure with instantaneous and short term relations (Mattson 1987, Håkansson and Snehota 1995). Mattson (1987) and Easton (1992) argue that the competitive activities are evident in Porter's basic model (1980), where competitive pressures from companies among the sellers of substitutes, potential entrants, powerful buyers and powerful sellers are the basic driving forces. In the network approach, however, both complementary and competitive interdependencies are identified (Mattson 1987). Openness, mutual trust and respect are important characteristics of relationships in the industrial network approach (Easton 1992). In Figure 2-4, I have tried to illustrate the difference between the neo-classical market organisation and the network organisation.

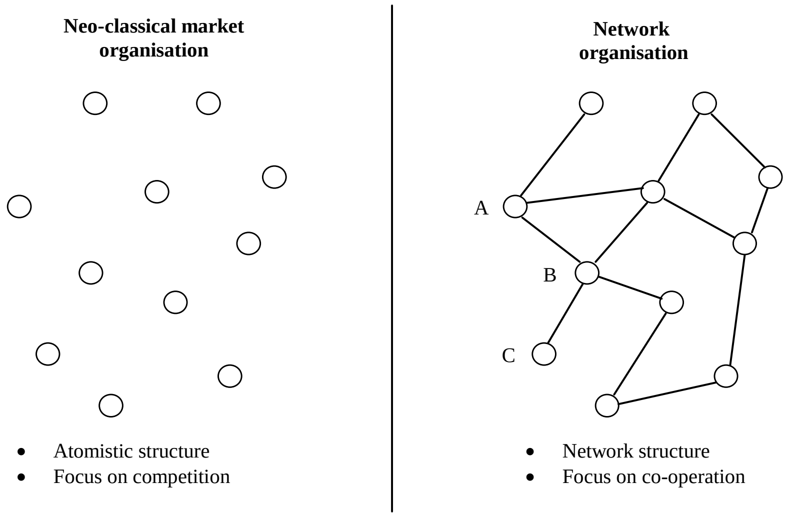


Figure 2-4 A network organisation as opposed to a neo-classical market organisation

The industrial network organisation ("University of Uppsala") contradicts the neo-classical market organisation (for example promoted by Porter (1980)) in terms of business structure and relations.

In a network, each actor has direct or indirect relations to the other actors (Mattson 1987, Easton 1992). The assumption of indirect relations implies that A may affect C through B (see Figure 2-4), simply because there are exchange relationships between all three parties. If a carrier (A) lowers his price to shipper (B), then a competing carrier (C) may be willing to do the same.

In the industrial network approach, the basic variables are actors, activities and resources. These variables are related to each other in the overall structure of the networks. Actors are defined as those who perform activities and/or control resources. In activities, actors use certain resources (defined as technology, material and knowledge resources) to change other resources in various ways (Håkansson and Johanson 1992).

So how does innovation take place according to network theory? To answer this question, the network theory assumes that resources are heterogeneous, having attributes in an unlimited number of dimensions. This means that the application of a specific resource (e.g. steel) can never be fully or finally specified (Easton 1992, Håkansson and Johanson 1992).

Resource development appears to take place to a large extent between companies. This indicates that the relations between companies play an important role in the innovation process. Fossen (1996) argues that the relations and interaction between companies will be central to the establishment of new resource combinations, and thus also central to innovations. Easton (1992) argues further that the continuous interaction between companies offers, on the one hand, the opportunity for innovation and, on the other, the existence of a known and predictable environment in which innovations can be realised.

A quantitative survey of innovation in the Norwegian industry, performed by the STEP group[3] (Nås et al. 1994), supports the empirical findings in the industrial network tradition. One of the findings in this survey was that companies often make use of accessible, external information to adjust and develop technological knowledge, as a substitute for, or complementary to, developing new knowledge by themselves. In the survey, the most important source of information was found to be customers of the company. The third most important source of information was suppliers to the company.

The industrial network approach does not give a prescriptive model of innovation, as the two earlier discussed approaches did, to some degree. However, network theory points to a very important, and empirically validated, characteristic of the innovation process: *relationships between actors*.

One of the lacks in the network model of innovations may be that the network approach seems to emphasise trust and mutual respect in relations, in place of possible opportunism and dominance. A large shipper may use five different carriers for his goods on a certain route and the shipper may be very important, in terms of income, for each of the five carriers. By playing the carriers up against each other, the shipper may gain very low freight rates due to his dominance and the carriers' dependency upon his freight. Instead of a long term co-operation with one or two of the carriers in order to develop a more integrated transport chain, the shipper may choose to use his dominance in order to cut freight rates.

In the network approach, it is argued that invention and innovation occur in networks not within but *between* companies. However, I will argue that some of the innovation may also actually take place *within* companies. Knowledge within a company, about market and technology such as cargo flows, navigation and skills in operation and maintenance of ships, may trigger and direct an innovation process. In a survey

[3] The STEP group is located in Oslo, Norway, and specialises in studies of technology, innovation and economic policy.

undertaken by Ying (1989), 18 Norwegian shipping companies respond that 56% of business ideas emerge from the company's own force.

As opposed to the chain-linked model, discussed in the previous section, the network approach claims that access to external knowledge is gained through a company's relations in a business network.

The industrial network approach to innovation implies that a carrier should pay considerable attention to his or her relations with customers (shippers) and suppliers (yards and equipment vendors). Through these relations the carrier gains insight into both technical (supplier dominated) and market (customer dominated) opportunities which have to be addressed during an innovation process. In the earlier mentioned survey carried out by Ying (1989), 18 Norwegian shipping companies agree that market research is important. Some of the typical market research activities are identified as (Ying 1989):

- Visit customers and discuss their problems with them.
- Visit relevant industrial fairs
- Customer interviews

I believe that a company's relations with other companies in a business network, is of vital importance in directing innovative efforts. By paying close attention to its customers and suppliers, a company may gain insight into events and trends shaping the future.

2.2.4 Similarities and shortcomings in the three models of innovation

In this section, the three models are compared and discussed in order to uncover similarities and possible shortcomings. Aiming for a complete picture of the innovation process, identified shortcomings are further addressed and discussed.

All three models address the development of new products. Previously, I have defined products rather broadly to include not only physical objects, but also technologies and methods. It seems as the linear model and the chain-linked model of innovation mainly describe the development of new physical products, while the network model of innovation may also be applied in describing the development of new technologies and new methods enabling new and improved services.

In the following, the three models of innovation are compared and discussed according to a set of characteristics:

- Triggers: How is the innovation process triggered, or initiated?
- Feedback: Are feedback paths from the market and/or within the process assumed?
- Activities: Which activities are included in the innovation process?
- Knowledge: How does the model address access to knowledge needed in the innovation process?

In the linear model, innovation is triggered by research, leading to development, production and finally marketing of the new product. No feedback paths are indicated and the access to knowledge needed in the innovation process is not specifically addressed.

The chain-linked model is an improvement in comparison with the former as the importance of feedback from the market and iterations in the innovation process are taken into account. A potential market need triggers the process, leading to an invention and/or production of an analytic design. Detailed design and testing then follow before redesigning and production, and, finally, distribution and marketing. Knowledge and research are assumed to be accessed whenever needed, indicating a treatment of knowledge as a generic commodity.

In the network model of innovation, a more sophisticated view on the innovation process is taken. Relations between actors in a business network are supposed to trigger the innovation process and provide feedback throughout the whole process. By combining heterogeneous resources, actors develop new products. Knowledge needed in the process is accessed through relations in the network.

A structured summary of the comparison of the three models is given in Table 2-1.

Characteristic of an innovation process	**The linear model of innovation (section 2.3.1)**	**The chain linked model of innovation (section 2.3.2)**	**The network model of innovation (section 2.3.3)**
Trigger(s)	Research	Potential market need	Customers and suppliers
Feedback	No feedback paths	From the market, and within the process.	Through relations with other actors in the business network
Activities	Research – development – production – marketing	Invent/produce analytical design – design and test – redesign and produce – distribute and market	Combine heterogeneous resources to innovate
Knowledge	Access to knowledge not specifically addressed. The process is, however, initiated by research – leading to new knowledge	Links to knowledge all along the central chain of innovation. External knowledge treated as a generic commodity to be used whenever needed	Access to external knowledge through relations with other actors in the business network

Table 2-1 A comparison of three models of innovation

Realising that the linear model was launched before the chain linked model, which again came before the network model, one may argue the perception of innovation has changed over time. Initially, the assumption was that the innovation process was generated from basic research, whereas the present view is that innovation is dependent on a complex and dynamic interplay between different actors in a business network.

However, three important characteristics of an innovation process, *organisational slack*, *institutional framework*, and *uncertainty* are not addressed specifically by any of the models discussed. These characteristics are discussed below, together with a further discussion of *triggers*.

Organisational slack

None of the three models discussed above address organisational slack needed in order to undertake innovation. Organisational slack is defined as available time, financial and competency resources.

Financial resources are required in order to develop new products. Market research, design and development of products require capital investments, for example in order to buy necessary equipment for developing and testing the new product. In addition to financial resources, competent people and time need to be dedicated to creative and innovative pursuits to uncover technological and market opportunities.

Generally, Norwegian short sea carriers lack organisational slack required to undertake innovation (Bartz-Johannesen 1996, Norges Forskningsråd – Industri og energi 1996). However, a co-operation between carriers and/or other actors in the transport chains may contribute in establishing a sufficient organisational slack. Co-operation between actors in transport chains is discussed in section 2.4.

Lack of organisational slack may hinder or constrain the innovation process for the single carrier, and is therefore identified as a possible obstacle to innovation.

Institutional framework

None of the three models discussed above address how the institutional framework may trigger, or constrain an innovation process. The institutional framework is often seen as specific to regional or national contexts (Smith 1997). Nelson (1992) argues that national education systems, university research, laws, fiscal monetary and trade policy to a large degree will remain national, despite increasing globalisation. In this context, I choose to define the institutional framework as consisting of:

- Authorities and institutions.
- Education systems.
- Research institutions.

The above factors are closely related to each other. A number of such relations may be demonstrated. For example, authorities may influence the development of both education systems and research institutions while research institutions may provide both authorities and institutions with decision support.

In the following, I discuss how these factors may both trigger and constrain innovations.

Authorities affect funding of research and development (R&D) activities, taxes and subsidising. Large investments in R&D activities may trigger innovations, while reduced investments in R&D may hinder new innovations (refer the linear model of innovation presented in section 2.2.1). In the same way, changes in the tax and subsidy levels may affect the rate of innovations.

An example of how R&D investments trigger innovations may be taken from the building of a ship model-testing tank (SMTT) in Norway. The building of the SMTT was very much dependent upon governmental support. The first Norwegian professor in shipbuilding, Hans Ramm Mørch, argued early for the need of a SMTT in Norway. The theoretical basis for calculating ship resistance and design of propellers was not good enough, and full-scale experiments were too costly. A plan for the establishment of a SMTT was launched in 1916. However, small economic contributions from the shipping industry in Norway (183 000 NOK as opposed to the needed 500 000) forced a need for governmental support. In 1919, the government granted 250 000 NOK for the project, but of little help as the new cost estimate for the SMTT had reached 1 million NOK. In the 1920s an economic depression hindered further grants. After additional public grants, the SMTT was finally opened in 1939. The SMTT contributed in developing better hull designs and propellers (Karlsen 1997).

In addition to authorities, various institutions may also trigger or constrain innovations. A large number of national and international institutions develop rules and regulations for shipping. Most known are the classification societies and IMO (International Maritime Organisation). IMO recently developed new safety standards for ro-ro vessels, after the disaster of the *Estonia*, influencing the design of the visor-doors at the bow (Wijnolst 1995). Classification societies develop the design rules for all classes of ships. The classification societies have also played an important role in the development of methods of design of ship structures (Wijnolst 1995). In this way, the classification societies have contributed to innovations in the form of improved hull designs. However, Meek (1997) argues that the classification societies have an almost too powerful influence and that some may even say that practically speaking they are the designers of ship structure. Classification societies may constrain innovative efforts as their rules may act in a preservative way.

International rules and regulations also affect the possibilities for patenting new products and thereby the innovator's ability to capture profits generated by an innovation. However, Teece (1986) argues that patents rarely confer perfect protection, and that they can be "invented around" at modest costs. An empirical survey carried out by Levin et al. (1987) looks at alternative means of protecting the competitive advantages of new or improved products. Generally, lead time, learning curves and sales or service efforts were regarded as substantially more effective than patents in protecting new products. Furthermore, diffuse patent regulations may contribute in constraining innovative efforts as the innovator will not be able to protect an innovation for a time long enough to justify the resources spent in developing the innovation.

Education systems may also trigger or constrain an innovation process. With the completion of the SMTT, Norway could educate more and better naval architects and strengthen the nation's competence in ship building (Karlsen 1997), and thereby increase organisational slack needed for innovation (i.e. required competency resources). An example of how a poor education system may constrain innovation may be related to the slow Norwegian transition from sail to steam. Berggren et al. (1989) point to the fact that the first Norwegian school for marine engineers did not receive government assistance before 1885, while more than half of the world seaborne transport was carried out by steamships in 1880 (Weyergang-Nielsen 1994).

Finally, I will look into how research institutions may trigger and constrain innovations. In Norway, several research institutions provide maritime research. The most known are MARINTEK (Norwegian Marine Technology Research Institute) located in Trondheim and SIØS (Centre for International Shipping and Economics) located in Bergen. According to the linear model, research shall be of importance in an innovation process (although newer contributions show that relations between actors in a network may be of greater importance). Research institutions employ competent people who provide specialised knowledge that may be of importance in an innovation process. Companies in need of specialised knowledge may order research services from the institutions. However, the Government normally supports a large degree of the research undertaken and directions for research-based innovation may therefore be constrained or triggered accordingly.

An example of a Norwegian financed project is TRANSDATA aiming to improve the information flows in the transport chain by developing a transport reference information model. Another Norwegian financed project is Aluminium in Ships. This project had a budget of 70 million NOK, including 25 million given by the Research Council of Norway (NFR).

Some of the results from TRANSDATA were (Norges Forskningsråd 1999):

- Improved design of hulls – 10% reduction in resistance.
- More effective production techniques.
- Hours/ton consumption – 15% reduction.
- Total cost savings in production of a 60 metres catamaran – 7 million NOK.

Triggers

The three models of innovation identify triggers of innovation as research, market needs and interactions with customers and suppliers. In the previous section, I also showed how an innovation process may be triggered by the institutional framework. However, several other triggers of innovation are identified in the innovation literature and these triggers are discussed below.

Rosenberg (1976) points to technical imbalance of a system as a possible trigger of innovation. Through examples from the machine tool industry, Rosenberg (1976) shows how changes in one component of an interdependent system create a stimulus for changes elsewhere in the system. Imbalances between components have led to an exploration of possibilities for corrective action whose eventual result has been major improvements in productivity. From the history of military technology it is shown how improvements in weapons have emerged from the continuos rivalry between offensive and defensive weapons. For example, the great increase in the destructive power of offensive weapons led to the application of armoured plates to ships to protect them against shells. It was out of this interplay that the modern warship was developed (Rosenberg 1976). In short sea shipping, ports may be regarded as technical imbalances (bottlenecks) in a transport chain. In European short sea shipping, the port costs will often be greater than the costs for the actual sea transport (Levander 1994, Coasterudvalget 1991).

Wijnolst et al. (1993a) identify five triggers of innovation in shipping:

1. <u>Physical laws.</u> Physical laws may lay restrictions that trigger innovation. Resistance in water will restrict the speed of a ship. If the speed is to be increased beyond a certain limit, dynamic lift and/or a powered lift may be used.
2. <u>Geographical restrictions.</u> Geographical restrictions may trigger certain changes in ship technology: the breadth of the ship may be restricted due to the breadth of channels such as the Panama and the Suez (resulting in designs such as the Panamax

and Suezmax carriers), the draft may be restricted by depth of ports, bridges may lay restrictions on the air draft of ships (leading to ship bridges that can be lowered to pass under the bridges).

3. Economic parameters. The drive of owners to develop new ship types of increased earning capacities and/or reduced costs is a strong trigger of innovation in shipping. Oil-bulk-ore carriers (OBO) are examples of ships providing an opportunity to shift to markets with higher freight rates.
4. National and international rules and regulations. Design and operation of ships is regulated by national and international regulations. An example is the Oil Pollution Act 1990, introduced by the USA after the *Exxon Valdez* accident, which led to the development of double hull tankers. Other examples on how rules and regulations trigger, or constrain innovations are given in the previous section treating the institutional framework.
5. (Technological) change in related sectors. Innovations in other areas, such as information technology, may enable the development of new transport services in shipping (e.g. more integrated transport chains).

Finally, I will argue that experience, knowledge and skills within a company may trigger and direct an innovation process.

Uncertainty

None of the models discussed address uncertainty related to possible changes in the business environment. It is important to acknowledge the *dynamic* nature of the business environment. Although an innovation may be well suited for the situation when is was made, it may not be sufficiently robust to tackle changes in business and technological environment.

Consider an example where a carrier invests in a certain information technology system used by their most important customer in order to offer the customer a better service. Two months after the implementation the customer goes bankrupt and no other customers are using the same information technology system. The innovation did not tackle a radical change in the business environment.

A structured approach for dealing with such uncertainties is presented in chapter 3.

2.3 Adopting new products

In section 2.1.2 it was concluded that adoption of new products could be considered an innovation for the adopter. In the previous section, I discussed three models of innovation addressing the development of new products. In this section, I look into the adoption of new products. Adoption is associated with the decision to buy, implement and make regular use of a new product.

First, Rogers' (1983) model of adoption is discussed. Rogers' (1983) model is one of the best known, and most referred to in the adoption literature. Thereafter, the decision to adopt is related to the diffusion process. Diffusion refers to the process where new products are communicated to actors through a social or business network. Three models of the diffusion process and their implications for shipping are discussed.

2.3.1 Rogers' (1983) model of the adoption process

Rogers (1983) presents an adoption model, consisting of two phases: initiation and implementation. The trigger of the process is identified as a performance gap:

> "*… the discrepancy between an organization's expectations and its actual performance*"
>
> (Rogers 1983, p.362)

In order to fill this gap, a company will seek information on new products used by other companies. If the new product is likely to contribute in filling the performance gap, a decision to adopt may be taken, and the implementation of the new product will follow. A simplified version of Rogers (1983) model of adoption is shown in Figure 2-5.

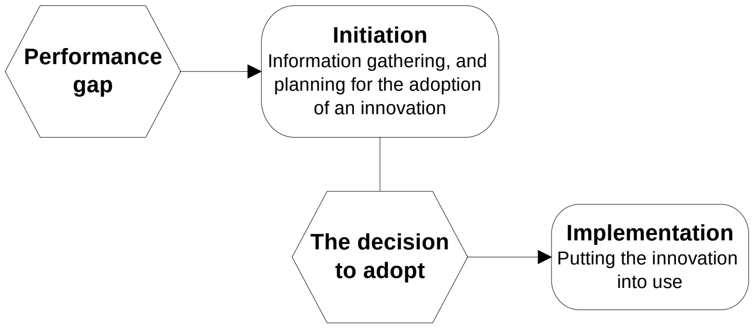


Figure 2-5 A simplified version of Rogers' (1983) model of adoption

A performance gap leads to a search for new products that may contribute to fill the performance gap. After the decision to adopt is taken, the implementation of the innovation starts.

A crucial element in Rogers' (1983) model is the decision to adopt. Rogers (1983) identifies five aspects of an innovation as being important for the decision to adopt:

1. **Relative advantages:** Relative advantages are often measured in economic terms including such aspects as increased efficiency, reduced uncertainty, lowered costs and increased flexibility in relation to existing products. Relative advantages are considered to be the basis of rational decision-making. Rogers (1983), however, found four additional aspects which are discussed below.
2. **Compatibility:** Compatibility includes both technological compatibility and cultural compatibility. If an innovation has poor technological compatibility with existing systems, the organisation must undergo greater change if adoption is to occur. This will reduce the relative advantages and increase the uncertainty due to the greater change necessary if adoption is to occur. Cultural compatibility address how well the innovation fits with norms and rules within the adapting organisation.
3. **Complexity:** Complexity can be seen as the number of interconnections in a system. The understanding or knowledge of a system is dependent on the understanding of its component relationships. The more of interconnections that are poorly understood the greater is the probability that the adoption will fail.
4. **Trialability:** Trialability refers to the extent to which an innovation can be tried on a small scale or temporarily. Trialability allows a potential adopter to decrease uncertainty by increasing tacit knowledge of the innovation through first hand experience without making a full commitment. Tacit knowledge is primarily gained through experience (insight) and is difficult to transfer (Ferguson 1995, Teece 1986, Dosi 1988b).

5. **Observability:** Observability of an innovation increases as more firms or individuals adopt the innovation. Observability increases the interest in the innovation by allowing potential adopters to increase their knowledge before making a commitment.

The final evaluation of whether to adopt an innovation or not may be based on a perceived balance of these aspects. An extreme relative advantage may outweigh a weakness in one of the other aspects – a large gain in efficiency, for example, may motivate adoption, even though the use of an innovation has a poor cultural compatibility with the adopting organisation.

Rogers' (1983) model seems to capture some of the key activities in an adoption process. However, I would like to question the assumption that the adoption process is triggered by a performance gap. In the previous section, several additional triggers of innovation were discussed (e.g. a market need).

Rogers' (1983) description of the adoption process, and his five aspects of innovations, provide a starting point for understanding how companies may perceive and evaluate potential adoptions.

Consider an example where a carrier is searching for new loading and unloading equipment to be installed on his/her ships. The equipment should contribute to a more efficient cargo handling. In addition to the relative advantages, such as increased efficiency and reduced costs in relation to the present equipment, the carrier must also address technical compatibility with existing port systems and cultural compatibility – how well does the technology fit with the competence of the crew? In addition, it may be necessary to consider the complexity of the new technology – the more of interconnections that are poorly understood the greater is the probability that the adoption will fail. If the new equipment could be tried temporarily on one of the carrier's ships, the carrier could obtain first hand experience and increased (tacit) knowledge of the innovation without making a full commitment. Similarly, if a lot of other carriers operating in the same trades already have adopted the innovation, the carrier may increase his knowledge by studying their operation before making a commitment.

Rogers (1983) does not specifically address the search process for a new product to be adopted – how does a company hear about an innovation in the first place? Diffusion theory, discussed in the following section, aims to describe these processes.

2.3.2 Diffusion of new products

In order for a company to adopt a new product, the company needs to be made aware of the new product in some way. Awareness of a new product is obtained by diffusion of knowledge of the new product into the relevant industry.

In diffusion theory the individual is normally the adopting unit. How then, is diffusion theory applicable to describe diffusion of products among companies? Realising that relations between companies are based on relations between individuals, I believe it is fair to suppose that diffusion of innovations among companies may be described by diffusion theory.

Valente (1995) defines diffusion of innovations in this way:

> "*The spread of ideas, opinions, and products is referred to as the diffusion of innovations*"
>
> (Valente 1995, p. xi)

The definition above implies implicitly that Valente (1995) relates innovations to ideas, opinions and products, which is a rather broad definition of the concept. In this section, I will relate innovations to new products only.

Another definition is given by Rogers (1983) defining diffusion as the process where:

> "*an innovation is communicated through certain channels over time among the members of a social system*"
>
> (Rogers 1983, p.5)

Valente (1995) argues that a network of communication determines how quickly innovations diffuse and the time of each individual's or company's adoption. Valente's (1995) understanding of networks may be related to the "industrial network approach" as discussed in section 2.2.3. Relations between actors may be regarded as channels for communication.

Traditionally, the diffusion effect is modelled by mathematical relations in which adopters influence non-adopters at a specified rate and by assuming that once a company has adopted an innovation, the company remains an adopter and does not discontinue his/her adoption or develop negative attitudes toward the innovation.

Valente (1995) gives a hypothetical diffusion case of 100 potential adopters in which adopters influence non-adopters to adopt at a 1% rate. With 5 initial adopters among the 100 potential adopters, 4,75 additional adopters are recruited (4,75 = 5x95x0,01) in time period 2. Now, at time period 3, there are 9,75 adopters and 90,25 non-adopters who interact, and 1% of those interactions result in adoptions: 8,8 new adopters. Thus after time period 3 there are 18,55 adopters (9,75 + 8,8). This diffusion effect continues until everyone in the system has adopted, which yields the diffusion curve as shown in Figure 2-6.

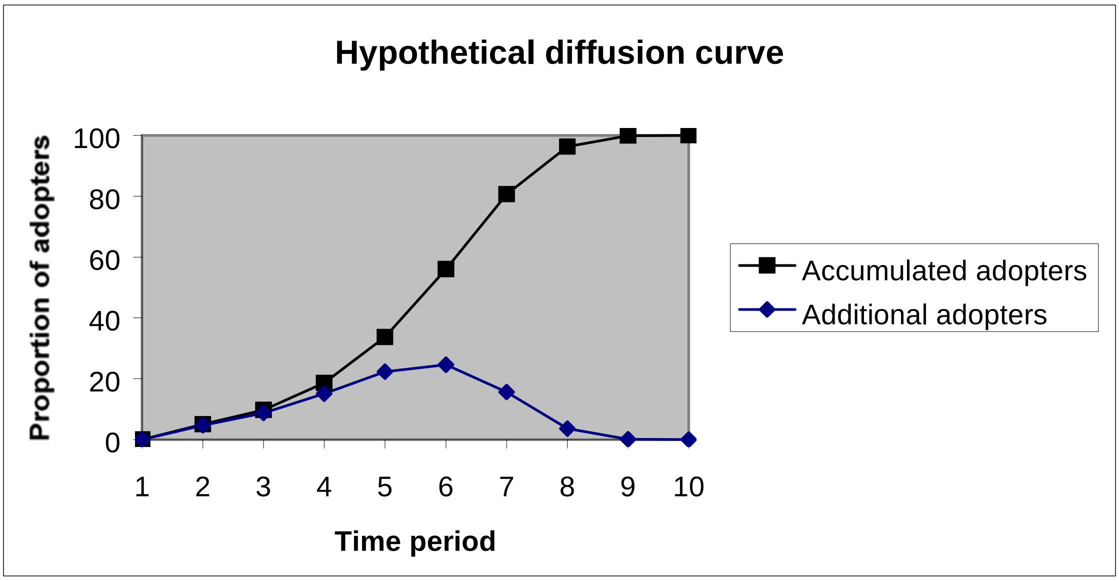


Figure 2-6 Hypothetical diffusion curve (Valente 1995)

The diffusion curve is based on adopters persuading non-adopters to adopt at a rate of 1% in a sample of 100 individuals with five initial adopters.

In the following, I will look closer into so called relational models of the diffusion process. Relational models propose that direct contacts between individuals influence the spread of an innovation.

Three relational models (Valente 1995) are discussed below, together with their implications for shipping.

1. **Opinion leadership:**
   - Opinion leaders are defined as those individuals in a network with whom most of the other individuals in the network communicate. Opinion leaders are early adopters of innovations. Generally, individuals in a network wait until the most influential members of the network adopt an innovation. After the opinion leaders adopt, risk and uncertainty about the innovation are considered to decrease and opinion followers are more likely to adopt the innovation.
   - In shipping, opinion leaders may be related to the larger and most influential carriers and their adoption behaviour.
2. **Group membership:**
   - Individuals who are connected to one another in a group are more likely to share information with one another and hence reach common understanding and perceptions when faced with a new product. Consequently, individuals in the same group can be expected to have similar adoption times. This is particularly true for innovations that create interdependency such as new information and communication technologies.
   - In shipping, group membership may be related to liner conferences and shipping pools and the interdependence between their members.
3. **Personal network density:**
   - Personal network density is the degree to which an individual's personal network is interconnected. A dense, or integrated, personal network is composed of numerous connections between the people who are communication partners. An individual with a dense network is not likely to receive much information from outside his/her own set of communication partners. Thus individuals with dense networks are more likely to hear of an innovation later and are thus, in average, later adopters of innovations. Non-dense networks are radial and indicate that an individual communicates with individuals who do not necessarily know or talk to one another and may enable an individual to hear about and thus adopt, an innovation early. Integrated and radial networks are illustrated in Figure 2-7.
   - In shipping, a radial network may be related to a company with a number of formal and informal relations with customers, suppliers, competitors, other industries and institutions.

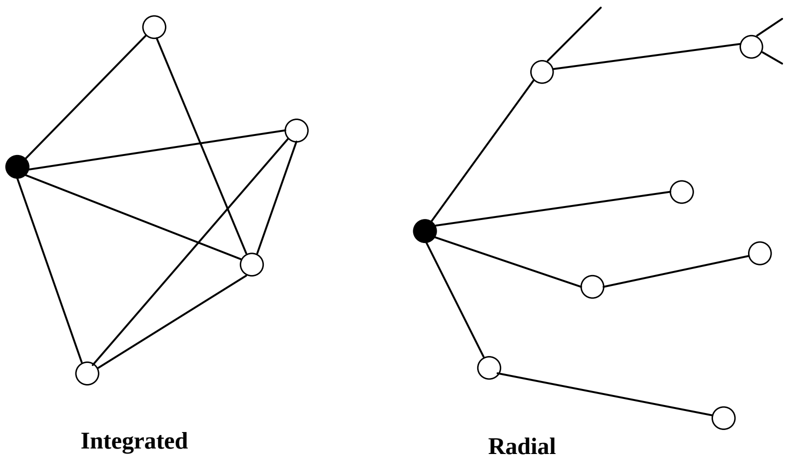


Figure 2-7 Integrated and radial networks (Valente 1995)

An individual with an integrated network is more likely to hear of an innovation later than individuals with a radial network.

Based on the above discussion of the three relational models, some implications for carriers may be drawn:

- If a carrier has limited organisational slack (resources), the carrier should not adopt an innovation until the opinion leaders adopt. After the opinion leaders adopt, the observability of the use of the innovation increases allowing potential adopters to increase their knowledge before making a commitment, thus reducing the need for organisational slack.
- Carriers who are connected to one another in a group should adopt an innovation at the same time, especially if the carriers are dependent on each other.
- In order for a carrier to spot new products earlier than his or hers competitors, the carrier should strive towards a radial network by communicating with, for example, actors in other industries. Best practice companies (e.g. Federal Express for door-to-door transport) may be studied in order to identify new ways of doing business.

All three models emphasise the importance of individual relations as channels for communication on new innovations.

2.4 New forms of co-operation

In section 2.1, I defined innovations in terms of new products, new processes and new forms of co-operation. In section 2.2 and 2.3 development and adoption of new products have been discussed. In this section, I look into new forms of co-operation. Usually, innovations have to be based on the development/adoption of new products and/or by co-operating with other companies. In section 2.1.1, I concluded that new forms of co-operation are considered to be innovations for the companies involved. New forms of co-operation may also contribute to increase the total organisational slack (resources) for the companies, thus improving the conditions for innovation. Therefore, I feel it is appropriate to spend some time discussing new forms of co-operation.

First, I discuss possible directions in which a company may co-operate.

Then, I discuss how a co-operation may be governed by using different governance mechanisms. The understanding of different governance mechanisms is based upon four theoretical contributions complementing each other; Transaction Cost Economics (Williamson 1975, 1985), Agency Theory (Eisenhardt 1989), Industrial Network Theory (Mattson 1987, Håkansson and Johanson 1992, Håkansson and Snehota 1995) and Contract Theory (Klein et al. 1978, Haugland 1996).

Finally, guidelines for developing and entering into a new co-operation are discussed.

2.4.1 Directions of co-operation in a transport chain

Haugland (1996) and Reve (1996) identify four directions in which a company may co-operate:

1. Downstream co-operation (e.g. carrier – shipper/receiver).
2. Upstream co-operation (e.g. carrier – supplier/sender).
3. Horizontal co-operation (e.g. carrier – carrier).
4. Related/unrelated co-operation (e.g. carrier – carrier in other trade (related), carrier – insurance company (unrelated)).

In a transport chain perspective, the four directions for co-operation are reduced to two basic forms of co-operation: horizontal co-operation and vertical co-operation. In addition, combinations of the two forms may occur. I define a horizontal co-operation as a co-operation between companies having the same task (e.g. sea transport), and a vertical co-operation as a co-operation between companies having different, but interdependent, tasks (e.g. sea transport and inland transport).

2.4.2 Governance mechanisms discussed by Transaction Cost Economics

Transaction Cost Economics (TCE) is an evolving field of research promoted by Williamson (Williamson 1975, 1985). In a shipping context, a transaction may be defined as purchase and delivery of a transport service. In TCE, the transaction is the basic element of analysis, and the properties of transactions are important in explaining the optimal governance mechanism for a co-operation.

TCE has frequently been used for analysing vertical forms of co-operation in transport chains. TCE may, however, also be applied to any other form of co-operation (Williamson 1993).

In TCE, the governance mechanisms range from price to ownership. The price mechanism is related to transactions taking place in a market (e.g. purchase of transport in a spot market). The ownership mechanism is related to internal organised transactions (e.g. a shipper taking care of his/her own transport needs by an internal transport division).

Generally, transaction costs are high when transactions are characterised by (Reve 1990):

- *Asset specificity*: investments which are specific to a particular transaction relationship (e.g. investments in common information technology systems, ships and special knowledge).
- *Uncertainty*: ambiguity regarding transaction definition and performance (e.g. uncertainty regarding a new transport service such as processing of raw materials during transport).
- *Infrequency*: transactions which are seldom undertaken (e.g. special type of transport service).

When asset specificity and uncertainty are low, and transactions are relatively frequent, transactions will be governed by the price mechanism and take place in the market. When asset specificity and uncertainty are high, and transactions are not so frequent, transactions will be governed by the ownership mechanism and take place internally.

Medium levels of asset specificity suggests bilateral relations through various types of co-operative agreements (e.g. strategic alliances) (Reve 1990).

TCE suggests that carriers seeking strong alliances with other actors in a transport chain are more likely to succeed if the transactions involved are characterised by high asset specificity. High asset specificity may be achieved by investments in e.g. common information technology and special competence.

2.4.3 Governance mechanisms discussed by Agency Theory

Agency Theory (AT) is dealing with the co-operation between two actors. One of the actors (the principal) delegates tasks to another actor (the agent), who performs the tasks. In shipping, several interpretations of the principal/agent relationship may be given. In spot shipping, shippers may be regarded as principals seeking standard transport solutions, from a number of carriers, or agents. A big carrier, operating in intercontinental deep-sea trades, may be defined as the principal and the smaller short sea carriers (providing feeder services[4]) as the agents. Finally, a big short sea carrier may delegate transport to a smaller short sea carrier leading to a principal-agent relation between the two carriers.

AT attempts to describe the principal/agent relationship by using the metaphor of a contract. The theory builds on the following assumptions (Eisenhardt 1989):

- People are self-interest seeking, have bounded rationality and are risk averse.
- Companies are faced with goal conflicts.
- Information is a commodity which can be purchased.

AT aims to determine the most efficient contract (behaviour versus outcome) a principal should choose to undertake with the opportunistic agent. AT has similarities with Transaction Cost Economics (TCE). Integration and ownership (TCE) roughly corresponds to behaviour-based contracts (AT). Price and market (TCE) roughly corresponds to outcome-based contracts (AT) (Eisenhardt 1989).

The core of AT is the trade-off between (a) the cost of measuring agent's behaviour and (b) the cost of measuring outcomes and transferring risk to the agent. Generally,

[4] Feeder services form a short sea network between ports in order for the freight (usually containers) to be consolidated or redistributed to or from a deep-sea service in one of these ports (hub-port).

outcome-based contracts are effective in curbing agent opportunism. Outcome-based contracts co-align the preferences of agents with those of the principal because the rewards for both depend on the same actions, reducing the conflicts of self-interest between principal and agent. Important guidelines for choosing the right type of contract (or governance mechanism) are (Eisenhardt 1989):

- **Good *information systems*[5] lead to behaviour-based contracts**. Information systems may be budgeting systems, reporting procedures and additional layers of management. In shipping, if a shipper has access to good logistics information systems, s/he may integrate with the carrier to some degree.
- **High *outcome uncertainty* leads to behaviour-based contracts.** When outcome uncertainty is high, the costs of shifting risk to an agent are high and behaviour-based contracts are attractive. In shipping, if outcome uncertainty is high (e.g. specialised transport), the shipper will want to integrate with the carrier (e.g. through ownership).
- **Large *goal conflicts* between principal and agent lead to outcome-based contracts.** In shipping, if goal conflicts between the shipper and the carrier are large, the shipper will use the price (market) as a governance mechanism in order to increase the motivation of the carrier.
- **Long *agency relationships* lead to behaviour-based contracts.** In a long-term relationship, it is likely that the principal will learn about the agent and so will be able to assess behaviour more readily. Behaviour-based contracts may therefore be increasingly preferred as a relation continues over time. In shipping, the shipper may choose to engage in a more close form of co-operation as time goes by and s/he learns about the capabilities of the carrier.

Both Transaction Cost Economics and Agent Theory seem to stress the competitive and opportunistic aspects of relations, rather than the complementary nature of companies' activities. In this way, the theories are useful in explaining the commodity segments of shipping characterised by a large number of carriers and fierce competition. However, for the more specialised industrial shipping segments, a counterbalance may be needed in order to explain relations between companies. In the next section, I will discuss Industrial Network Theory offering an alternative view on relations between companies.

[5] In agency theory, information is regarded as a commodity: it has a cost, and it can be purchased. The implication is that organisations can invest in information systems in order to control agent opportunism (Eisenhardt 1989).

2.4.4 Governance mechanisms discussed by Industrial Network Theory

Industrial Network Theory (INT) assumes that relations between industrial actors are stable and characterised by openness, mutual trust and respect (Mattson 1987, Håkansson and Johanson 1992, Håkansson and Snehota 1995). The network model of innovation, discussed in section 2.2.3, is based on INT.

Haugland and Reve (1994) argue that the governance mechanisms used in a specific situation seem to be dependent not only upon *transactional* properties, but also on *relational* properties. By complementing social dimensions from INT with the findings from Transaction Cost Economics and Agency Theory, they view the governance mechanisms of co-operations as combinations of price, authority (e.g. through ownership) and trust. Price reflects the market mechanism, while authority reflects the integration mechanism. Trust refers to compliance with social norms and personal relationships. Through an empirical survey of international distribution channels for Norwegian farmed salmon, they find support for the use of trust as a dominant governance mechanism in stable relationships or long-term contracts.

Haugland and Reve (1994) argue that efficient governance cannot be achieved through implementation of one "right" governance mechanism, but rather through implementation of an optimal combination of different governance mechanisms. They use the concept of a *vector* to illustrate this point and argue that some combinations are common (e.g. a price-dominated vector, a trust-dominated vector and an authority-dominated vector).

From a carrier‘s point of view, INT indicates that as a relationship evolves over time, trust will be an increasingly important governance mechanism.

2.4.5 Governance mechanisms discussed by Contract Theory

Co-operation is often governed through the use of contracts. It is common to discriminate between explicit and implicit contracts. If information about all relevant factors is known and implemented in the contract, before it is signed, the contract is called an explicit contract. However, most contracts must address uncertainty, and do not address all imaginable future problems. The problems are solved as they appear and the contracts are termed as implicit contracts (Haugland 1996).

The time-horizon is another important aspect of contracts. Short-term contracts are often referred to as market contracts. Market contracts are used when all relevant factors are known (explicit contracts). The most common use of market contracts is in situations with purchase and sale of explicitly defined commodities and services within a limited time span (e.g. standard port to port transport in a spot market). The governance mechanism for market contracts is price. However, as the time span is widened and uncertainty (in future conditions) and possible post-contractual opportunistic behaviour[6] increases, price as a governance mechanism has limited efficiency (Haugland 1996).

Three different forms of long-term contracts are identified and categorised according to their uncertainty and main governance mechanism (Haugland 1996):

1. **Classical long term contracts:** These contracts try to specify all relevant factors before signing of the contract (approaches an explicit contract). The dominant governance mechanism is price.
2. **Internal contracts**: These contracts focus the use of authority, rules and routines. The dominant governance mechanism is authority (e.g. integration through ownership).
3. **Relational contracts:** These contracts focus co-operation based on trust. Relational contracts may be used in relations characterised by complex activities (e.g. in an innovation process). In such relations it will be complicated and costly to develop efficient price mechanisms or rules and routines for managing all possible future situations. The complexity will demand flexibility and continuous adaptation between the partners. The dominant governance mechanism is trust.

Classical long-term contracts may be used in commodity shipping. Internal contracts may be associated with a tight co-operation (possibly through ownership) between a shipper and a carrier, in order to optimise a transport chain. Relational contracts may be used to govern a co-operation between a carrier and a yard during an innovation process.

[6] Klein et al. (1978) examine the possibilities of post-contractual opportunistic behaviour. Their argument is that as asset specificity increases, the possible gains from opportunistic behaviour will increase, and the cost of contracting will generally increase more than the cost of vertical integration, leading to vertical integration as the co-operative form. This argument corresponds neatly with the guidelines for choosing co-operative forms, as given in Transaction Cost Economics.

2.4.6 Governance mechanisms and corresponding characteristics of transactions/relations

With a basis in the four theoretical perspectives discussed in the previous sections, three different forms of co-operation are identified as market, alliance and integration. I have summarised the different governance mechanisms and the corresponding characteristics of transactions/relations for each of the three forms of co-operation in Figure 2-8.

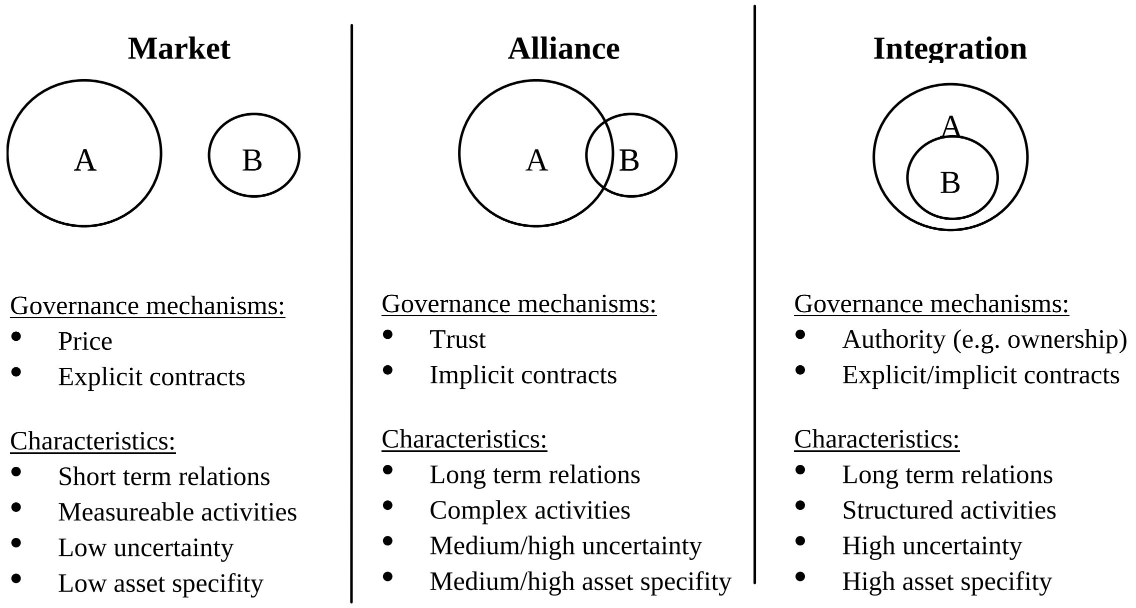


Figure 2-8 Governance mechanisms and corresponding characteristics of transactions/relations

Company (A) co-operates with another company (B).

In addition to characteristics of transactions/relations, optimal governance mechanisms are subject to the institutional environment defining the rules of the game. Williamson (1993) argues that changes in property rights, contract laws, norms, customs and the like, may induce changes in the comparative costs of governance. In shipping, anti-trust legislation may ban attempts to establish carrier cartels or monopolies (through horizontal co-operation).

I will argue that if a carrier seeks co-operation with other companies in order to increase organisational slack and thereby the ability to innovate, a horizontal alliance with another carrier could be the first step in this process. A vertical alliance may involve a carrier in activities where it has very little experience and should therefore not be pursued before financial security and risk sharing is made possible through a horizontal co-operation. Full horizontal or vertical integration through ownership, may require extensive capital resources and increases administrative costs, although transaction costs and uncertainties are reduced. Falkenberg (1992) gives support for my argument that vertical integration may be difficult to obtain for a carrier. Falkenberg (1992) studied the use of governance mechanisms of strategic alliances in Norwegian shipping. Sixteen companies or divisions of companies participated in the study. In the study, a shipping liner company states that:

> "*… the requirement of integration into areas of transportation so that you are able to provide a door to door service. … We have seen shipping companies purchasing trucking companies, and it has proven devastating. … because there are different conditions when it comes to operating a shipping company. I think that a natural way of creating door to door services would be to utilize organizations in the best possible way, namely to build on the knowledge that is within each individual company and try to find some kind of way of operating together – to build an alliance in that way. I think that will happen more and more.*"
>
> Falkenberg (1992, p.44)

In the Falkenberg (1992) study, a strategic alliance is defined as a co-operation between two or more companies in which each company attempts to add to its own competence by combining its resources with those of other companies. The most common type of alliances was found to be pooling agreements and these were investigated in-depth. Falkenberg (1992) makes use of the following definition of a pool:

> "*Pool: A co-operation between owners who place vessels in a jointly controlled financial and operational unit where freight income on a time charter basis is divided between the partners according to a predetermined key.*"
>
> (Falkenberg 1992, p. 42)

The Falkenberg (1992) study showed that no single governance mechanism was applied in a co-operation, but all three (price, trust and authority) were used as circumstances varied.

In the following, results from Falkenberg's (1992) study of pooling arrangements are discussed.

In the study, trust is an important element in the governance of strategic alliances. One of the companies stated:

> "*We've never abused their trust – and we've seen no signs that they've ever done anything but the reciprocal on their side*"
>
> (Falkenberg 1992, p. 52)

Price is also used as a governance mechanism in strategic alliances. The expectation of the partners is that the alliance will do as well or better than the market. Two of the companies state:

> "*Make better return than the average market*" and "*produce satisfactory – which should be better than the average market*"
>
> (Falkenberg 1992, p.54)

The last governance mechanism is authority. This control mechanism may include elements such as meetings, reports and rules. Some quotes from the companies were:

> "*We are sitting on the phone with them half the day and night, we have to supply them with all kinds of information*"
>
> (Falkenberg 1992, p.54)

> "*Control is built into the frequent regular, reporting within each section of such a working relation – complete openness is a key factor to have a successful relationship – daily exchanges as to what is happening in the market – regularly reporting, more formalised weekly and months summarising what is going on*"
>
> (Falkenberg 1992, p.54)

Falkenberg's (1992) findings underline the argument of Haugland and Reve (1994) that efficient governance cannot be achieved through implementation of one "right" governance mechanism, but rather through implementation of an optimal combination. Falkenberg (1992) states that trust is an important control mechanism and it is used when the reputation of the partners is known and good. However, trust is not used without price. Price is used as a requirement that the alliances should be able to gain better prices than the market. Authority is used to a greater extent in cases where the reputation of the partner is not known or is poor. Authority is also used in the early stages of a co-operation in which the partners do not know each other.

2.4.7 Developing and entering into a co-operation

In this section, I present some guidelines for developing and entering into a co-operation.

Haugland (1996) points to five stages in the development of a new co-operation:

1. **Discover complementarity:** Companies realise that common goals may be reached by combining resources and competence.
2. **Identify activities and how to manage a co-operation:** Identify activities for the co-operation and how to organise and manage the co-operation.
3. **Change:** After some time there will usually be a need for changes in the co-operation. This may be due to the fact that the importance of the co-operation becomes very critical for one of the actors and less critical for the other.
4. **Reorganise:** The actors decide (separately) if it is fruitful to continue the co-operation, and which activities should be included and how to manage these.
5. **New premises:** After the reorganisation, the co-operation continues on new premises.

Partly inspired by the five stages referred above, I present a model of the development of a new co-operation in Figure 2-9.

In the model, a discovery of complementarity or equality in operation is assumed to trigger the co-operative efforts (the discovery may for instance be based on new customer requirements, e.g. need for just in time deliveries). After the companies have agreed to co-operate, they have to identify relevant activities which may constitute the basis of the co-operation. They also have to agree on the appropriate governance mechanisms (price, trust and authority) of the co-operation before entering into the co-operation. After some time, a change in terms of power-dependency aspects will probably be experienced in the co-operation. This may be because one of the actors is more dependent upon the co-operation than the other, because of opportunistic behaviour by one of the actors, or because new complementarity or equality is discovered, leading to new business opportunities. The actors may choose to reorganise their co-operation according to the identified changes in the relation, or they may wish to end the co-operation. If they choose to reorganise, the search for complementary or equal activities and resources and appropriate governance mechanisms should start over again.

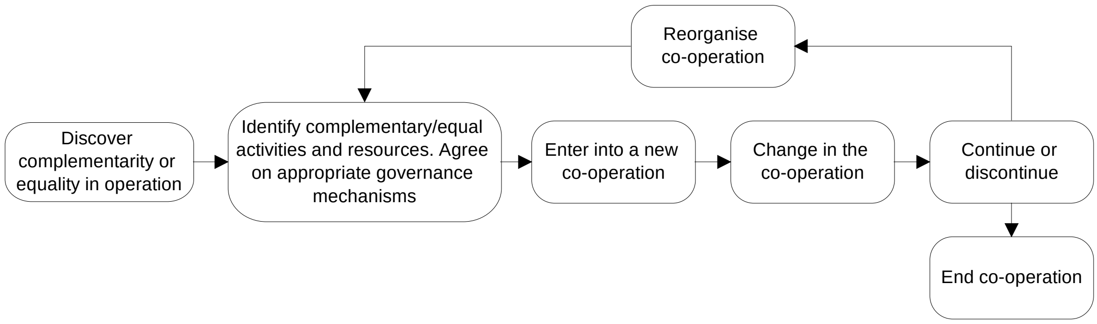


Figure 2-9 A model of the development of a co-operation

Two actors choose to co-operate based on a discovery of complementarity or equality in operation. Complementary or equal activities and resources are identified and governance mechanisms are agreed upon before entering into a co-operation. Power-dependency aspects, opportunism and discovery of new complementarity or equality may change the basis for the co-operation, leading to a reorganisation or termination.

A rationale for seeking a co-operation may also be explained with a basis in Power-Dependency Theory (Emerson 1962). Emerson argues that power is a property of a social *relation* – it is not an attribute of the actor. Hence, to say that "X has power" is meaningless, unless one specifies "over whom". Emerson (1962) states that the power of A over B is equal to, and based upon, the dependence of B upon A (Emerson 1962, p.33).

Emerson argues that:

> "*The power of actor A over actor B is the amount of resistance on the part of B which can be potentially overcome by A*"
>
> (Emerson 1962, p. 32)

> "*The dependence of actor A upon actor B is (1) directly proportional to A's motivational investment in goals mediated by B, and (2) inversely proportional to the availability of those goals to A outside of the A-B relation*"
>
> (Emerson 1962, p.33)

In a commodity market with many carriers and strong competition, one may assume that a shipper does not have a significant dependence upon a single carrier. The shipper may be encouraged to exercise his/her power by playing the carriers up against each other and thereby lower his/her transport costs. The power/dependency relation between the shipper and the carriers is unbalanced. According to Emerson (1962), a number of balancing operations are likely to be initiated. One of these balancing operations may be related to horizontal alliances, where carriers seek to reduce possible alternatives for the shipper to realise his/her need for transport. Another of the balancing operations may be related to vertical alliances, where a carrier seeks to increase the shipper's motivational interest in the carrier's goals. If the shipper realises that a stronger co-operation with the carrier may lead to a decrease in transport costs or an increase in customer satisfaction, a stronger co-operation may emerge, creating a more balanced power/dependency relation.

Haugland (1996) points to four factors influencing the decision to enter into a co-operation or not:

- **Strategic core:** Co-operation close to the company's strategic core necessitate certain precautions, as there is a certain risk that an opportunistic partner will seek to imitate the company's core skills.
- **Relation specific investments:** If one of the parts has significant higher investments in a co-operation than the other, and the other quits the co-operation, the part with the big investments may suffer a considerable economical loss.
- **Equal or complementary activities and resources:** Companies need to identify and evaluate benefits of co-ordinating equal or complementary activities and resources.
- **Complexity:** A complex co-operation is characterised by a high degree of required resources and activities not known ex-ante.

In the following, a further discussion of each of the four factors is given.

Strategic core

Strategic core may be defined as unique and valuable assets that are necessary to attain a company’s strategic goals (Reve 1990). Reve (1990) argues that examples of core skills include specific availability of natural or technological resources, human assets, and know-how. However, strategic core may also be related to external relationships that the firm masters better than its competitors (Reve 1996). Core skills may be visible (e.g. physical assets), but more often they are invisible (Itami 1987) and contained in people's heads and organisational routines and culture (Reve 1990).

In a study of Norwegian shipping companies undertaken by Falkenberg (1992), companies defined the strategic core of their company both in terms of physical assets (e.g. ships), as well as in terms of human assets (e.g. management and operation of ships).

As the strategic core is the most unique of a company, it has to be protected in order to prevent imitation from other companies. Co-operation close to the company's strategic core necessitate certain precautions, as there is a certain risk that an opportunistic partner will seek to imitate the company's core skills (Haugland 1996).

Relation specific investments

Relation specific investments are treated in section 2.4.2, referred to as asset specificity. Relation specific investments may not have many applications outside a co-operation: the investments may be related to investments in buildings, machines, human capital (special knowledge) and organisational routines and methods (Reve 1991). In situations where both parts have invested to the same extent, they will generally have the same interest in a continuation of a co-operation. However, all actors are not necessarily opportunistic, but one can not know ex-ante if any of them will act opportunistic (Haugland 1996).

Equal or complementary activities and resources

Co-ordination of equal activities and resources may contribute to benefits related to economies of scale, and co-ordination of complementary activities and resources may result in new services and/or new markets. Companies need to identify and evaluate benefits of co-ordinating equal or complementary activities and resources.

In shipping, an example of a co-operation based on equal activities and resources is pooling of a certain type of vessels. Two or more carriers may market and operate their ships together. An example of a co-operation based on complementary activities and resources is co-operation between a short sea carrier and a deep sea carrier. Together, the two carriers may offer new transport solutions including short sea distribution and feedering.

Complexity

Complexity is related to what extent it is possible to plan in advance the execution of the co-operation. A high complexity may be associated with the development of completely new products, requiring competence that is not presently available in the co-operating companies.

In shipping, a complex co-operation may be related to a carrier and a trucker co-operating in order to develop a transport service involving real time tracking of cargo. A less complex co-operation may be related to two carriers pooling their vessels in order to reduce their costs. While the former co-operation is characterised by activities not known ex-ante, the latter is characterised by activities well known by the actors.

2.5 Conclusions of chapter 2

In section **2.1**, it is concluded that companies requesting innovations may:

- Develop, adopt and implement,
- evolutionary and revolutionary,
- products and co-operative forms,
- by acknowledging and treating uncertainty with respect to changes in the business environment.

It is concluded that in order to increase the probability of success, companies need to have an opinion of the future in an innovation process. However, as the future can not be predicted, companies are faced with a number of challenging uncertainties, as they plan their future service portfolio.

In section **2.2**, it is concluded that the innovation process is presently viewed as a complex and dynamic interplay between different actors in a business network. Stable relations between actors are viewed as a precondition for initiating and accomplishing an innovation process.

Further:

- Innovative activities require organisational slack (resources).
- The institutional framework (authorities, institutions, education systems and research institutions) may trigger, or constrain an innovation process.
- Several conditions (e.g. geographical restrictions) may trigger innovations.
- Products should be developed based on an understanding of possible changes in the business environment.

In section **2.3**, it is concluded that five aspects of a new product are important for a decision to adopt:

1. Relative advantages (e.g. increased efficiency and flexibility).
2. Compatibility (e.g. technological and cultural compatibility with existing systems and organisation).
3. Complexity (e.g. number of interconnections in a system).
4. Trialability (e.g. possibility of small scale tests).
5. Observability (e.g. number of users at a given time).

Further, the decision to adopt is related to a diffusion process, where a new product is communicated to members of a network. Three models describe how relations between members of a network influence the diffusion process and the decision to adopt:

1. Opinion leadership: After the opinion leaders (e.g. large carriers) adopt, risk and uncertainty about the innovation is considered to decrease and opinion followers are more likely to adopt the innovation.
2. Group membership: Companies connected to one another in a group (e.g. a shipping pool) can be expected to have similar adoption times.
3. Personal network density: Companies with a radial network of relations (e.g. relations to companies in other industries) are more likely to hear about a new product earlier than companies with an integrated network of relations (i.e. few, but strong relations).

In section **2.4**, it is concluded that a company may co-operate in four directions:

1. Downstream co-operation (e.g. carrier – shipper/sender).
2. Upstream co-operation (e.g. carrier – supplier/receiver).
3. Horizontal co-operation (e.g. carrier – carrier).
4. Related/unrelated co-operation (e.g. carrier – carrier in other trade (related), carrier – insurance company (unrelated)).

Further, three forms of co-operation are identified as market, alliance and integration. A co-operation is normally governed by using a combination of price, authority and trust.

A model of the development of a new co-operation is presented, assuming that two actors choose to co-operate based on a discovery of complementarity or equality in operation.

Finally, four factors influencing the decision to co-operate are identified and discussed:

1. Strategic core.
2. Relation specific investments.
3. Equal or complementary activities and resources.
4. Complexity.

3 Theoretical foundations – Scenarios

In this chapter I present a set of scenario-based guidelines for innovation in shipping. By following these guidelines, a company may:

- Explore innovations
- Evaluate innovations
- Implement innovations

First, the history of scenarios is reviewed in order to understand how scenarios have been used in the past and how scenarios are used today. Then, the benefits of using scenarios are discussed in order to show how scenarios may guide innovation. A company has to develop a set of scenarios prior to the application of the scenario-based guidelines for innovation and a representative technique for developing scenarios is therefore presented. Finally, the scenario-based guidelines for innovation are presented.

3.1 The history of scenarios

In this section, I review how scenarios have been used in the past and how scenarios are used today. The review is roughly divided into three periods:

- 1940-1970
- 1970-1990
- 1990-Today

which are reviewed in the following sub-sections.

3.1.1 Initial use of scenarios (1940-1970)

Scenarios emerged following World War II, as a method for military planning. The U.S. Air Force tried to imagine what its opponents might do, and prepared alternative counter active strategies (Schwartz 1991).

In the 1960s, Herman Kahn, who had been involved in the Air Force effort, refined scenarios and developed a business tool for prognostication. In 1967, Kahn and Wiener defined scenarios as:

> "*... hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and decision-points*" (Kahn and Wiener 1967, p.6).

The scenarios considered by Kahn and Wiener were to a large extent focused on governmental and military issues. The scenarios were developed in order to have a preventive effect (e.g. avoid use of nuclear weapons) and did not aim to serve the needs of specific companies.

In parallel with Kahn and Wiener's scenario efforts, traditional quantitative forecasting techniques developed in the 1960s. Such techniques include trend analyses (for example time series methods, regression models and extrapolation techniques) and econometric models (Linneman 1983, Mandel 1993, Elias 1997). As they rely explicitly on past data, they may be useful in forecasting the short term, but work less well for longer range forecasting. Significant structural change can invalidate their projections seriously (Makridakis and Wheelwright 1989, Mandel 1993, Elias 1997). However, the techniques, worked fine in the 1960s as everything was more or less directly related to the gross national product (GNP), rising by about 5% a year (Godet 1987).

3.1.2 The rise and fall of scenarios (1970-1990)

The early 1970s, or more specifically the oil price shock in 1973, is frequently referred to as a turning point at which the future ceased to be predictable, due to increased uncertainty and more turbulence (Godet 1983, 1987, Mandel 1993, Mandel and Wilson 1993, Schwartz 1991, Wack 1985a, Makridakis and Wheelwright 1989, Amara and Lipinski 1983, Fahey and Randall 1997a). Mintzberg (1994) criticises the extensive use of the word turbulence, meaning "violent disorder" or "commotion" according to his dictionary. He argues that turbulence is simply uncertainty in the marketplace, due to the unexpected. Further, he criticises the traditional forecasting and prediction techniques that emerged in the 1960s, due to their limited capability to handle the uncertainty.

In the search for techniques being able to handle uncertainty, the theoretical and practical foundations for the use of scenarios in business were developed in the 1970s.

One of the theoretical foundations of scenarios was developed by Godet when he was in charge of the Department of Futures Studies with the SEMA Metra Consulting Group from 1974 to 1979 (Godet 1983, 1987, 1990). The scenario methodology developed by Godet makes extensive use of structural analysis and expert methods (Delphi and Cross-impact matrix, refer section 3.3) in order to identify key variables concerning the future and to assign probabilities to these.

Practical development of scenarios, to guide strategy rather than for academic uses, was initiated by a community of thinkers on the topic in the early 1970s. The importance of using scenarios to address uncertainties in strategic planning was dramatically underlined by the confusion which followed the oil price shock in 1973 (Mercer 1995). Before proceeding with the history of scenarios, I will shortly discuss the oil price shock, its implications for shipping and how Royal Dutch Shell did manage to prepare for the shock by using scenarios.

Up till the early 1960s, seven large Oil Companies (Chevron, Esso, Gulf, Mobil, Texaco, British Petroleum and Shell), referred to as “the Seven Sisters”, controlled production, distribution and sales in all important oil-producing countries in the Western world. In 1960, thirteen oil-producing countries formed a cartel named OPEC (Organisation of Petroleum Exporting Countries) in order to reduce the power exerted by the large Oil Companies (Tenold 1995).

In the early 1970s, the United States was beginning to exhaust its oil reserves, and the American demand for oil was steadily rising (Schwartz 1991). In the tanker market, the freight rates were increasing, and from May to September 1973, the rates increased from Worldscale[7] 100 to Worldscale 475. The Yom Kippur war between Egypt and Israel in October 1973 lead to a dramatic change in this development. After the war, the Arabian member countries in OPEC decided to reduce their oil-production with 25%, resulting in a 400% increase in the oil price and a significant reduction in the demand for oil transport. In the market for large tankers, the rates dropped from Worldscale 450 in October to Worldscale 55 in November (Tenold 1995).

A number of Norwegian shipowners got into trouble and went bankrupt due to the low freight rates. Norwegian shipowners controlled 15% of the world tanker tonnage and 50% of the tonnage was offered in the spot market. In contrast to foreign shipowners, the majority of Norwegian shipowners based their new-building contracts on historical levels of freight rates rather than expectations of future supply and demand conditions,

[7] Worldscale is a freight rate system used in the tanker segment of shipping.

resulting in a high number of contracted tanker deliveries in the following years (Tenold 1995).

Not all companies were caught by surprise when the oil price rose in 1973. In the early 1970s, planners at Royal Dutch/Shell experimented with scenarios and were looking for events that could affect the price of oil, which had been more or less steady since World War II. Now, however, there seemed to be several significant events in the air. The United States was beginning to exhaust its oil reserves. Meanwhile, American demand for oil was steadily rising, and the OPEC was showing signs of flexing its political muscle. Most of these countries were Islamic, and they bitterly resented Western support of Israel after the 1967 six-day Arab-Israeli war. Looking at these factors, the planners at Royal Dutch/Shell realised that Arabs *could* demand much higher price for their oil. There was every reason they *would*. The only uncertainty was *when*. Based on these events, two scenarios were developed just in time to prepare Royal Dutch/Shell for the emerging oil crisis (Schwartz 1991).

In chapter 1, the first of the necessary conditions for developing scenarios states that "The future is uncertain". Scenarios may help in analysing and preparing for changes in the business environment. The example above clearly underlines the importance of having an opinion of how the future may develop when contracting new ships or introducing new services and innovations in a market.

The use of scenarios gained rapid acceptance in the late 1970s. Empirical research conducted by researchers in the United States in the late 1970s show that scenario techniques were among the most popular strategic planning tools. A survey of Fortune 500 firms in 1977, conducted by Diffenbach (1983) shows that scenarios were the third most used planning technique, following expert opinion and trend exploration.

In addition, Linneman and Klein (1979) and Linneman (1983) measured a rapid increase in the use of scenarios between 1977 and 1981 by examining the Fortune 1000 industrials. In 1981 50% of the respondent firms (215 firms responded) stated that they used multiple scenarios, compared to 22% in 1977. The non-respondent bias check showed that 35% of these firms (72 of 78 contacted firms responded) used scenarios in 1981, compared to 13% in 1977. The surveys also showed that scenarios usually were developed without expert methods, such as the Delphi and Cross-impact analysis (refer section 3.3). Klein and Linneman (1981) also provided eight case studies of representative companies using scenarios, based on their 1977 study. These companies were involved in a set of rather diverse business areas such as food processing, chemicals, petroleum, transportation equipment and steel manufacturing.

From the early 1980s and up till the late 1980s, the use of scenarios was not particularly popular. Mercer (1995) argues that possibly as a result of sophisticated approaches (e.g. extensive use of structural analysis and expert methods as promoted by Godet (1983, 1987, 1990)), scenarios earned a reputation of difficulty and cost in use.

3.1.3 Rethinking the use of scenarios (1990-Today)

From the late 1980s and up till now, there seems to be an increased interest in scenarios. Elias (1997) argues that the interest in scenario planning has increased sharply in recent years, based on the number of articles on this subject appearing in three major databases of English-language business and trade literature. This trend seems to continue into the late 1990s, as several comprehensive books on the topic recently have been published, see for example Georgantaz and Acar (1995), Van Der Heijden (1996), Fahey and Randall (1997a) and Ringland (1998).

In Norway, Statoil’s Exploration and Development Division introduced scenario-based planning in the late 1980’s to develop a research and development strategy for oil and gas exploration and production. A review and discussion of this work is given by Stokke et al. (1990) and by Wilson (1997). At about the same time, a big Norwegian scenario project identified three possible scenarios for Norway in the year 2000. A presentation of the scenarios is given by Hompland (1987).

More recent Norwegian contributions are given by Reve and Stokke (1996). They use a scenario methodology in the development of a model for strategy analysis. Finally, in the period 1997-1998, MARINTEK and SRI Consulting produced a report that gives a scenario-based analysis of innovation in the container industry (Trondsen 1998). Results from this project were presented on the International RINA Conference on Design and Operation of Containerships (Kroneberg 1999a). A copy of the RINA paper (Kroneberg 1999a) is in Appendix A.

Elias (1997) argues that although number-crunching computer power is available today at a lower cost than ever before, companies are moving away from quantitative tools in favour of more qualitative techniques, such as scenario techniques. Scenarios allow the inclusion of elements that are impossible to quantify, such as new regulations, value shifts, or radical innovation. The trend towards qualitative descriptions of the future may be due to the fact that they are quicker to develop and are usually perceived as more realistic images.

3.2 The benefits of scenarios

In this section, the benefits of scenarios are discussed in order to show how scenarios may guide innovations. First, I discuss how scenarios treat uncertainty about future development as I have underlined the importance of addressing the future in an innovation process several times (refer section 1.1, 1.2, 2.1, 2.2 and 3.1). Thereafter, I discuss how scenarios may contribute in guiding the exploration, evaluation and implementation of innovations according to the goals put forward in section 1.2.

3.2.1 Scenarios treat uncertainty regarding how the future might develop

Scenarios are structurally different stories about how the future might develop. This implies that the first of the necessary conditions in chapter 1 ("The future is uncertain") has to be met in order to develop scenarios.

In developing scenarios, companies have to analyse how external forces may lead to a future structurally different from the situation today. An example of an (aggregated) external force may be globalisation. Today, companies are increasingly producing for a global market. Global companies require global suppliers of logistics services thus resulting in a number of mergers among carriers. A recent example is the merger between Wallenius Lines and Wilhelmsen Lines (July 1999). Wallenius Wilhelmsen Lines is the world's largest vehicle and RoRo transportation and Logistics Company with a market share of 23%.

By analysing how external forces may develop and play out, a number of plausible futures (scenarios) are identified. In this way, the scenarios may be used as a "map of the future", enabling companies to prepare for the future and identify directions for innovation. The "map of the future" analogy is supported by a number of scenario projects undertaken by SRI Consulting[8]. In these projects, companies report a wide range of benefits including the development of consistent frameworks and language for discussing critical future issues throughout the business (Zaman and Wilson 1991, Mandel and Wilson 1993, Mandel 1993, Fergusson 1998).

In order to make a good "map of the future" the scenarios should embrace the extreme points of plausible futures relevant for the strategic decisions, which need to be taken.

This understanding corresponds to the last of the three scenario requirements as presented in section 1.4.

3.2.2 Scenarios guide exploration of innovations

A number of well known scenario practitioners and authors argue that scenarios may be used to identify possible business opportunities and new strategy alternatives. See for example Fahey and Randall (1997b 1997c), Fahey (1997), Schwartz (1991), Mandel and Wilson (1993) and Wack (1985b).

A couple of quotations from the above mentioned contributions underline the potential for scenarios to guide the exploration of directions for innovation:

> "*Scenarios are thus the most powerful vehicles I know for challenging our "mental models" about the world, and lifting the blinders that limit our creativity and resourcefulness*"
>
> (Schwartz 1991, p. xv)

> "*The scenario process increases the range of what participants see and expands their mental models*"
>
> (Van Der Heijden 1996, p. 51)

> "*Using the newly developed scenarios the team mentally makes new combinations of scenario elements, leading to the invention of new and original strategy*"
>
> (Van Der Heijden 1996, p. 125)

Further, Mason (1994) relates scenario-based exploration of strategies to a learning process. He argues that our experience-based mental models are based on past knowledge and may not be carrying new, critical information, thus leading to possibly wrong strategic decisions. He argues further, in concert with Schwartz (1991), that a key success factor is how fast a company can learn, and that the ability to learn can be enhanced through the use of scenarios in strategic discussions.

Accepting that scenarios may be used to identify possible business opportunities and new strategy alternatives, it follows that scenarios may guide the exploration of

[8] Stanford Research Institute Consulting is a subsidiary of Stanford Research Institute International. Stanford Research Institute International helped pioneer the use of scenarios more than 25 years ago, along and in parallel with Royal Dutch/Shell (Syed 1996, Fergusson 1998).

directions for innovation. This application of scenarios is further supported by a number of scenario projects undertaken by SRI Consulting. In these projects, companies report a wide range of benefits including benefits related to new ways of thinking about and planning for the future, i.e. exploratory studies (Zaman and Wilson 1991, Mandel and Wilson 1993, Mandel 1993, Fergusson 1998).

However, some pitfalls may arise in exploratory exercises. Hamilton (1981) argues that a game-like atmosphere may occur. In order to avoid an atmosphere characterised by lack of true commitment from participants one may:

- Underline that the explorative efforts will provide a basis for a further development and evaluation of identified directions for innovation.
- State that the goal of the scenario process is to implement a set of new services.
- Assure participation of decision-makers in the process (i.e. participants from the top management). The decision-makers will have the authority to approve further development, evaluation and finally implementation of innovations.

Another pitfall may be related to people tending to be conservative and resistant to imagine dramatic shifts in the business environment. Scenarios may, however, be of help in forcing conservative people to think beyond a “most likely” future and expand their mental models of the future.

Finally, a pitfall may be related to problems in concretising the implications of the scenarios (e.g. directions for innovation). The reason for this is that scenario techniques are mainly of a qualitative and intuitive nature, thus resulting in “story-based” scenarios. The strategic consequences of stories may sometimes be hard to concretise and quantify (e.g. “How many vessels, of what capacity and speed should be bought or chartered if this scenario should occur?”). A lack of clear understanding of strategic consequences derived by scenarios, is a potential obstacle for fully realising the benefits from using scenarios. Fagerholt and Kroneberg (2000) integrate scenario and optimisation techniques in order to improve the applicability of scenarios in terms of quantifiable consequences. A copy of this paper is given in Appendix B.

3.2.3 Scenarios guide evaluation of innovations

In the previous section I argued that scenarios might guide the exploration of innovation. By using scenarios a company may identify business opportunities and with that directions for innovation. However, the company may be forced to choose a limited number of opportunities for further development and the possible directions for innovation therefore have to be evaluated. In this section, I show how scenarios may contribute in this respect.

In a scenario-based evaluation of the directions for innovation, the organisational slack of the company must be taken into account. Although a certain innovation may meet the future requirements (e.g. market needs) in a superior way, limitations in organisational slack may prevent a further development and implementation of the innovation. In chapter 1, organisational slack is defined as time, financial and competency resources.

A Company is faced with two possible techniques for evaluating and deciding on which directions for innovation to be further pursued:

1. Identify robust directions for innovation. A robust direction for innovation is defined as a direction that will play out well in all of the scenarios (i.e. a payoff > 0 for all scenarios).
2. Identify optimal directions for innovation. An optimal direction for innovation is defined as the direction that will play out best in a given scenario (i.e. the highest payoff in a given scenario).

A scenario/strategy payoff matrix (Leemhuis 1985) may be used to present the results of a scenario-based evaluation process. The results are accumulated into consistent quantitative or qualitative payoffs for each of the scenarios. An example of such a payoff matrix is given in Table 3-1.

Strategy (Direction for innovation)	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
1	100	20	20	50
2	40	50	90	-30
3	20	50	-50	10

Table 3-1 A scenario/strategy payoff matrix

With a basis in Table 3-1, one may identify both robust and optimal directions for innovation:

- Strategy 1 is a robust direction for innovation as the payoff never goes below zero.
- Optimal directions for innovation are defined as the directions with the best payoff for a given scenario:
  - Scenario 1: Strategy 1.
  - Scenario 2: Strategy 2 and 3.
  - Scenario 3: Strategy 2.
  - Scenario 4: Strategy 1.

The scenario-based evaluation process may be carried out at different levels of detail according to a company's need. A comprehensive evaluation may be obtained by attaching different levels of weight or probability to the scenarios.

However, there are some arguments in favour of not attaching different levels of probability to scenarios. Mandel (1993) argues that comprehensive scenarios are quite improbable, due to the fact that each scenario includes much information and many estimates about future conditions. For all these conditions to happen as described is unlikely. The future that actually occurs will more likely fall within the envelope of uncertainty indicated by a good set of scenarios. The problems with attaching probabilities to scenarios are also underlined by Bonnett and Olson (1994) and Schnaars (1987). As the purpose of scenarios is partly to enrich the understanding of future uncertainties in the business environment, scenarios aim more to examine the interplay and dynamics of forces shaping the future than to identify a most probable scenario. Godet (1987) points to the case of four different scenarios (S) with the following probabilities: S1, probability 0.40; S2 probability 0.25; S3, probability 0.15; S4 probability 0.20. The most probable *scenario* (S1) is in fact the least probable *outcome* – the most probable outcome is that any one of the three other scenarios will emerge.

With a basis in the discussion of problems in assigning probabilities to scenarios, it is generally recommended that companies pursue robust directions for innovations. Alternatively, a monitoring system may be established in order to track emerging scenario(s) and respond quickly by pursuing already identified optimal directions for innovation. Monitoring systems are treated in the next section.

The evaluation of directions for innovation should also include considerations related to some of the findings in chapter 2:

- In section 2.1, I concluded that one could distinguish between the development and the adoption of new products. In this respect it may be useful to think of the total range of innovation processes as extending continuously from those that involve modest to those that involve very great uncertainty (i.e. uncertainty related to technical conditions and customer acceptance of new product or service). At the one end, the adoption of an earlier developed and tested product and at the other end the development of a completely new product.
- In section 2.2, I concluded that innovation is presently viewed as a complex and dynamic interplay between different actors in a business network. Stable relations between actors are a precondition for initiating an innovation process and for ensuring market success. Further, I argued that the institutional framework might constrain certain directions for innovation.
- In section 2.3, I concluded that five aspects of a new product are important for a decision to adopt (relative advantages, compatibility, complexity, trialability and observability).
- In section 2.4, I concluded that four factors are influencing the decision to co-operate (strategic core, relation specific investments, equal or complementary activities and resources and complexity).

The above mentioned findings should be addressed and attached importance to, when assessed as relevant.

3.2.4 Scenarios guide implementation of innovations

With a basis in a scenario-based evaluation of directions for innovation (refer previous section), robust directions for innovation may be identified and analysed further in order to implement new robust transport services.

Optimal directions for innovation, however, may be the right choice only if a certain scenario or combination of scenarios is emerging. A monitoring system may as mentioned contribute in tracking emerging scenario(s).

Scenarios are based on assumptions regarding developments in key drivers of change (clusters of external forces with high impact on the decisions to be taken and with a high uncertainty with respect to their outcome). The key drivers of change point to key indicators for monitoring. By monitoring key indicators, a company may track the migration of business towards a certain scenario or combination of scenarios (Zaman and Wilson 1991). In this way, monitoring of key indicators creates an early warning system and ensures that innovative efforts are consistent with the likely emerging scenario(s). The importance of an early warning system is underlined by Porter (1980), Hamilton (1981), Schwartz (1991) and Fahey and Randall (1997a).

Makridakis and Wheelwright (1989) give a review of some of the different monitoring systems in use. They argue that the critical element in monitoring is the selection of the type of factor (describing the key driver of change) to be monitored. One of the monitoring techniques they look into is based on the concept of quality control charts. The principle of quality control is to discover as soon as possible, when a process or a product has deviated in a non-random manner from its normal value. The desired mean or average is plotted as a horizontal line, and above and below it two parallel lines are drawn. The upper line is called the upper control limit (UCL) and the lower line is called the lower control limit (LCL). The analyst sets the distances of these two limits from the mean by addressing the importance and the characteristics of the factor being measured. I will argue that monitoring of key indicators identified by the scenarios may be carried out in a similar way. The scenarios may identify branching points where one scenario moves towards another. If the key indicators stay within the control limits, a “More of the same” scenario is expected. An illustration of a monitoring chart is given in Figure 3-1.

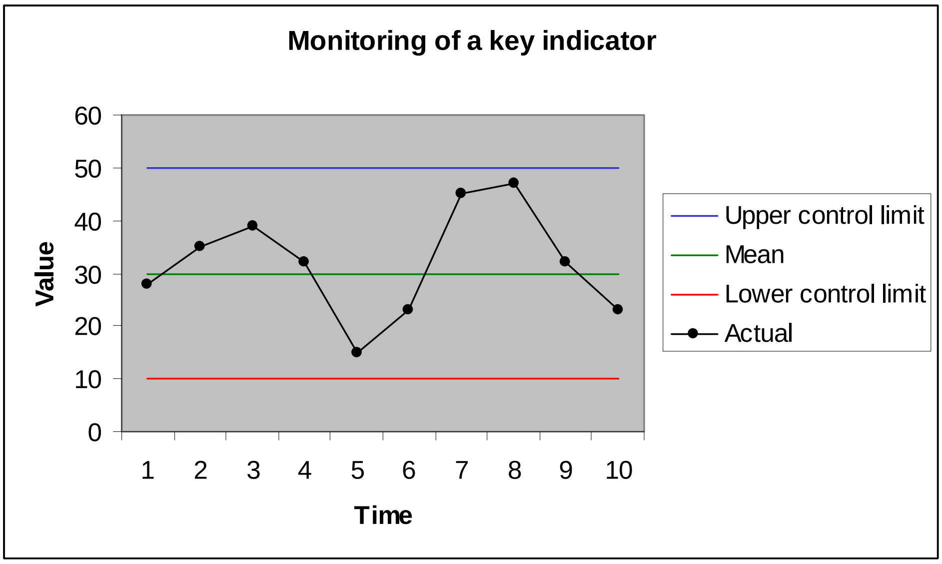


Figure 3-1 Monitoring of a key indicator

Key indicators may be monitored in order to uncover emerging scenario(s). The upper control limit and the lower control limit correspond to the value range for a key indicator in a specific scenario. If these limits are crossed another scenario, or combination of scenarios, may be emerging giving reasons for a shift in direction for innovation.

In Figure 3-1, the monitoring of a quantifiable key indicator is shown. However, some key drivers of change may not so easily be translated into quantifiable key indicators for monitoring. Some key drivers of change may be related to qualitative processes, e.g. a political process leading to a deregulation of the liner conferences (refer Kroneberg 1999a). It is important that different key drivers of change are monitored differently according to their characteristics. Typical sources for information on key indicators may be official statistics, journals, magazines, newspapers, conferences, fairs and a company's relations to other actors in a business network.

Finally, monitoring may provide signals for necessary changes in the scenarios themselves:

- New drivers of change are discovered.
- Some of the drivers are assigned known outcomes (e.g. an irreversible deregulation of the liner conferences may occur).

By guiding necessary revisions of scenarios, monitoring efforts may contribute to a continuos strategic discussion, uncovering business opportunities as they appear.

3.3 Developing scenarios

In this section, a representative technique for developing scenarios is presented, together with potential pitfalls related to the development.

Today, techniques for developing scenarios are mainly of a qualitative nature (refer section 3.1.3) with various degrees of analytical and intuitive inputs. For an introduction to the broad spectrum of various scenario techniques, see for example Van Der Heijden (1996), Fahey and Randall (1997a) and Ringland (1998).

In this section, I will present a technique for developing scenarios as applied by SRI Consulting. During the work on my thesis, I spent six months with SRI Consulting.

I will try to elaborate and complement the presentation of the SRI Consulting technique by including and discussing additional contributions from the scenario field of research. The SRI technique is used as a basis for developing scenarios in each of the three case studies presented in chapter 4.

3.3.1 The SRI technique for developing scenarios

The SRI technique for developing scenarios includes six steps that a multidisciplinary team performs in a series of workshops (refer Figure 3-2).

Ahead of the process, the company assures that organisational slack is present for developing the scenarios (corresponding to the second of the necessary conditions for developing scenarios as stated in chapter 1). Some companies may not have the necessary organisational slack required for developing a comprehensive and thoroughly prepared set of scenarios. It takes time and money to develop scenarios (refer case studies in chapter 4). In addition, a company needs competence and experience in how to develop a set of scenarios, otherwise it may be necessary to hire some external facilitators. In this context, a facilitator is defined as a person responsible for the practical execution of the scenario process. The facilitator will prepare workshops, collect, systemise and analyse critical information and assure continuity and progress in the process of developing and using the scenarios.

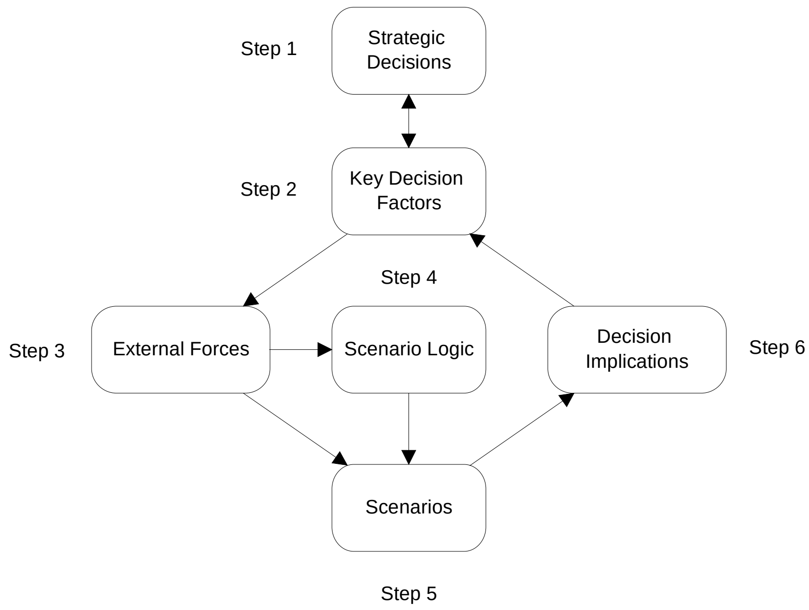


Figure 3-2 The SRI technique for developing scenarios (Mandel and Wilson 1993)

The development of scenarios is initiated by upcoming strategic decisions, which outcomes are subject to possible changes in the business environment. Key decision factors are the matters one needs to know more about in order to make a good decision. The outcome of the key decision factors is determined by how the external forces play out. The scenario logic provides a framework for the scenarios and then the scenarios are described in sufficient detail to be of use in analysing the upcoming strategic decisions.

In the following, each of the six steps are presented and discussed.

Step 1: Identify strategic decisions

In this context, strategic decisions are defined as upcoming strategic decisions, the outcome of which is subject to possible changes in the business environment.

Identifying and describing the strategic decisions the scenarios should answer both focus and constrains the subsequent steps in the process and make the scenarios more relevant for the specific company (Mandel and Wilson 1993). By identifying the strategic decisions, the scope of the process is narrowed. A narrow decision may be “What new services should we offer customer A in a five year perspective” and a broad decision may be “What services should we offer to our new and existing customers in a five year perspective”.

A rule of thumb is that a scenario ought to cover the full time-span relevant to the strategic decisions. Identifying the strategic decisions and the time horizon for the scenarios corresponds to the second of the sufficient conditions for developing scenarios as identified in chapter 1 ("Strategic decisions have to be taken, but not within a limited time period").

If the scenarios aim to serve as a basis for exploration, evaluation and implementation of innovations, the strategic decisions should be identified accordingly to this purpose. Relating the strategic decisions to innovation corresponds to the first of the sufficient conditions for developing scenarios as identified in chapter 1 ("Forced innovation is wanted").

Step 2: Identify key decision factors

Key decision factors are defined as the matters that decision-makers want more information about, in order to make a good strategic decision (as identified in step 1) (Mandel and Wilson 1993, Mandel 1993).

The key decision factors are identified at a rather aggregated level and will serve as a starting point for identifying external forces in the next step. One way of identifying the key decision factors may be to ask each team member to name five major matters s/he would like to know more about before making the decision.

Step 3: Identify external forces

External forces are defined as forces that influence the outcome of the key decision factors, as identified in the previous step. It is often helpful to structure the identification of external forces around micro forces and macro forces (Wilson 1997). Micro forces may be analysed according to Porter's (1980) five competitive forces (competitors, suppliers, customers, substitutes and potential entrants). Macro forces may be analysed by using the SEPT scheme – in which external forces are organised in terms of Social, Economic, Political and Technological forces (Mandel 1993).

Step 4: Establish scenario logic

The scenario logic is defined as the organising principle of the key drivers of change (i.e. in what way will the key drivers of change develop and change the business environment).

In developing scenarios, companies have to analyse how key drivers of change may lead to a future structurally different from the situation today. An example of a key driver of change may as already mentioned be globalisation. Today, companies are increasingly producing for a global market. Global companies require global suppliers of logistics services thus resulting in a number of mergers among carriers.

Analysing the external forces in terms of their relative uncertainty and impact on the key decision factors will contribute in identifying the key drivers of change. The results from such an analysis can be displayed on an impact/uncertainty matrix, as illustrated in Figure 3-3.

		Degree of uncertainty		
		Low	Medium	High
	High			
Level of impact	Medium			
	Low			

Figure 3-3 Impact/uncertainty matrix

The impact/uncertainty matrix highlights some important insights (Zaman and Wilson 1991):

- The sources of difference between the scenarios (i.e. the key drivers of change) – lie in the forces grouped in (or near) the high impact/high uncertainty cell of the matrix.
- The high impact/low uncertainty cell contains important entries: relatively predictable forces that may affect the business, regardless of the scenario.
- As for other entries on this matrix, low impact/low uncertainty forces can, by and large, be set aside. However, planners should monitor events of low impact/high uncertainty to check whether the assessment of high uncertainty might have influenced the planners' judgement about the impact.

A potential pitfall in the development of scenarios is related to difficulties in limiting the number of key drivers of change to be considered. Structuring scenarios around combinations of all high impact/high uncertainty forces may often create an unmanageable number of alternative futures. For n key drivers of change with two levels of occurrence (e.g. high/low, significant/insignificant), 2^n scenarios have to be generated in order to capture all combinations.

In order to reduce the number of key drivers of change to be used, the scenario team may choose to cluster the high impact/uncertainty forces. In order to cluster the forces, two different techniques may be used:

- **Cross-impact analysis:** According to most accounts, cross-impact analysis was first used in developing scenarios at Kaiser Aluminum in 1966. The basic philosophy of the cross-impact analysis is that no development occurs in isolation. Rather, it is rendered more or less likely by the occurrence of some other events or forces. A cross-impact analysis attempts to capture these "cross-impacts" effects from judgmental estimates of experts. The experts provide some estimate of how likely it is that some development will occur given the occurrence of some other development (Schnaars 1987). By identifying cross-impacts, forces may be clustered into a limited number of key drivers of change. The use of cross-impact analyses in the development of scenarios is described by for instance Godet (1983, 1987, 1990) and Millett (1997).
- **Influence diagrams:** Influence diagrams describe developments and dependencies of different forces. An influence diagram attempts to uncover cause/effect relations between the forces. In this way, forces with high dependency are identified and may be clustered into a limited number of key drivers of change.

By clustering the forces, a limited number of independent key drivers of change are established. Each key driver is now assigned extreme, but plausible, levels of occurrence. Then, by combining the different levels of occurrence, possible skeletal scenarios are identified. Using the arguments underlying the logic of each scenario, the scenario team makes simple statements about basic conditions in external forces and key decision factors. These statements partly flesh out the scenarios and help the team to judge their value, and possibly redefine the scenario logic (Mandel 1993). Finally, a set of scenarios is selected based on which scenarios are logical, plausible and most useful in supporting the strategic decisions (Refer arguments in section 1.4 and 3.2.1 regarding a need for scenarios embracing the extreme points of plausible futures relevant for the strategic decisions).

Regarding the number of scenarios, different recommendations are given. Three scenarios may direct focus to a "most likely middle case" only and two scenarios may result in one "good" and one "bad" (Schnaars 1987). Four scenarios seem to avoid such pitfalls (Schwartz 1991). Duncan and Wack (1994) and Mercer (1995) recommend two scenarios, Quinn and Mason (1994) recommend four to five scenarios, while a literature survey conducted by Schnaars (1987) shows that most scenario techniques include two to four scenarios.

In chapter 1, I stated that the minimum number of scenarios to be developed is two and the maximum number is five. There is no need to develop just one scenario, as this would imply that the future is certain. The minimum number of scenarios to be developed is therefore two. There seems to be a tendency towards developing two to five scenarios, and I will argue that a maximum number of scenarios should be set to five. In addition, learning and problem-solving experiments show that the amount of information that can be held in the short-time memory appears to be seven, plus or minus two (Miller 1956).

Step 5: Describe scenarios

In this step, the scenarios are described in sufficient detail to be of help in analysing the scope of strategic decisions as identified in step 1. The scenarios may be described by:

- A story line incorporating developments and interactions in important external forces and key decision factors. It is important that the story lines are characterised by causal relations and internal consistency with respect to the underlying logic (refer step 4),
- A table showing how the key parameters vary across the scenarios,
- Specific events, and
- A creative name or heading[9].

[9] While writing the scenarios, it is important to develop titles that capture the attention of decision-makers. Titles such as "Best case"/"Worst case", "High growth"/"Low growth" tell little about the true character of the business environment and virtually nothing about its dynamics. Royal Dutch/Shell has used titles such as "Sustainable World" and "Global Mercantilism". The terms may mean little without the story line, but once explained and elaborated, they tend to stick in the mind and convey a complex structure of forces, issues and business implications (Wilson 1992).

Regardless of how the scenarios are eventually presented, they should always include clear statements of the underlying logic (refer step 4) and key assumptions (Mandel and Wilson 1993, Mandel 1993).

Step 6: Analyse decision implications

In the final step, the scenario team analyses and interprets the scenarios to identify their implications for the strategic decisions (Mandel and Wilson 1993).

In the next section I will present a set of guidelines for how scenarios may be used in exploring, evaluating and implementing innovations.

3.4 Scenario-based guidelines for innovation

In this section, the scenario-based guidelines for innovation are presented. By following these guidelines, a company may explore, evaluate and implement innovations. The application of the guidelines is subject to the fulfilment of necessary and sufficient conditions, as identified in chapter 1.

The scenario-based guidelines are presented in Figure 3-4. The guidelines are not described in detail at a prescriptive level. The reason for this is that the individual companies should be able to tailor the guidelines according to their needs.

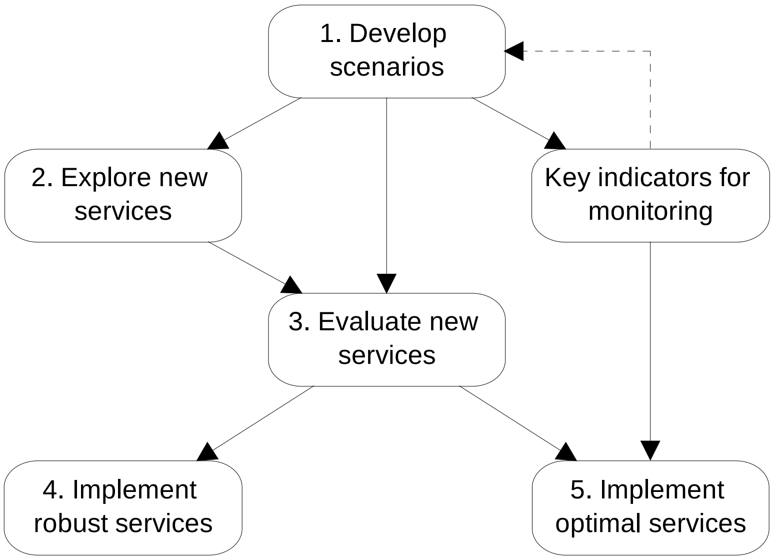


Figure 3-4 Scenario-based guidelines for innovation

The scenario-based guidelines for innovation consist of five major steps. Not all of the steps need to be carried out each time the process is run (e.g. the evaluation of new services may come out negative, resulting in no further implementation efforts). The process is also iterative (e.g. monitoring of key indicators may provide signals for necessary changes in the scenarios and evaluation of new services may trigger additional ideas for new services).

In the following, the content of each step is described.

Step 1: Develop scenarios

In the first step, a set of scenarios is developed aiming to guide the exploration, evaluation and implementation of innovations.

The scenarios may be developed according to the technique described in section 3.3.

With a basis in the scenarios, key indicators for monitoring are identified (refer section 3.2.4). By monitoring key indicators, a company may track the migration of business towards a certain scenario or combination of scenarios. In this way, the monitoring may support the implementation of optimal services (step 5) and provide signals for necessary changes in the scenarios themselves (indicated by dotted line in Figure 3-4).

Step 2: Explore new services

Refer section 3.2.2 for applicability of scenarios to guide explorative studies.

In the second step, the scenarios are used to explore future needs for services and identify directions for innovation. The exploration may be carried out by the team who developed the scenarios, or by teams consisting of both original and new participants. In this way, the basis for creative ideas and suggestions may be extended. The explorative discussions may be carried out in a set of workshops.

A member of the team who developed the scenarios should conduct the workshops in order to give a proper presentation of the scenarios and their logic. The scenarios should be presented in an easy understandable way, e.g. by highlighting the major scenario differences and assumptions.

After a presentation of the scenarios, the exploration teams should imagine themselves living in the scenarios and ask questions such as (Van Der Heijden 1996, Fahey and Randall 1997c):

- What would we want to do if this was how the real world would be developing, what would seem good business opportunities?
- Which new services or innovations does each scenario suggest?
- How are these services different from each other?
- How different are these services to those currently being considered?

For each scenario a set of directions for innovation with a basis in future needs for services is established. During the exploration phase, creative methods (e.g. brainstorming) may be used. In addition, a set of provoking questions or statements for each scenario may be used to trigger creativity.

Potential new services and directions for innovation may be displayed in a scenario/service matrix as shown in Table 3-2. This matrix will be subject to an evaluation in the next step.

Scenario 1 Direction for innovation	**Scenario 2** Direction for innovation	**Scenario 3** Direction for innovation	**Scenario 4** Direction for innovation
Service 1.1	Service 2.1	Service 3.1	Service 4.1
Service 1.2	Service 2.2	Service 3.2	Service 4.2
Service 1.3		Service 3.3	Service 4.3
Service 1.4		Service 3.4	Service 4.4
		Service 3.5	

Table 3-2 Scenario/service matrix

For each scenario, a direction for innovation is identified and further specified by indicating need for relevant/corresponding new services.

Step 3: Evaluate new services

Refer section 3.2.3 for applicability of scenarios in evaluating directions for innovation and need for new services.

In the third step, the scenarios are used to evaluate the new services and potential directions for innovation as identified in the previous step. The evaluation teams should include both members from the team who developed the scenarios (step 1) and members from the teams who explored the scenarios (step 2).

First, the new services are evaluated according to what they require of the organisational slack (resources) of the company. If a service has to be rejected, it should be archived together with documentation stating why it was rejected and how the organisational slack has to increase in order for the service to become viable.

Secondly, new services that may be provided within the organisational slack are evaluated with a basis in the scenarios in order to identify:

1. Robust services/directions for innovation (i.e. services with a payoff > 0 for all scenarios).
2. Optimal services/directions for innovation (i.e. service(s) with the highest payoff in a given scenario).

Step 4: Implement robust services

Refer section 3.2.4 for applicability of scenarios in implementing innovations.

In the fourth step, the company needs to develop and analyse the robust services further in order to implement and introduce them to the market.

Step 5: Implement optimal services

Refer section 3.2.4 for applicability of scenarios in implementing innovations.

In the fifth step, optimal services are implemented provided that a monitoring of key indicators gives reasons to believe that (parts of) the related scenario will be materialised.

3.5 Conclusions of chapter 3

With a basis in section **3.1**, it is concluded that scenarios have evolved from being used as military tools, to develop government policies, and finally to support business strategies. Today, there is a trend towards qualitative descriptions of the future (i.e. scenarios), possibly as a result of the fact that qualitative descriptions of the future are quicker to develop and are usually perceived as more realistic images of the future.

With a basis in section **3.2**, it is concluded that scenarios treat uncertainty regarding how the future might develop by analysing how key drivers of change may lead to a future structurally different from the situation today.

Scenarios may contribute in exploring directions for innovation by expanding our experience-based mental models. Further, scenarios may contribute in evaluating identified directions for innovation by testing them against a range of plausible futures (referred to as a “map of the future”). Finally, scenarios point to key indicators to be monitored. By monitoring these indicators, a company may track the migration of business towards a specific scenario or combination of scenarios. In this way, the scenarios may guide the implementation of innovations.

With a basis in section **3.3**, it is concluded that a set of scenarios needs to be developed prior to the exploration, evaluation and implementation of innovations. A broad spectrum of techniques for developing scenarios exists and a representative technique for developing scenarios as applied by Stanford Research Institute Consulting (SRI Consulting) is presented.

With a basis in section **3.4**, it is concluded that the application of the guidelines is subject to the satisfaction of necessary and sufficient conditions, as identified in chapter 1. The guidelines are not described in detail at a prescriptive level. The reason for this is that the individual companies should be able to tailor the guidelines according to their needs.

The scenario-based guidelines for innovation indicate five major steps as illustrated in Figure 3-4.

4 Practical implications

Chapter 4 reports from how the guidelines developed in chapter 3 have been applied in three different companies:

- MARINTEK.
- Statoil Driftstjenester.
- Wallenius Wilhelmsen Lines.

The methodology used and underlying the empirical work is described and discussed in section 4.1. The three cases are treated in section 4.2 – 4.4. In section 4.4, I discuss general and case-specific problems related to implementation of innovations.

For each case, the scenario process is described according to the following structure:

1. Introduction:
   - Company profile.
   - Conditions leading to interest in scenarios.
   - Goals of scenario process and time horizon for scenarios.
   - Time for accomplishing the scenario process.
   - Organisational slack available for the scenario process.
   - Scenario team.
2. Development of scenarios (step 1 in the scenario-based guidelines for innovation, refer Figure 3-4):
   - The practical execution and results of each step are described.
3. Exploration, evaluation and implementation of innovations (step 2-5 in the scenario-based guidelines for innovation, refer Figure 3-4):
   - The practical execution and results of each step are described.
4. Evaluation of the scenario-based guidelines for innovation:
   - Advantages and disadvantages based on feedback during the execution of the process and interviews with participants shortly after the termination of the process.

In the description of the three cases, the practical execution of each step is emphasised. The actual results of the process, in terms of new services and strategies, are described to the extent possible within the companies' approval. The actual results are to some degree constrained by commercial confidentiality.

For each case, theoretical foundations as outlined in chapter 2 and 3 contributed to the end result. However, I have not made explicit references to relevant parts of chapter 2.

4.1 Methodology for empirical studies

Each of the three case descriptions given in section 4.2 – 4.4 has been read, commented upon and approved by a leading company representative in order to assure correctness of the findings reported in the thesis. The leading company representatives were:

- MARINTEK: Geir Langli, Research Manager, Maintenance Technology
- Statoil Driftstjenester: Arne Solheim, Manager, Business Development
- Wallenius Wilhelmsen Lines: Reidar Nilsen, Manager, Research and Development

Observations of the three cases may be structured in the following way:

1. Development of scenarios
2. Use of scenarios to guide innovations
3. Evaluation of scenario based guidelines for innovation

In the following, the methodology used for each of the empirical parts is described.

1 Development of scenarios

In developing the scenarios the SRI technique, as described in section 3.3.1, has been applied. In the MARINTEK and Statoil Driftstjenester cases, the SRI technique was applied in a strictly prescriptive manner by a core team carrying out all steps. In the Wallenius Wilhelmsen Lines case, some of the steps related to identification of key decision factors and external forces had been performed in previous in-depth studies. Further, the work of the core team were complemented by regional workshops addressing specific regional challenges and more generally – the core team findings.

For each of the three companies the development of scenarios is described with a basis in minutes of meeting (read and commented upon by all team members) and final company approved reports/presentations. In addition, a leading company representative has approved the findings reported in the thesis. By this, the development of scenarios has been described in a proper manner as far as the scenario teams are concerned.

2 Use of scenarios to guide innovations

For using the scenarios to guide exploration, evaluation and implementation of innovations, the scenario-based guidelines for innovation (refer section 3.4) were applied in all cases.

As for the development of scenarios, the use of scenarios to guide innovations is described with a basis in minutes of meeting (read and commented upon by all team members) and final company approved reports/presentations. In addition, a leading company representative has approved the findings reported in the thesis. By this, the use of scenarios has been described in a proper manner as far as the scenario team is concerned.

3 Evaluation of scenario-based guidelines for innovation

This is an important part of my work as the evaluation of the scenario-based guidelines for innovation is the basis of the recommendations with respect to the applicability of the guidelines.

For each case, the evaluation has been structured in the following way:

1. Evaluation of the guidelines (refer Figure 3-4).
2. Evaluation of the practical execution of the process.
3. Evaluation of how the goals of the scenario process were satisfied.
4. Necessary adjustments of guidelines.

The evaluation is based on feedback received from participants during the execution of the process. In each workshop, I made notes with respect to comments related to the four points mentioned above. Most of the workshops were concluded by discussions around the table with emphasis on participants' impressions of the day ranging from scenario specific details to more general observations addressing for instance the practical execution of the process.

In the MARINTEK and Statoil Driftstjenester cases, each of the participants were interviewed shortly after the termination of the process. In the MARINTEK case personal interviews were carried out while the Statoil Driftstjenester interviews were carried out by written correspondence. For the two cases I used an interview guide directing attention towards the four points mentioned above. In addition, the interviews were specifically tailored with respect to the company in question. One of the questions relating to satisfaction of scenario process goals in the Statoil Driftstjenester case was:

“Have you increased your understanding of the external forces shaping the future business environment?”

For this question, answers could be given according to a scale ranging from “To a large degree” to “No change at all”. In addition, the participants could comment upon each question beyond merely setting an X for the perceived score.

For the Wallenius Wilhelmsen case, the evaluation is based on notes taken during the execution of the process and discussions at the end of the workshops.

It is my experience that evaluations based on formal interview procedures are difficult to account for due to subjective elements. Different people may attach different scores to conditions that they actually have the same perception of. In addition, the number of participants in the MARINTEK and Statoil Driftstjenester cases was limited thus preventing reliable statistics. I experienced that comments received during the workshops and from “round the table discussions” summing up the workshops were more to the point and more extensive than comments received through the interviews. The interviews tended to be short and to some degree disconnected from the actual process as they were held after the termination of the process.

4.2 MARINTEK

In this section, the scenario process run by MARINTEK is described.

4.2.1 Introduction

Company profile:

MARINTEK is a research company within the SINTEF Group. MARINTEK delivers marine technology research and development (R&D) services within shipping, shipbuilding and offshore. 234 employees contributed to a 210 million NOK turnover in 1998. MARINTEK is based in Trondheim, Norway.

Conditions leading to interest in scenarios:

MARINTEK's interest in scenarios was largely triggered by two conditions.

In the period 1997-1998, MARINTEK and SRI Consulting produced a report that gives a scenario-based analysis of innovation in the container industry (Trondsen 1998). Results from this project were presented on the international RINA conference on Design and Operation of Containerships (Kroneberg 1999a). A copy of the RINA paper (Kroneberg 1999a) is, as already mentioned, given in Appendix A.

Another line may be drawn back to an earlier MARINTEK project concerning international business opportunities for Norwegian suppliers of technology for floating production of oil. The project was finished in November 1997. A number of interesting results emerged from the project, but the project participants were not sure how to follow up on the results.

With a basis in these two conditions, one of the MARINTEK managers suggested a scenario process. The scenario process could contribute to a continuance of the floating production project. In addition; the scenario process would allow MARINTEK to test out the scenario methodology on an internal case before offering scenario services to industry.

Goals of scenario process and time horizon for scenarios:

The time horizon for the scenarios was set to ten years, and the goals were:

1. Identify and evaluate MARINTEK's future marine technology research and development services within offshore, in a ten-year perspective.

2. Learn about forces and mechanisms influencing the development of the offshore sector and the need for new research and development services.

Time for accomplishing the scenario process:

The scenario process was performed in three months: 01.09.98 – 01.12.98. In this period, three workshops were held (09.09.98, 01.10.98 and 10.11.98).

<u>Organisational slack available for the scenario process:</u>

The available financial and time resources for the project were limited. Two facilitators spent about 250 hours in preparing the workshops and collecting and analysing relevant information. A facilitator is defined as a person responsible for the practical execution of the scenario process. The facilitator will prepare workshops, collect/systemise and analyse critical information and assure continuity and progress in the process. Direct costs (travel expenses, books, lunches) added up to a total of 8.000 NOK. It was difficult to identify relevant persons with sufficient time to participate in all of the workshops. Four persons did however participate in all of them.

<u>Scenario team:</u>

<u>Facilitators:</u>
André Kroneberg, Research Fellow, Norwegian University of Science and Technology
Torbjørn Landmark, Research Engineer, Logistics, MARINTEK

<u>Participants:</u>
Peter C. Sandvik, Senior Research Engineer, Offshore Structures, MARINTEK
Harald Ellingsen, Senior Research Engineer, Ship Performance, MARINTEK
Geir Langli, Research Manager, Maintenance Technology, MARINTEK
Trond Andersen, Research Engineer, Maintenance Technology, MARINTEK

In addition to the participants listed, three other MARINTEK managers attended one or more of the workshops.

4.2.2 Development of scenarios (step 1)

In order to develop the scenarios, the scenario team applied the 6-step SRI technique as described in section 3.3.1 and illustrated in Figure 3-2.

<u>Step 1: Identify strategic decisions:</u>

This step was undertaken in the first of the workshops held 09.09.98. In a brainstorming session all participants gave their views on the subject. Through an open discussion all participants agreed to a short one-line decision focus, capturing the goals of the process:

“Offshore services provided by MARINTEK in a ten-year perspective”

Step 2: Identify key decision factors:

The first attempt to identify the key decision factors was carried out at the first workshop (09.09.98). An additional refinement of the factors was undertaken in the second workshop (01.10.98). During the workshops, the facilitators wrote down suggestions from a brainstorming session on post-it notes and displayed them at a blackboard visible to all participants. Analysing and discussing all identified factors resulted in four clusters of key decision factors:

1. Energy development (Developments in oil price and alternative energy sources).
2. Political conditions (Public R&D spending, environmental and safety politics, role of European Union).
3. Market actors (Competitors, potential alliance partners).
4. Technology leaps (Radical innovations in offshore technology).

These key factors were all believed to heavily influence the strategic decision focus agreed upon in step 1.

Step 3: Identify external forces:

External forces were identified at the first workshop. By asking the question: “What external forces may influence the key factors?” and by using a framework based on Porter’s (1980) five competitive forces and the SEPT scheme – in which external forces are organised in terms of Social, Economic, Political and Technological forces, 53 external forces were identified. The facilitators wrote down suggestions from a brainstorming session on post-it notes and displayed them at a blackboard visible to all participants. The layout of the blackboard and a few examples of the external forces are given in the figure below.

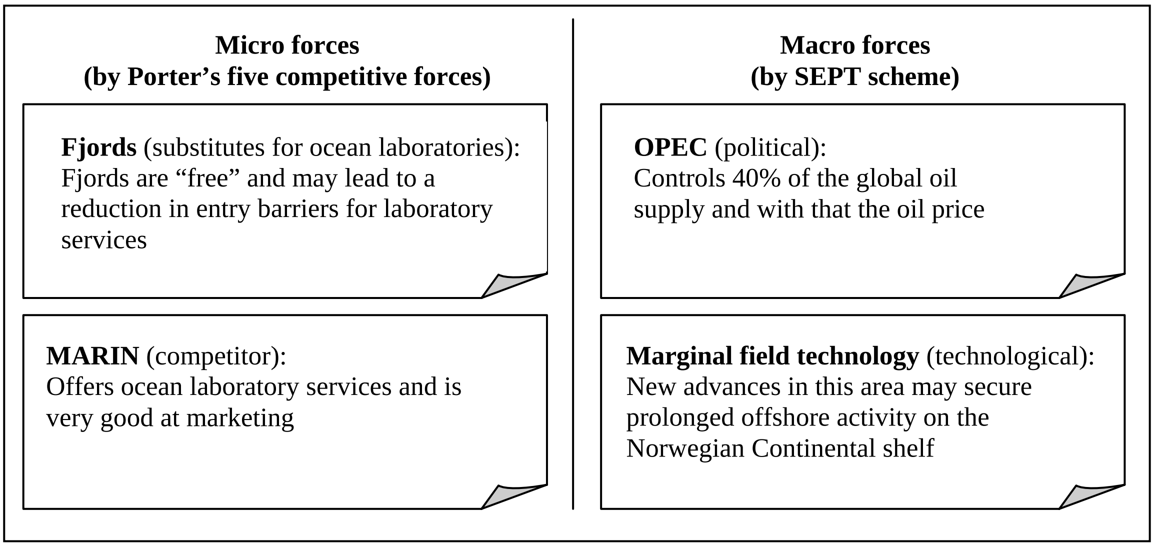


Figure 4-1 Blackboard set up for the identification of external forces

External forces were identified in a brainstorming session where the facilitators wrote down ideas on post-it notes and displayed them on a blackboard visible to all participants. In the figure, four examples of external forces are shown.

Step 4: Establish scenario logic:

The scenario logic was established in the second workshop (01.10.98). Ahead of the workshop, the facilitators wrote down all external forces on post-it notes. Each post-it note corresponded to one external force. All post-it notes were placed in an impact/uncertainty matrix (refer Figure 4-2).

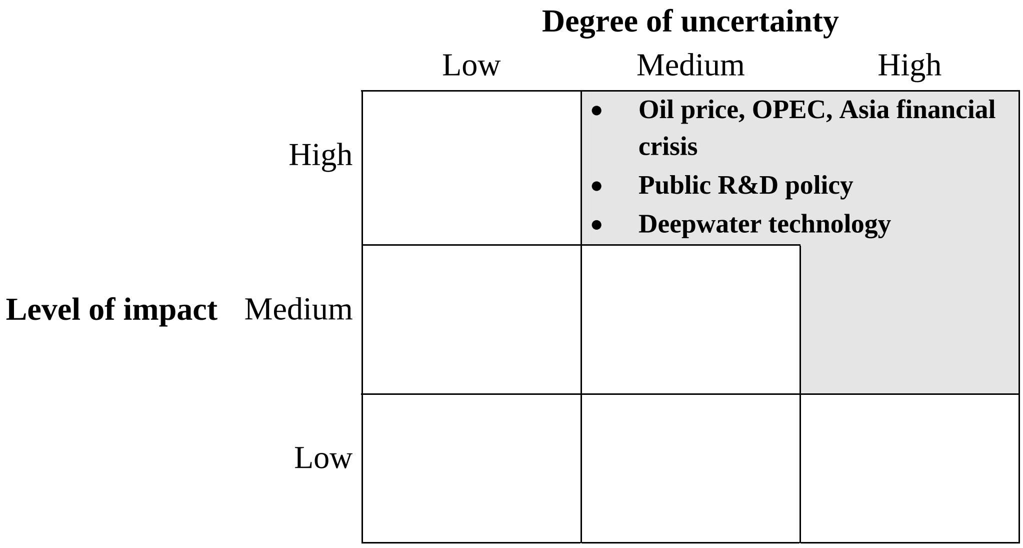


Figure 4-2 Example of external forces displayed on an impact/uncertainty matrix

External forces (on post-it notes) were displayed on a blackboard visible to all participants. The key forces confronting the strategic decision focus, and the sources of difference among the scenarios, lie in the forces grouped in (or near) the high impact/high uncertainty area. In the figure, a few examples of key forces are shown.

An example of a force with high impact on the decision focus and key factors was the oil price. In addition, the oil price is very uncertain and is influenced by a number of other forces (e.g. actions taken by OPEC regarding reductions in oil production and financial crisis in industrialised regions of the world, such as Asia). Forces believed to have high uncertainty and high impact on the decision focus were clustered into four groups by analysing how the forces influenced each other.

With a basis in the four clusters, two key drivers of change were identified, aiming to stretch the room of uncertainty to its plausible limits:

1. The oil price: A major driver with high impact on the extent and type of services requested from MARINTEK in the future.
2. Government intervention: A driver with high impact on R&D activities in the industry and in the Research institutions.

In the selection of the two key drivers of change, one tried to identify drivers with a high level of independence, in order to achieve structurally different scenarios. Each of the drivers was assigned two extreme, but plausible, levels of occurrence. In this way, the extreme points of plausible futures were embraced. Based on the two key drivers of change a scenario logic was established as shown in Figure 4-3.

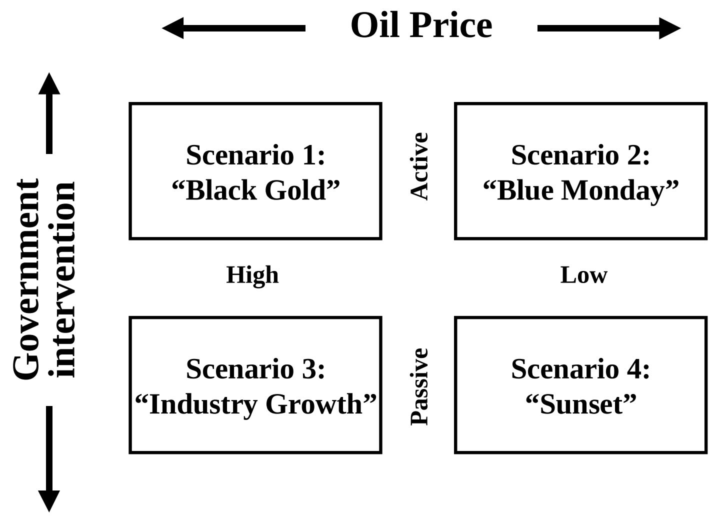


Figure 4-3 Scenario logic – MARINTEK

The first scenario is characterised by a high oil price and active Government intervention. The second scenario is characterised by a low oil price, but active Government intervention. The third scenario includes a high oil price, but passive Government intervention. The fourth and last scenario includes both a low oil price and passive Government intervention.

Step 5: Describe scenarios:

The facilitators undertook this step between the second (01.10.98) and the third (10.11.98) of the workshops. Each of the scenarios was fleshed out by:

- A story line incorporating developments and interactions in important external forces. A lot of effort was put into developing causal relations and internal consistency.
- Specific events (e.g. election day in 2001 leading to a conservative Government).
- A creative name or heading.
- A table showing how the key parameters varied across the scenarios.
- Fictive front pages of Dagens Næringsliv (the major industrial paper in Norway).

During the process of describing the final scenarios, the participants frequently assessed drafts of the scenarios. In Figure 4-4, a short summary of the scenarios is given.

Scenario 1 “Black Gold” **(High Oil price, Active Government intervention)**	**Scenario 2 “Blue Monday”** **(Low Oil price, Active Government intervention)**
Reductions in the OPEC exports result in an oil price of 25 $/barrel. The Norwegian Government launches an active offshore policy and allows exploration and development in new areas of the Norwegian Continental Shelf. Major advances in deepwater technology occur and the demand for verification services is increasing. Marin, a major competitor, expand their services by building laboratory facilities both in Norway (Stavanger) and the USA (Houston). In the USA, major research projects regarding renewable energies are intensified. New environmental taxes are constantly introduced and cleaning technology becomes one of the top priorities in the Norwegian Research Council. The public R&D spending in the offshore sector increases, and support is also given to promote an offshore cluster in Stavanger, including a strengthening of the offshore education in that region.	A lack of powerful, governing incentives leads to a significant “illegal” export of OPEC oil. In addition, Iran and Iraq are allowed to export more oil, as they gradually become more Western oriented. The oil price resides in a low level around 8-12 $/barrel. The Norwegian Research Council is strengthened and focus is on increasing the efficiency of offshore activities (including automation of some processes) and on improving the utilisation of existing fields. Some of the less profitable production vessels and drilling rigs are laid up. The development of smaller fields stops due to lack of profitability. Norwegian yards are faced with nearly no new building activity. Some of the yards try to enter new markets by offering services related to operation and maintenance of installations in existing fields. Environmental issues are on the agenda, and CO_2 quotas are traded between nations.
Scenario 3 “Industry Growth” **(High Oil price, Passive Government intervention)**	**Scenario 4 “Sunset”** **(Low Oil price, Passive Government intervention)**
A boost in the Asian economy leads to increased consumption of oil, and the oil price reaches a level of 20 $/barrel. The election day in 2001 leads to a conservative Government. Subsidies for Norwegian yards are reduced. The demand for supply ships is decreasing and Fosen Mekaniske Verksted, Umoe Haugesund and Ulstein Verft (Norwegian yards) are all shut down. Norwegian yards experience a 70% reduction in number of employees. Shipping companies, on the other hand, are experiencing good times as the refund system is strengthened and the taxes are lowered. Environmental technology is on the agenda of the Research Council of Norway. Statoil is privatised and undergoes an extensive internationalisation process, in order to survive as most of the Norwegian oil production ends around 2010. SHELL buys a major share in Statoil. DNV starts to offer laboratory tests as part of their service.	Internal disagreements in OPEC and a prolonged Asian crisis contribute to a low oil price in the area of 10-13 $/barell. The gas price follows the oil price, and there is no interest in a further development of gas fields. The demand for supply ships is decreasing and some of the Norwegian yards take over the operation and maintenance of some of the existing fields and become third party providers. The operators who are experimenting with outsourcing a number of earlier in-house functions support this development. New international regulations concerning the environment are introduced. Statoil undertakes a centralisation of its activities to Stavanger (including their Trondheim based R&D division). The Government is not interested in maintaining a regional policy, and parts of a highly competent work force in Trondheim choose to move to Oslo.

Figure 4-4 Summary of scenarios – MARINTEK

Key indicators for monitoring were not formally identified in this process. However, some of the participants stated that they were paying greater attention to the news, with respect to forces and mechanisms influencing the offshore services provided by MARINTEK, than prior to the scenario process.

4.2.3 Exploration, evaluation and implementation of innovations (step 2-5)

In this section, the practical execution and results of step 2-5 in the scenario-based guidelines for innovation are described.

Step 2: Explore new services:

This step was undertaken in the third and final workshop (10.11.98).

For each scenario, main directions/needs for innovation were identified. Then, a brainstorming session was held. Approximately 8-10 ideas for new services were identified for each scenario. Below, a few examples are given:

- Offer deepwater verification services related to emerging deepwater concepts (e.g. ROV[10]-support) by investing in a new deepwater laboratory (scenario 1 – high oil price and increased focus on deepwater technology).
- Offer traditional offshore services to the shore-based oil industry in the Middle East (scenario 2 – low oil price, reduced activities on the Norwegian Continental Shelf, increased activity in the Middle East due to low production costs).
- Establish MARINTEK as an R&D co-ordinator for oil companies' R&D investments (scenario 3 – passive Government intervention).
- Offer consultancy services instead of R&D services (scenario 4 – passive Government intervention).

[10] ROV: Remote Operated Vehicle.

<u>Step 3: Evaluate new services:</u>

After the identification of directions for innovation and need for new services, each service was evaluated in the following order:

1. **How well does the service meet the external requirements (e.g. a low oil price, no public R&D funding) of the scenario it was triggered from?** All services triggered from a given scenario would probably meet the requirements fairly well. However, in order to differentiate the services, they were assigned either a + or a ++ in an evaluation scheme.
2. **How well does the service meet the internal requirements as given by MARINTEK?** Internal requirements were identified as:
   - <u>Organisational slack:</u> Will the development of the new service require capital investments beyond available financial resources? How much time and what kind of competency are required in order to develop the new service, and are time and competency available?
   - <u>Strategic core:</u> Will the new service imply a movement away from the strategic core (e.g. offering R&D activities to land-based industry may be a movement away from the core which is related to R&D activities in the maritime sector)?

   Each service was assigned a + or a – indicating respectively a good or bad service according to the internal requirements of MARINTEK.
3. **How well does the service meet the external requirements of the other scenarios?** This step was undertaken in order to identify possible robust services able to meet, for example, both a high and low oil price.

After the third workshop some of the participants contributed in a further evaluation of the services. In the middle of this process, the scenarios were presented for the Norwegian Ministry of Petroleum and Energy. This presentation ought to have been undertaken before new services were identified, as the Norwegian Ministry of Petroleum and Energy had some comments regarding the structure and content of the scenarios. However, the presentation was useful and contributed in a further evaluation of the identified services.

As a result of the evaluation process, two new services were further developed and detailed for possible implementation.

The first service was named “The 6 dollar concept”. This service would be able to face a continued low oil price (scenario 2 and 4). The service may also be relevant for higher oil prices and it was therefore robust with respect to the oil price.

The second service was named “Green package”. Environmental considerations are important for all scenarios (a predetermined force with high impact, but low uncertainty), and the service is thus robust.

Both services were developed by describing:

- Their technical/professional content.
- Their business profile (the balance between research and consultancy work).
- Their internal requirements (organisational slack and closeness to strategic core).
- Their potentials for further development and extension (e.g. possible synergies with other, related services).

Step 4/5: Implement robust/optimal services:

Two new services were developed and described in detail, but no major effort has been put into the implementation of these.

A discussion of challenges related to implementation of new services is given in section 4.5.

4.2.4 Evaluation of the scenario-based guidelines for innovation

In this section, the scenario process run by MARINTEK is evaluated with a basis in feedback received during the execution of the process and interviews with participants shortly after the termination of the process.

The evaluation has been structured in the following way:

1. Evaluation of the guidelines (refer Figure 3-4).
2. Evaluation of the practical execution of the steps.
3. Evaluation of how the goals of the scenario process were satisfied.
4. Necessary adjustments of guidelines

Evaluation of the guidelines:

- Put a larger emphasis on the implementation of new services (step 4 and 5). During the whole process one should keep in mind that this is not a game, but actually an effort in developing a set of new services which should possibly be implemented.
- Some of the participants missed an initial step aiming to develop a common platform and understanding of the company and its current strategies and goals. Such a step would contribute in bringing all participants to the same level before the process started.
- All participants would consider making use of scenarios in later strategic discussions. It was underlined that this method, compared to other strategy methods, forced the participants to look beyond their traditional perception of the business environment.
- The participants felt that, especially in an early phase, scenarios were of help in evaluating new services.
- Regarding the final scenarios, participants were satisfied with the way the scenarios were presented. One of the participants underlined the fictive newspaper headlines as very successful. Another of the participants argued that the table showing how the key parameters varied across the scenarios should possibly be excluded in favour of a scenario comparison based on the extreme differences between the scenarios. This could trigger more creative discussions.

Evaluation of the practical execution of the process:

- More time resources should have been reserved for step 4 and 5 (refer the above evaluation of guidelines).
- Three of the participants felt that the time between the workshops should be reduced to two weeks. One of the participants suggested that workshops should be undertaken once a week. Shorter time between the workshops would keep the process fresh and less effort would be needed in preparing for the workshop. One of the participants argued that time between workshops could increase for workshops held later in the process.
- Each workshop should last for at least half a day. Two of the participants suggested one day.
- All participants felt that a scenario process should include at least three to four workshops.
- The importance of continuity was underlined. The same persons should participate in all workshops.

- Refreshments should be served during each workshop in order to revitalise discussions.

Evaluation of how the goals of the scenario process were satisfied:

- Three of the participants felt that they had increased their knowledge and understanding of forces and mechanisms influencing the development of the offshore sector and the need for research and development services provided by MARINTEK. The last participant said that he could have increased his understanding if more effort had been put into systemising key factors and external forces identified in the first and second workshop.
- Two of the participants felt that the scenarios stimulated creativity in the exploration of new services. Two of the participants stated that many of the identified services were rather obvious beforehand, but that the scenarios contributed to a better documentation and reasoning for why to implement them.
- The identified services were not developed further for implementation, possibly as a result of lack of ownership (refer necessary adjustments of guidelines below).

Necessary adjustments of guidelines:

- A clarification of the ownership of the process should be undertaken early in the process. One (or more) of the participants should be assigned the responsibility of developing the identified services further and eventually implement the services in the company. The clarification of ownership should be undertaken ahead of step 1.
- An initial step aiming to develop a common platform and understanding of the company and its current strategies and goals should be added. Such a step would contribute in bringing all participants to the same level before the actual scenario process starts.

4.3 Statoil Driftstjenester

In this section, the scenario process run by Statoil Driftstjenester is described.

4.3.1 Introduction

Company profile:

Statoil Driftstjenester is a support unit for Statoil (a major Norwegian Oil Company). Statoil Driftstjenester is responsible for:

- Operation of terminals ashore (terminal services, material administration, customs clearance and administration of spare part stock).
- Personnel transport by helicopter.
- Sea transportation (standby vessels, anchor handling vessels, vessels for ROV-support and supply vessels).
- Purchasing (acquisitions for operating platforms).
- Emergency preparedness and traffic supervision.
- Catering service for most of Statoil's offshore installations.

Statoil Driftstjenester employs about 650 persons (including 450 persons for the catering service) and is responsible for a budget of approximately 3 billion NOK (1997). Statoil Driftstjenester is based in Bergen, Norway.

Conditions leading to interest in scenarios:

Statoil Driftstjenester's interest in scenarios emerged from a large R&D project with participants from MARINTEK, Statoil Driftstjenester and Statoil F&U (Research & Development unit). The project was aiming at analysing problems and challenges in order to identify potentials for improvements.

Statoil Driftstjenester was facing an increasingly turbulent environment with uncertainties, for instance, related to corporate strategies for outsourcing non-core activities and the development of the oil price and potential new competitors. In order to survive and prosper in the future, Statoil Driftstjenester wanted to become "The best of the best" in delivering services for offshore installations.

During one of the project meetings, I gave a presentation of the scenario methodology and its advantages to a couple of managers from Statoil Driftstjenester. They found the presentation interesting, and a couple of months later, a scenario project for Statoil Driftstjenester was initiated as part of the larger R&D project. By using scenarios, a structured analysis of uncertainties could be undertaken, together with an exploration of the need for future services.

Goals of scenario process and time horizon for scenarios:

The major goal for the project was to develop scenarios that could:

- Enhance the regular strategy process run by Statoil Driftstjenester.
- Contribute to adjust the R&D project run by Statoil Driftstjenester, Statoil F&U and MARINTEK.

In addition, the project stated some process goals:

- Develop a common mental framework for strategic discussions related to the future.
- Contribute to an overall understanding of the interaction between the external forces that shape the future business environment.
- Challenge "established truths" and question developments easily taken for granted.

The time horizon for the scenarios was set to five years.

Time for accomplishing the scenario process:

The scenario process was performed in a time of approximately four months. In this period, one kick-off meeting and four workshops were held (26.01.99, 22.02.99, 10.03.99, 19.03.99 and 29.04.99).

Organisational slack available for the scenario process:

The available financial and time resources for the project were considerably better than for the MARINTEK project. Two facilitators spent about 450 hours in preparing the workshops and collecting and analysing relevant information. Direct costs (travel expenses, books, conference fees and expenses related to guest speakers) added up to a total of approximately 70.000 NOK. Five persons participated in all of the workshops. In addition, three guest speakers participated in some of the workshops. The guest speakers' role was to contribute with a fresh perspective and bring new thoughts and ideas into the discussions.

Scenario team:

Facilitators:
André Kroneberg, Research Fellow, Norwegian University of Science and Technology
Torbjørn Landmark, Research Engineer, Logistics, MARINTEK

Participants:
Arne Solheim, Manager, Business Development, Statoil Driftstjenester
Svein Sævild, Manager, Sea Transportation, Statoil Driftstjenester
Audun Gunnarsen, Manager, Terminals, Statoil Driftstjenester
Bjørn Tyssøy, Business Development, Statoil Driftstjenester
Johnny Litzheim, Project Manager, Statoil Forskning og Utvikling

Guest speakers:
Bjørn E. Asbjørnslett, Research Fellow, Norwegian University of Science and Technology (workshop 1)
Jan Tore Pedersen, Independent Consultant (workshop 2)
Per Anton Kleppa, Manager, North Sea Container Line (workshop 2)

4.3.2 Development of scenarios (step 1)

In order to develop the scenarios, the scenario team applied the 6-step SRI technique as described in section 3.3.1 and illustrated in Figure 3-2.

Ahead of each workshop, the facilitators scanned and reviewed a set of relevant journals and papers in order to provide the participants with some stimulating articles to be read prior to the workshop. In addition, the facilitators conducted conversations with internal customers in Statoil, external suppliers and competitors and the Norwegian Ministry of Petroleum and Energy. All these actors had different views on how the industry would develop over the next five years, and their inputs were used as a basis for discussions in the workshops. A major oil and gas conference was also attended in order to increase the understanding of the offshore industry.

Initial Step: Develop common platform:

In the MARINTEK case, some of the participants missed an initial step aiming at developing a common platform and understanding of the company and its current strategies and goals. In this case, such a step was undertaken in order to bring all participants to the same level before the actual scenario process started. The facilitators collected information about present internal and external challenges, goals and strategies ahead of the first workshop. This information provided the basis for initial discussions in the first workshop.

Step 1: Identify strategic decisions:

This step was undertaken in the first workshop held 22.02.99. Each participant was given five minutes to write down a couple of suggestions for relevant strategic decisions. Subsequently, each participant presented his suggestions in plenary. In this way, the contribution of all participants was assured.

After a discussion, the decision focus was agreed:

"The role of Statoil Driftstjenester in integrated supply chains: Robust strategies with a focus on control of the chains"

Step 2: Identify key decision factors:

This step was undertaken in the first workshop held 22.02.99. After agreeing on the strategic decision focus, the participants identified a set of key factors. As for the previous step, each participant was given five minutes to write down a couple of suggestions for key factors. Subsequently, each participant presented his suggestions in plenary and post-it stickers were attached to a blackboard visible to all participants. By clustering key factors with high dependencies, five clusters were obtained:

- Political actions (e.g. changes in regulations for licenses, taxes and ownership).
- Market development (e.g. cost/service requirements and competitors).
- Corporate actions (e.g. degree of internationalisation and outsourcing).
- Technology development (e.g. floating production and sub-sea processing).
- Energy development (e.g. oil price and alternative energy sources).

Ahead of the second workshop, the facilitators analysed the key decision factors and developed an influence diagram showing the dependencies between the key decision factors. This diagram was used in order to understand how the key decision factors may interact and as a map for the following steps.

Step 3: Identify external forces:

The second workshop was entirely devoted to an identification of external forces influencing the level of occurrence of the key factors. Approximately 100 external forces were identified by using a framework based on Porter's (1980) five competitive forces and the SEPT scheme – in which external forces are organised in terms of Social, Economic, Political and Technological forces. All forces were written on post-it stickers and displayed at a blackboard (refer Figure 4-5 for examples of external forces).

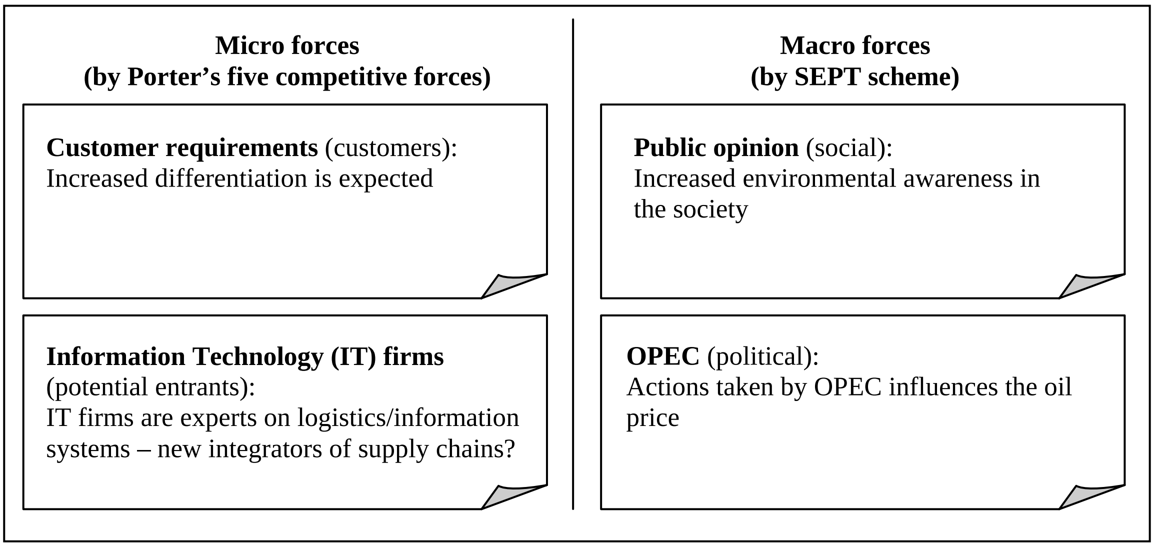


Figure 4-5 Identification of external forces

Step 4 establish scenario logic:

The scenario logic was established in the third workshop (19.03.99). Ahead of the workshop, the facilitators wrote down all external forces on post-it stickers. Each post-it sticker corresponded to one external force. All post-it notes were placed in an impact/uncertainty matrix (refer Figure 4-6).

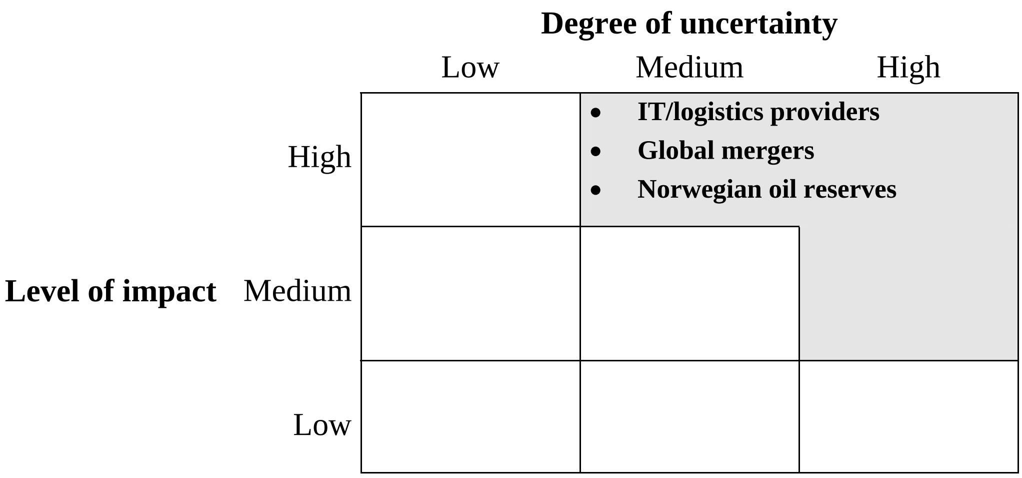


Figure 4-6 Example of external forces displayed on an impact/uncertainty matrix

External forces (on post-it notes) were displayed on a blackboard visible to all participants. The key forces confronting the strategic decision focus, and the sources of difference among the scenarios, lie in the forces grouped in (or near) the high impact/high uncertainty area. In the figure, a few examples of key forces are shown.

Forces believed to have high uncertainty and high impact on the decision focus were clustered into six groups by analysing how the forces influenced each other.

With a basis in the six clusters, two key drivers of change were identified, aiming to stretch the room of uncertainty to its plausible limits:

1. <u>Intensity in exploration and development in the North Sea:</u> At what level will exploration activities take place? What kind of developments will take place (e.g. sub-sea, floating production, deep water and close to/far from existing infrastructure)?
2. <u>Globalisation of offshore logistics:</u> Will global supply chain integrators enter the offshore industry? Who are the competitors of tomorrow? What kind of role will Information Technology play?

Each of the drivers was assigned two extreme, but plausible, levels of occurrence. In this way, the extreme points of plausible futures were embraced. Based on the two key drivers a scenario logic was established as shown in Figure 4-7.

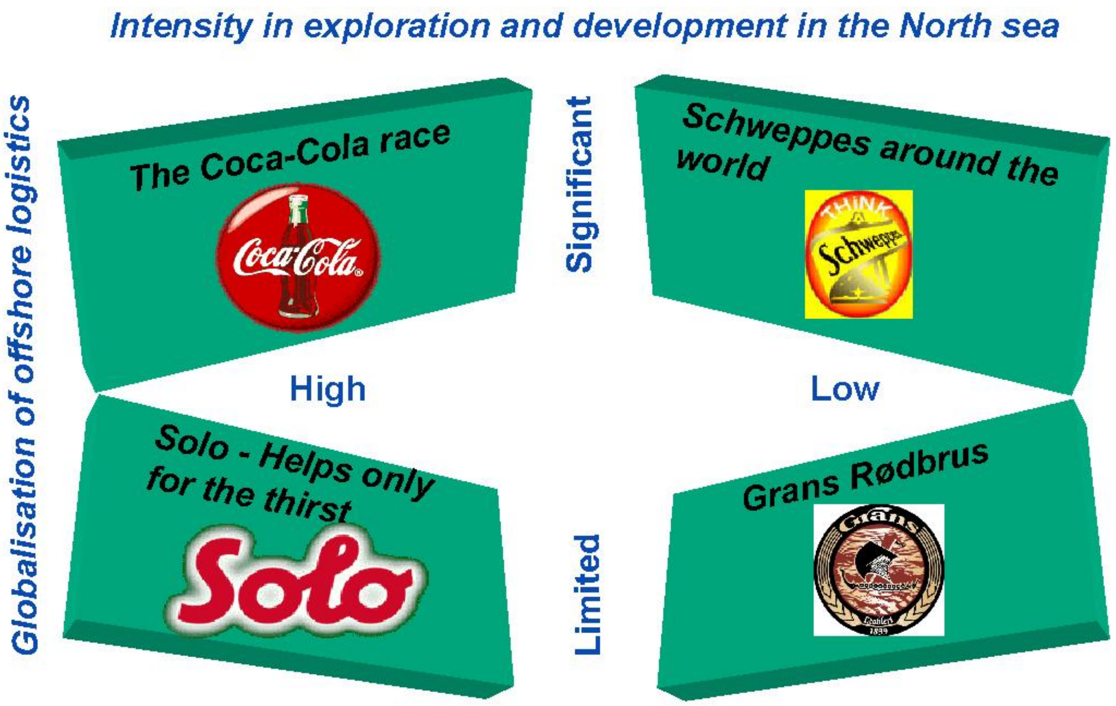


Figure 4-7 Scenario logic – Statoil Driftstjenester

<u>Step 5: Describe scenarios:</u>

The facilitators undertook this step between the third (19.03.99) and the fourth (29.04.99) of the workshops.

The scenarios were given names based on a “soft drink” theme. Coca-Cola is a global brand (significant globalisation) and has high sales (high intensity). Schweppes is also a global brand (significant globalisation), but has lower sales (low intensity). Solo is a Norwegian brand only (limited globalisation), but has high national sales (high intensity). Grans Rødbrus is a Norwegian brand only (limited globalisation) and has very limited sales (low intensity). The scenario names were easy to remember and at the same time they captured the essence of each scenario.

Each scenario was fleshed out by a story line incorporating specific events, developments and interactions in important external forces. In Figure 4-8, a short summary of the scenarios is given.

Scenario 1 "The Coca-Cola race" (High Intensity, Significant Globalisation")	Scenario 2 "Schweppes around the world" (Low Intensity, Significant Globalisation")
• Oil price of 20 $/barrel • Scattered and dynamic activity on the Norwegian Continental Shelf • Floating production in focus • Standardised IT systems • Global logistics suppliers offer total solutions for the offshore industry • Deregulation of the Norwegian Continental Shelf • Privatisation of Statoil	• The oil price fluctuates around 6-7 $/barrel • Focus on sub-sea developments connected to existing infrastructure • Global suppliers of logistics services enter the North Sea market • Statoil undergoes an internationalisation process in order to survive • Deregulation of the Norwegian Continental Shelf • Privatisation of Statoil
Scenario 3 "Solo" **(High Intensity, Limited Globalisation")**	**Scenario 4 "Grans Rødbrus"** **(Low Intensity, Limited Globalisation")**
• The oil price reaches 18-19 $/barrel • Deep water technology in focus • Traditional suppliers of offshore logistics • The North Sea is perceived as one market (including both the Norwegian and British areas) • Statoil operates regionally • Privatisation of Statoil	• Oil price down to 6 $/barrel • Stagnation of exploration and development activities in the North Sea • Operation on existing installations • Increased exploitation and sub-sea solutions • Traditional suppliers of offshore logistics • Non-standardised IT systems • Privatisation of Statoil

Figure 4-8 Summary of scenarios - Statoil Driftstjenester

In addition to the story lines, the scenarios were also visualised by block diagrams showing the construction of the scenarios (refer Figure 4-9).

In the block diagrams, a deregulation of the Norwegian Continental shelf and a privatisation of Statoil are expected in all scenarios. Further, the development in each of the key drivers of change is described in a "cause – effect" way, following the arrow. The resulting effects for "The Coca-Cola Race" scenario (refer Figure 4-9) are the emergence of a new type of competitors with high skills in IT and logistics and clients with increasingly differentiated logistics needs.

One block diagram was developed for each of the scenarios and they were of particular help in discussing new services (step 7).

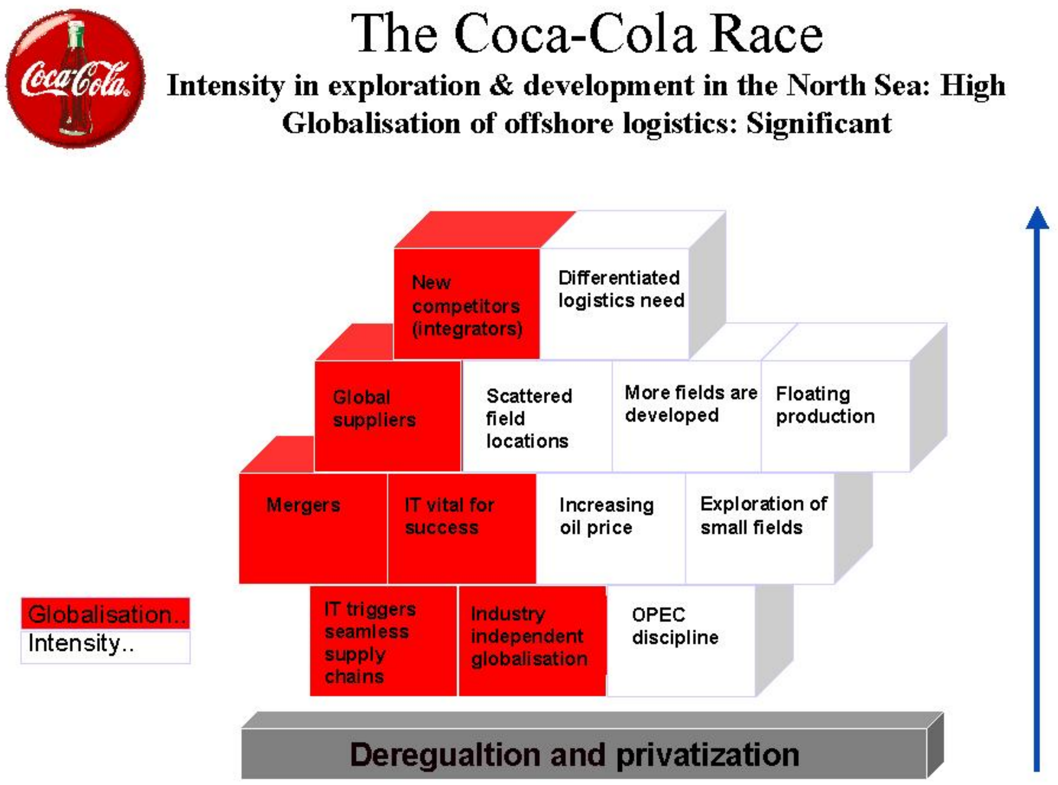


Figure 4-9 Block diagram for "The Coca-Cola Race" scenario

Guidelines for monitoring of key indicators were given. In addition, the interface between monitoring system, scenarios and the regular strategy process as run by Statoil Driftstjenester was defined.

4.3.3 Exploration, evaluation and implementation of innovations (step 2-5)

In this section, the practical execution and results of step 2-5 in the scenario-based guidelines for innovation are described.

Step 2: Explore new services:

The exploration of new services took place in the fourth and final workshop.

For each scenario, main directions/needs for innovation were discussed. In a brainstorming session, approximately 2-4 new services or strategies were identified for each scenario. Below, a few examples are given:

- Develop a niche strategy, focusing on value added services to be offered in restricted geographic areas (scenario 1 – global logistics providers enter the arena).
- Be a cost-effective supplier with a flexible organisation structure adaptable to reduced activity on the Norwegian Shelf (scenario 4 – low intensity in exploration and development in the North Sea and a low oil price).

Step 3: Evaluate new services:

After the identification of directions for innovation and new services, the services were evaluated in the same way as for the MARINTEK case. A robust strategy including a set of new services was established. A keyword for the strategy was *Supply Chain Management*. In establishing the strategy, the following conditions were considered:

- How to obtain a balanced service portfolio?
- Where are the markets for the services?
- What kind of IT systems are needed?
- Is there a need for developing strategic alliances in order to be able to offer the services?
- Is there a need for changes in organisation structure and type?

Step 4/5 Implement new services:

The robust strategy identified in step 3 has later been developed in more detail with inputs from the regular strategy process, and has gradually been implemented. The strategy involves a significant departure from present practice for Statoil Driftstjenester. The strategy outlines a number of new services to be offered in a supply chain management perspective, need for internal change, degree of asset investments and need for alliances (refer section 2.4 for different forms of co-operation and their different governance mechanisms).

A discussion of challenges related to implementation of new services is given in section 4.5.

4.3.4 Evaluation of the scenario-based guidelines for innovation

In this section, the scenario process run by Statoil Driftstjenester is evaluated with a basis in feedback received during the execution of the process and interviews with participants shortly after the termination of the process.

Feedback from participants in the MARINTEK case contributed in improving the scenario process run by Statoil Driftstjenester (e.g. an initial step was undertaken aiming at developing a common platform and understanding of the company and its current strategies and goals). Generally, fewer comments were received in the Statoil Driftstjenester case than in the MARINTEK case.

The evaluation has been structured in the following way:

1. Evaluation of the guidelines (refer Figure 3-4).
2. Evaluation of the practical execution of the process.
3. Evaluation of how the goals of the scenario process were satisfied.
4. Necessary adjustments of guildelines.

Evaluation of the guidelines:

- All participants would consider making use of scenarios in later strategic discussions.
- It was underlined that the scenarios contributed in stimulating creativity and exploring new ideas. The systemised construction of the scenarios forced the participants to look beyond their traditional perception of the business environment.
- One of the participants argued that it is a challenge to integrate the scenarios with the regular strategy process. Although some time was spent in defining the interface between the monitoring system, scenarios and the regular strategy process, more emphasis should have been put upon defining new roles and responsibilities. All participants felt that it was of great importance to make the scenarios a part of the on-going strategic discussions.
- The participants felt that scenarios could contribute in an evaluation of new services.
- Generally, the participants were very pleased with the way the scenarios were presented.

Evaluation of the practical execution of the process:

- More time resources should have been reserved for integrating the scenarios with the regular strategy process (refer the above evaluation of the guidelines).
- All participants were pleased with the way the process was facilitated.
- Some of the participants emphasised the advantages of having guest speakers with provoking and stimulating perspectives in some of the workshops.

Evaluation of how the goals of the scenario process were satisfied:

- The process contributed in adjusting the R&D project run by Statoil Driftstjenester, Statoil Forskning og Utvikling and MARINTEK.
- Together with the regular strategy process run by Statoil Driftstjenester the scenario process contributed in establishing a robust strategy including new service elements. However, more resources should have been put into integrating the scenarios with the regular strategy process.
- The scenarios contributed in a better documentation and reasoning for why to implement new strategies and services.
- All participants felt that they had increased their knowledge and understanding of the interaction between external forces shaping the future business environment.
- A common mental framework for strategic discussions related to the future was established.
- Established truths were challenged.

Necessary adjustments of guidelines:

- Introduce an additional step, following step 1, aiming to define the interface between the monitoring system, scenarios and the regular strategy process. In addition new roles and responsibilities (related to monitoring efforts and an integration of scenarios in the regular strategy process) should be defined. In this way, the scenario process will not die, but be part of the on-going strategic discussions in the company.

4.4 Wallenius Wilhelmsen Lines

In this section, the scenario process run by Wallenius Wilhelmsen Lines (WWL) is described.

4.4.1 Introduction

<u>Company profile:</u>

WWL is the world's largest vehicle and ro/ro transportation and logistics company with an annual turnover reaching 1.5 billion USD. WWL has a global market share of 23% for ocean going vehicle and ro/ro transportation services and transports around 1.5 million car units and 300.000 ro/ro units annually. The WWL fleet consists of almost 70 vessels. WWL's headquarters are in Oslo, Norway and Stockholm, Sweden.

<u>Conditions leading to interest in scenarios:</u>

WWL's interest in scenarios emerged from a large R&D project with participants from MARINTEK and WWL. The project is aiming at developing new global logistics services to be offered by WWL. Failure to offer global logistics services could limit WWL's role to become a sub-contractor for major third party providers of logistics (e.g. UPS and FedEx).

MARINTEK suggested that WWL should run a scenario process in order to undertake a structured analysis of how key drivers of change could lead to a future structurally different from the situation today and how the clients' needs with respect to logistics could change.

<u>Goals of scenario process and time horizon for scenarios:</u>

The time horizon for the scenarios was set to five years and the major goals of the scenario process were to develop a set of scenarios in order to:

- Explore the need for future logistics management services.
- Contribute in the (2001) strategy formulation process and in establishing divisional and regional measures and targets with respect to new logistics management services.

- Develop a common mental map of the future with respect to new logistics management services.
- Evaluate whether scenarios should be used regularly in the WWL strategy planning process.

Time for accomplishing the scenario process:

The scenario process was performed in approximately five months (15.12.99-15.05.00). In this period, one kick-off meeting, three core team workshops and four regional workshops were held.

Organisational slack available for the scenario process:

Two facilitators spent about 500 hours in preparing the workshops and collecting and analysing relevant information. Direct costs added up to a total of approximately 150.000 NOK. Ten WWL managers participated in some or all of the workshops undertaken by the core team. In addition, a number of people participated in the four regional workshops held in Europe, America (two workshops including participants from Far East) and Oceania.

Scenario team:

Facilitators:
André Kroneberg, Research Fellow, Norwegian University of Science and Technology
Torbjørn Landmark, Research Engineer, Logistics, MARINTEK
Eivind Dale, Research manager, MARINTEK

Participants:
Bengt Eurén, Senior Vice President, Operation, WWL
Steve Cadden, Senior Vice President, Global Logistics, WWL
Jan Walle, Senior Vice President, Business Services and Finance, WWL
Reidar Hauge, Senior Vice President, Information Systems, WWL
Anders Boman, Senior Vice President, Commercial, WWL
Reidar Nilsen, Vice President, Research and Development, WWL
Bengt Ramberg, Vice President, Global Logistics, WWL
Fridtjof Næss, Vice President, Business Performance & Pricing, WWL
Jesper Olsson, Research and Development, WWL
Gudbrand Fløtaker, Information Systems, WWL

4.4.2 Development of scenarios (step1)

The scenarios were developed with a basis in the 6-step SRI technique as described in section 3.3.1 and illustrated in Figure 3-2. However, the technique was not applied in a strictly prescriptive manner as in the two previous cases (MARINTEK and Statoil Driftstjenester). Step 2 and 3 of the SRI technique had already been undertaken as part of the large R&D project. In the first core team workshop, step 1 and 4 were on the agenda. In the second core team workshop, further discussions related to step 4 took place. In the last core team workshop, a set of scenarios were used to explore new strategies and services with respect to logistics management. Several follow-up meetings were held after the third core team workshop in order to integrate the scenario findings with the regular strategy process. In the following, a structured discussion of the scenario development is given according to the SRI technique.

Initial Step (1): Clarify ownership of process and responsibility for integrating scenarios in the regular strategy process:

In the Statoil Driftstjenester case, one of the participants argued that it could be a challenge to integrate the scenarios with the regular strategy process. More emphasis should have been put upon defining roles and responsibilities with respect to the scenario process. All participants felt that it was of great importance to make the scenarios a part of the on-going strategic discussions.

In the WWL scenario process, an initial step was undertaken in order to define roles and responsibilities with respect to integrating the scenario process as a part of the on-going strategic discussions. The WWL R&D department was given the responsibility to ensure that the scenario process was anchored in the top management team and taken seriously as a strategic tool for discussions related to future WWL logistics services. The scenario findings together with regular R&D activities such as macro economic analysis and trade forecasts would constitute a basis for the regular strategy formulation process starting in May (refer Figure 4-10).

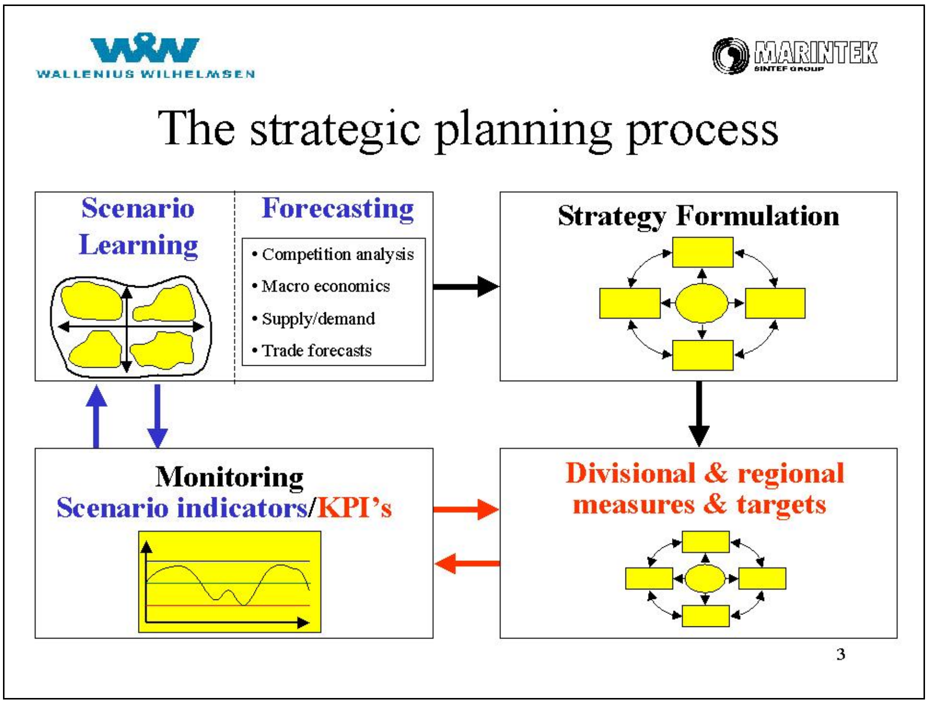


Figure 4-10 The inclusion of scenarios in the regular WWL strategy process

The traditional WWL forecasting efforts will be supplemented by scenario processes in order to enhance the regular strategy process which is based on the use of Balanced Scorecard.

<u>Initial Step (2): Develop common platform:</u>

In line with the Statoil Driftstjenester scenario project, an initial step was undertaken in order to bring all participants to the same level with respect to understanding of the logistics concept. These discussions took place at the first workshop held 21.02.00. The following questions were raised as part of a group work:

- Define the concept of logistics with respect to activities and processes.
- Discuss the present WWL logistics services with a basis in your marketing ads. Do the marketing ads really reflect your logistics services?

Generally, all participants had similar understandings of the logistics concept. The participants agreed that logistics consists of management of information and physical flow of cargo. With respect to logistics services offered by WWL, the participants stated that WWL offers customised logistics solutions to key clients. An understanding of the client's needs (e.g. with respect to lead times and information needs) was therefore of vital importance. The participants also agreed that WWL did not want to become a sub-supplier, but rather to maintain direct contact with clients in order to understand their needs and be able to differentiate their services from what was offered by other players.

Step 1: Identify strategic decisions:

Ahead of the first workshop, the facilitators in co-operation with a few key participants had formulated a proposal for the strategic decision focus:

"*Logistics management services required by new and existing customers in the next five years*"

This formulation was based on the WWL vision:

"*Help our customers succeed through innovative transportation and logistics solutions*"

The strategic decision focus was discussed and accepted by all participants.

Step 2: Identify key decision factors:

Key decision factors were identified with a basis in several studies undertaken in the MARINTEK/WWL R&D project. These studies were specifically discussing:

- Global market trends.
- Global logistics and information technology trends.
- WWL partners'/competitors' engagement in logistics management.

With a basis in the studies, four clusters of key decision factors were established:

- Customers (Who is the future customer of WWL and what services are required? Continuance of mega-mergers in the auto industry?, Increased regional production of cars?).
- Competitors (Emergence of new competitors including non-asset owners?).
- Regulatory regime (Deregulation of liner conferences?).
- E-business (New ways of doing business?).

In the first regional workshop, held in Brunswick, Georgia, three of the key decision factors were discussed more in detail. In this workshop, representatives from all WWL regions (Europe, Asia, Oceania and Americas) were present. A total of 18 participants were organised into two groups. One of the groups discussed competitor's actions and how they could use e-business as part of their strategies in the future. The other group discussed how customers' requirements could change as a result of mergers/acquisitions in the auto industry, reduction of lead times and emerging e-business solutions applied by large auto companies.

Step 3: Identify external forces:

External forces were identified with a basis in the above mentioned studies undertaken in the MARINTEK/WWL R&D project. Examples of external forces are:

- Mergers/acquisitions in the auto industry:
  - Nissan/Renault, Ford/Volvo/Jaguar/Mazda, Mercedes/Chrysler, GM/Saab, Toyota/Daihatsu.
- Common platforms (frameworks for cars):
  - The new auto companies use common platforms for different brands (e.g. Nissan/Renault – common Micra/Clio platform).
- Fewer platforms:
  - Auto companies use fewer platforms in order to realise economies of scale (e.g. Volkswagen base their brands on four platforms only).
- E-commerce:
  - Ford and GM move all their purchasing operations on to the Internet[11]. November 2, 1999, Ford and Oracle formed a joint venture, to establish AutoXchange. AutoXchange will be the preferred vehicle for all of Ford's $80 billion annual purchases of components and materials. Further, the supply chain back-end will integrate with Ford's consumer facing web sites. These efforts will transform Ford's supply chain from one based on forecasts and building for inventory, to a real time build to order model.
- The emergence of large, global supply chain integrators (e.g. Caliber, Ryder and Exel, in co-operation with IT providers such as i2 and IBM).

Step 4: Establish scenario logic:

As opposed to the MARINTEK and Statoil Driftstjenester scenario projects, one tried to carry through a more thorough assessment of potential key drivers of change. Several

[11] After the workshop, GM, Ford and Daimler/Chrysler have announced that they are planning to combine their efforts to form a business-to-business integrated supplier exchange through a single global portal. This venture will create the world's largest virtual marketplace.

key drivers of change were discussed in the first and the second workshop, the goal being to identify the truly critical key drivers with a high impact on the logistics services to be offered by WWL in the future.

In the first workshop, three key drivers of change were discussed:

1. “Erosion of conferences”
   - Conferences are critical to the ocean car transport industry profitability today.
   - Increased focus on cost and service level could induce auto makers to exert pressure to eliminate conferences.
   - Politically, the regulatory justification for conferences is on a shaky ground today.
2. “Containerised sea transport of cars”
   - If a cost-effective solution for carrying finished vehicles by containers appears, the supply of deep sea auto transportation would increase dramatically and WWL profitability could be significantly reduced.
   - A projection of significant excess slot capacity in the container industry in the foreseeable future may contribute to develop technology for transport of cars in containers.
   - The new boss of Neptun Orient Lines (NOL) (NOL recently acquired American President Lines) thinks container auto shipments is quite viable.
3. “Emergence of global lead logistics providers (LLPs)”
   - Emergence of integrated logistics companies (e.g. UPS and Ryder) may pose a threat to WWL and their need for direct contact with their clients. WWL could become a sub-supplier to an integrator.
   - A reform in U.S. maritime law now permits shippers and carriers to enter into multi-faceted contracts. This will probably induce LLPs to become much more involved in the maritime supply chain.
   - In order to effectively manage global supply chains, auto makers require state of the art logistics capabilities. GM and Ford are presently pursuing globalisation and will reach out to logistics providers who have the required competencies. This has also to do with information systems technology which through the Internet is at the stage where integration of global logistics can occur.
   - Integrators, such as UPS and Ryder, have finally accumulated enough experience in domestic markets to have credibility for expanding into global and thereby ocean services.

The participants were organised into three groups, and each group was assigned one key driver of change for discussion, with respect to:

- What strategies/logistics services should WWL pursue in order to maintain/increase profits?
- What strategies/logistics services are other players (e.g. customers and competitors) likely to pursue?
- Requirements related to change in WWL strategic core?
- Time horizon/viability of key driver?

Presentations of the group work were given in plenary followed by a discussion.

In the second workshop, the goal was to explore key drivers of change with respect to structure of inland distribution in the future. The goal was to throw light on which role WWL should play in inland activities in the transport chain.

Three key drivers of change were chosen as a basis for discussions:

1. Customer’s requirements.
   - What expectations/needs do customers have for inland activities/distribution in the future?
2. Existing/emerging inland logistics actors.
   - What strategies do existing/emerging inland actors have for inland activities? Traditional asset based operators versus third party logistics providers? What about mergers/acquisitions/partnering? Will some of the actors come between WWL and its customers?
3. E-commerce.
   - How may e-commerce change the rules of the game?

Once again, the participants were organised into three groups. Instead of assigning one driver to each group, all drivers were to be treated by each group this time. WWL is a global company with global business and representation organised in four regions: Europe, America, Asia and Oceania. In order to trigger discussions with respect to WWL inland engagements in each of the regions, three key trades were chosen:

1. Asia-Europe.
2. Europe-North America/North America-Europe.
3. Europe/North America-Oceania.

The three key trades represent a significant share of total WWL revenue. All three groups discussed the Europe region (the region best known to the participants), and at the same time the other three regions were touched upon. Representatives from the four regions were allowed to give their views with respect to WWL inland activities in the regional workshops.

Each group was asked to imagine themselves being the key trade team responsible for the trade in question. Each group was asked to:

1. Develop a set of scenarios for the guidance of WWL's inland engagements in the future.
   - Give a short description of how each of the three key drivers may develop.
   - Combine the descriptions into scenarios.
   - Assess the viability of the scenarios and what forces/events could change the scenario assumptions and content radically?
2. Develop a strategy for WWL inland engagements in the regions relevant for the key trade in question.
   - Goals: Why should (not) WWL be involved in inland activities in the regions?
     - Secure/strengthen trade, key customer's requirements, market shares and revenue in inland activities?
     - Are there any specific synergies between the deep sea trade and inland services to be offered by WWL?
   - Strategy:
     - What kind of inland activities/services in what regions?
     - What kind of co-operations (e.g. Joint Venture or full ownership) may be formed for what activities?
     - What would be a rational degree of investment in assets?

In the regional workshops, the same approach was taken in discussing WWL's future engagement with respect to inland logistics. However, the regional participants were also asked to describe the situation today with respect to organisation/structure of logistics in the region. The description should include discussions related to organisation of trucking, rail, PDI (Pre Delivery Inspection) and terminal operations, seeking answers to:

- Who are the actors and how do they co-operate?
- In what way is the customer involved (what activities/services are insourced/ outsourced)?

- How is e-commerce applied?

The description of the situation today, provided the core team with a frame of reference.

On this basis, scenarios should be developed addressing the same elements as mentioned above. The participants were also asked to identify what could radically change their scenario assumptions. With a basis in their scenarios, the groups were asked to develop a WWL strategy for inland engagements in the regions.

With a basis in the findings from the core team and regional workshops, the following key drivers of change were identified:

1. <u>Deep sea supply + customer relations:</u> The supply of deep sea tonnage and the type of customer relations are believed to have a high degree of dependence. If a cost-effective solution for transporting cars in containers emerge, the potential tonnage supply will increase sharply due to excess slot capacity in the container trades today. If the tonnage supply increases, one is likely to see a commodity market and more short-term and dynamic customer relations. Short term customer relations could also be a result of the global web portals being pursued by the large auto companies today.
2. <u>Degree of regionalisation:</u> How will mass customisation, postponement of production and shorter delivery times influence the production of cars? Will we see an increase in regional production and transplants (Transplants are common production facilities resulting from the mergers/acquisitions and development of common platforms in the auto industry. E.g. Renault produces Nissan cars in Europe and vice versa).

Each of the drivers was assigned two extreme, but plausible, levels of occurrence. In this way, the extreme points of plausible futures were embraced. Based on the two key drivers a scenario logic was established as shown in Figure 4-11.

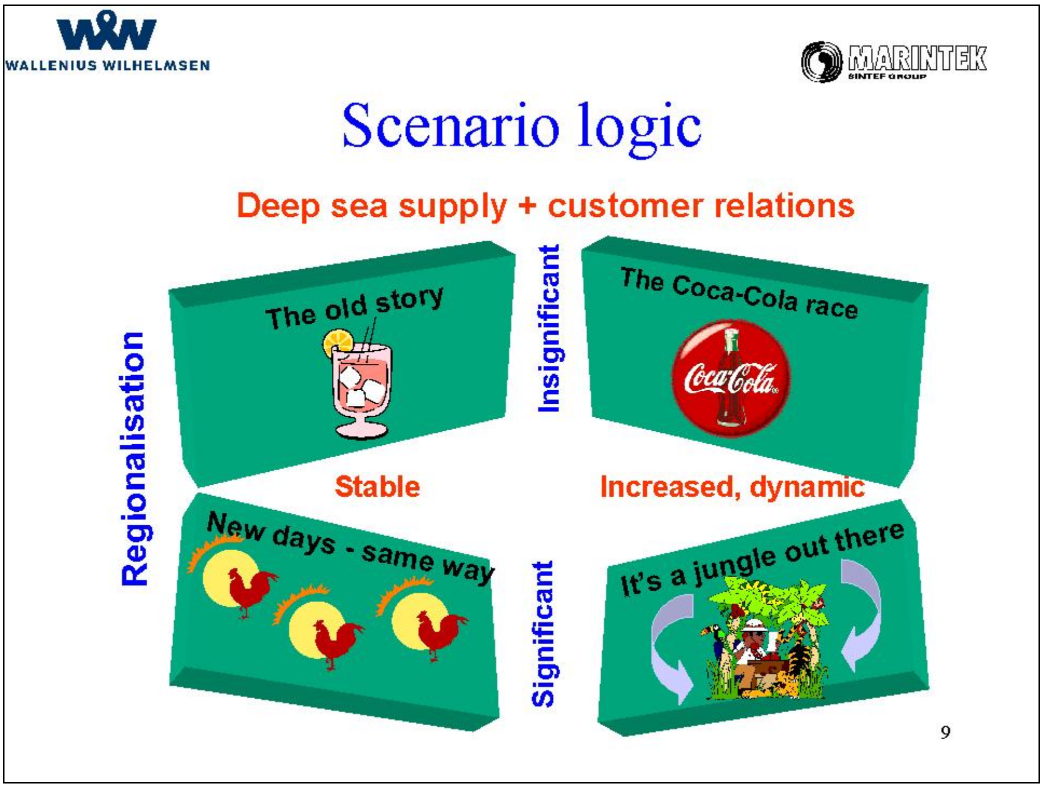


Figure 4-11 Scenario logic - Wallenius Wilhelmsen Lines

Step 5: Describe scenarios:

This step was undertaken by the facilitators between the second and the third of the workshops.

A short story line was developed for each of the scenarios. In addition, block diagrams were used to highlight the main contents of and the main differences between the scenarios (refer Figure 4-12).

Figure 4-12 Block diagram for "It's a jungle out there" scenario

The block diagram aims to capture and highlight the main assumptions and content of the scenario. The broad arrow tries to illustrate the cause-effect relations (e.g. customers co-operate with IT providers and establish global web portals thus leading to more dynamic and short term relations).

In a series of follow-up meetings, the scenario findings were integrated with the regular WWL strategic planning process and procedures for monitoring of scenario key indicators were established.

4.4.3 Exploration, evaluation and implementation of innovations (step 2-5)

In this section, the practical execution and results of step 2-5 in the scenario-based guidelines for innovation are described.

<u>Step 2: Explore new services:</u>

In the third workshop, needs and directions for innovation were identified for each of the scenarios. Two groups discussed the scenarios and came up with a suggestion for new WWL logistics services to be offered. For each scenario, the following questions were raised:

1. Scope: What logistics services to what customers, regions and trades?
2. Which are competitive advantages/uniqueness?
3. How to develop and offer new services using internal/external resources?

Below, an example is given:

- Increase High & Heavy (project cargo such as rail wagons, escalators and agricultural machines) cargo volumes by using ro/ro vessels for High & Heavy cargo exclusively, while the PCCs (Pure Car Carrier) and PCTCs (Pure Car Truck Carrier) would take care of the decreasing car cargo volumes (scenario 4 – increased tonnage supply and reduced deep sea car transport demand).

A further development of the service descriptions took place in a number of follow-up meetings. After an aggregation and clustering of services, 3-5 services were identified for each scenario.

<u>Step 3: Evaluate new services:</u>

After the identification of directions for innovation and potential new services, the services were evaluated in the same way as for the MARINTEK and Statoil Driftstjenester cases.

<u>Step 4/5: Implement new services:</u>

A possible implementation of new services will be decided in the regular strategy process starting in June, 2000. Important elements to be considered are related to degree of outsourcing of non-core activities (refer section 2.4 for discussions on strategic core), investments in IT systems capabilities and extended scope of services for selected key customers (e.g. degree of logistics services to be provided in different parts of the chain).

A discussion of challenges related to implementation of new services is given in section 4.5.

4.4.4 Evaluation of the scenario-based guidelines for innovation

In this section, the scenario process run by WWL is evaluated with a basis in feedback received during the execution of the process.

Feedback from participants in the MARINTEK and Statoil Driftstjenester cases contributed in improving the scenario process run by WWL. Initial steps were undertaken aiming to:

- Clarify the ownership of the scenario process and the responsibility for integrating scenarios in the regular strategy process.
- Develop a common platform and understanding of the logistics concept and the company's logistics services today.

Generally, fewer comments were received in the WWL case than in the MARINTEK and Statoil Driftstjenester cases.

The evaluation has been structured in the following way:

1. Evaluation of the guidelines (refer Figure 3-4).
2. Evaluation of the practical execution of the process.
3. Evaluation of how the goals of the scenario process were satisfied.
4. Necessary adjustments of guidelines.

Evaluation of the guidelines:

- The WWL managers felt that by using scenarios they would be better prepared for serious changes in the business environment. One of the managers stated that WWL had never before, in a structured way, addressed such "what if" scenarios. The typical was to discuss new strategies/services after a significant change in the business environment had taken place. The scenario discussions were said to represent a structured and pro-active way of moving the business in the right direction.
- A cross-functional team was perceived as useful in developing and discussing the scenarios. Managers from all WWL divisions were participating in the workshops.

- The regional anchoring was emphasised as important by the core team. If no workshops had been held in the regions, regional representatives should have joined the core team. The regional inputs were useful in evaluating the findings in the core team workshops.
- The managers felt that scenarios should be used on a regular basis also for longer/shorter time horizons than five years.
- Some of the managers felt that the scenario discussions contributed to identify early warning signs.
- One of the managers suggested that short-term follow-ups could be initiated based on the scenario discussions (i.e. pursue critical initatives right away instead of waiting till the scenario process is finalised).

Evaluation of the practical execution of the process:

- No significant comments were received.

Evaluation of how the goals of the scenario process were satisfied:

- An exploration of the need for future logistics management services was accomplished.
- The scenario findings served as input in the (2001) strategy formulation process and in establishing divisional and regional measures and targets with respect to new logistics management services.
- A common mental map of the future with respect to new logistics management services was established.
- An evaluation of whether scenarios should be used regularly in the WWL strategy planning process was undertaken and WWL decided to use scenario learning on a regular basis.

Necessary adjustments of guidelines:

- Based on the feedback, there is no indication that adjustments of the guidelines should be made.

4.5 Challenges related to implementation of innovations

In this section I will briefly discuss some general problems and challenges related to implementation of innovations triggered by scenarios. The discussion will be illustrated by drawing upon experience gained from the three case studies.

Based on my experience from working with scenarios, there are basically three main problems related to a successful implementation of innovations triggered from scenarios:

1. A game-like atmosphere may occur, thus hindering true implementation efforts.
2. Difficult to decide the right time for making a radical change in service portfolio due to radical need for internal change.
3. Difficult to concretise the service if quantifiable consequences are needed.

In the following, each of the three points mentioned above are further discussed.

Game-like atmosphere

Initiatives aiming at avoiding an atmosphere characterised by lack of true commitment from participants in a scenario-based innovation process are outlined in section 3.2.2. The initiatives may be summarised as:

- Emphasise that the scenario process is part of a larger strategic process aiming at exploring and implementing innovations.
- Assure (continuos) participation of the decision makers in the process.

In the MARINTEK case, the participants commented that a larger emphasis should have been put on the implementation efforts. Recommendations were to put more time resources into preparing implementation efforts, possibly through an implementation plan. In addition, it was agreed that one (or more) of the participants should be assigned the responsibility of implementation management.

In the Statoil Driftstjenester case, the participants pointed to the challenge of integrating scenarios into the regular strategy process. By defining roles and responsibilities in this respect, the importance of the process would be further underlined.

In the Wallenius Wilhelmsen case, the ownership of the scenario process together with responsibilities for integrating the scenarios in the regular strategy process were clarified early in the process. The problem of a game-like atmosphere with no true commitment form participants was not present in this case study and no critical comments regarding implementation efforts were received.

The right time for implementation

Although robust innovations may be implemented right away, such innovations may imply radical changes in internal organisation (e.g. dismissal of employees and outsourcing of activities). Some managers are resistant to such changes and are not willing to give a go on such initiatives unless absolute necessity can be demonstrated. A natural implication following this observation is that the scenarios need to be well documented and argued for. The managers need to believe in the scenarios and their underlying logic. Again continuos participation of the decision makers is called for. In order to improve the continuity, one of the participants in the Wallenius Wilhelmsen case suggested that the participants could be given the responsibility for performing small tasks between the workshops (e.g. analyse and document strategic initiatives in the container industry with respect to transport of cars in containers).

In addition to robust services, the scenarios may also reveal optimal services suited for one particular scenario, or a certain combination of scenario elements. The right time for implementation of such services may be hard to decide. A monitoring system may contribute in this respect. In addition, one needs to consider the time needed for implementation in relation to possible early warning signs given by the monitoring of key indicators. How long is it appropriate to wait in order to be sure that a certain scenario is unfolding? In appendix B, these questions are dealt with in a case study aiming to develop an optimal transport system for a set of offshore installations today and in the future.

In the Statoil Driftstjenester and Wallenius Wilhelmsen cases, guidelines and responsibilities for monitoring of key indicators were established. However, the effects of monitoring have not been documented well enough for any of the cases as these effects only will be measurable over a longer term.

Identification of quantifiable consequences

Some services need to be optimised through quantification in order to be implemented. Consider the task to design an optimal transport system for serving offshore installations today and in the future (refer Appendix B). The transport system could be defined by the number and type of vessel (e.g. small/large, slow/fast). Several forces may affect the design of such a system. However, a set of scenarios consisting of stories and mainly qualitative elements may not give clear indications on number and type of vessels in an optimal fleet. In Appendix B, a methodology integrating scenario and optimisation techniques are presented in order to solve problems related to quantification of scenario consequences.

However, not all services need to be quantified in a manner as outlined above in order to be implemented. For the Wallenius Wilhelmsen Lines case, some services were related to strategic questions such as:

- Should we offer pre-delivery inspection (PDI) of cargo,
- for which customers,
- and should we invest in PDI facilities or just co-ordinate such services?

Generally, it is my impression that scenarios help in taking major strategic decisions related to the introduction of new services and that other techniques may be used in order to concretise scenario implications when found necessary.

5 Conclusion

Chapter 5 wraps up the thesis by assessing how the goals of the thesis are met and by concluding the applicability of the scenario-based guidelines for innovation.

5.1 Recapturing the goal of the thesis

In chapter 1, my main goal is stated as:

Show how innovation in shipping may be guided by using scenarios.

In order to reach this goal I have developed and tested a set of guidelines for using scenarios to undertake innovation.

The scenario-based guidelines were developed with a basis in a relatively broad understanding of innovation. In addition, the literature surveyed has been illustrated with a number of examples from the shipping industry in order to make the theory more comprehensible.

The guidelines consist of five major steps (refer Figure 5-1). For a further description of each step, please refer to section 3.4.

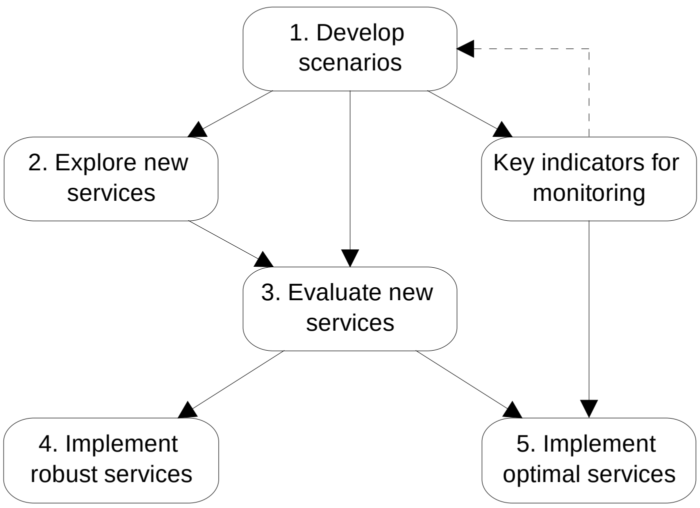


Figure 5-1 Scenario-based guidelines for innovation

The guidelines were tested and evaluated by three companies with different engagements in shipping. The three case studies uncovered a need for a few revisions of the guidelines, the following should be added:

1. Clarification of the ownership of the process. One (or more) of the participants should be assigned the responsibility for developing the identified services further and eventually implement the services in the company. This task has to be undertaken ahead of the development of scenarios.
2. Development of a common platform and understanding of the company and its current strategies and goals among the participants. This activity should contribute to bring all participants to the same level before the actual scenario process starts, and needs to be part of an initial step, ahead of step 1.
3. Development of plans for how to integrate development and use of scenarios in the regular strategy process and how to monitor key indicators. Define roles and responsibilities for these tasks. This task may be undertaken ahead of the development of the scenarios, but may also be subject to the outcome of the scenario process.

With a basis in these findings, revised guidelines are given in Figure 5-2.

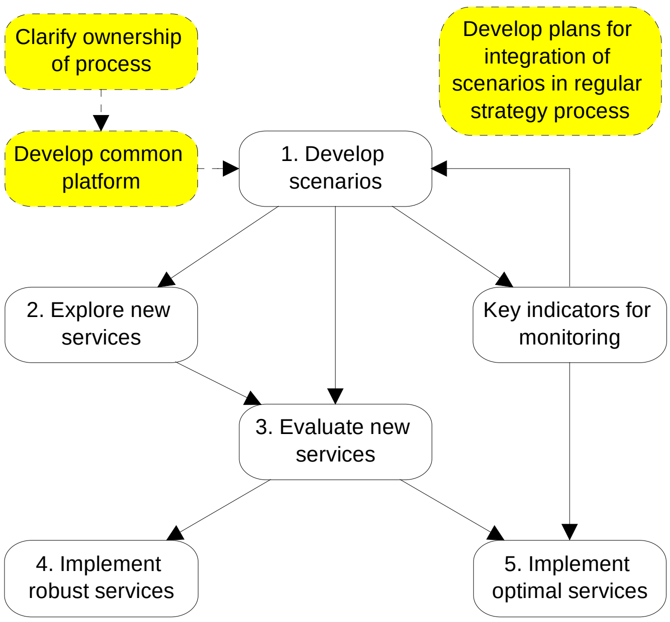


Figure 5-2 Revised scenario-based guidelines for innovation

Revisions are indicated by dotted boxes and lines. Integration of scenarios in the regular strategy process may take place ahead, during or after the scenario process.

With a basis in the above discussion, I will argue that the goal of the thesis is met.

5.2 The applicability of the scenario-based guidelines for innovation

Generally, all companies confirmed the applicability of the guidelines.

In chapter 1, I presented a set of conditions and requirements which have to be met in order to develop and use scenarios for innovation in shipping. In the following, the three cases are discussed according to how they meet these conditions and requirements.

The first of the necessary conditions states that the future has to be uncertain in order to develop scenarios. This condition was met in all cases, as demonstrated in chapter 4.

The second of the necessary conditions states that organisational slack is needed in order to develop scenarios. This condition was met in all cases, but to a different level. MARINTEK had rather limited financial and personnel resources for the scenario process. The resources were substantially better in the Statoil Driftstjenester and Wallenius Wilhelmsen cases. MARINTEK was mainly interested in gaining experience from running scenario processes, while the two other companies had a higher motivation and need for innovation. The results were that MARINTEK did not follow up the results from the scenario process, while the two other companies managed to identify and follow up need for innovation and new services. The findings indicate that sufficient organisational slack is needed in order to develop and use scenarios for innovation.

If sufficient conditions are present, the applicability of scenarios is secured, provided that the necessary conditions are met.

In chapter 1, the first of the sufficient conditions states that the company has to request forced innovation in order to develop scenarios. This condition was met in all cases. All companies were somehow forced to innovate in order to adapt to changing conditions in the business environment (e.g. WWL did not want to become a sub supplier, but rather to maintain direct contact towards clients).

The second of the sufficient conditions states that strategic decisions have to be taken, but not within a limited time period. This condition was met in all cases as the companies were planning new services for a 5-10 year horizon.

If both necessary and sufficient conditions are present, scenarios are to be developed. In order to be of use, however, scenarios should satisfy a set of *requirements*. The requirements are related to the number of scenarios and the time horizon and also that the scenarios should embrace the extreme points of plausible futures. The three requirements were met in all cases, as demonstrated in chapter 4.

Both the theoretical and practical results of this thesis confirm that scenarios may be used to guide innovation in shipping. More specifically, the three cases confirm that scenarios may be used to guide exploration, evaluation and implementation of innovations in shipping given that necessary and sufficient conditions and requirements are present.

However, more time is needed in order to asses how monitoring of key indicators may guide the implementation of innovations. The effects of monitoring have not been documented well enough for any of the cases as these effects only will be measurable over a longer term.

Scenarios provide guidance for innovations in shipping involving major strategic decisions. Other techniques (e.g. optimisation techniques) may be used in order to concretise scenario implications when found necessary. Further work is needed in order to identify ways of combining scenario techniques with quantitative techniques in order to reveal quantifiable consequences of scenarios when needed.

5.3 Closure

Results from the thesis have been communicated to the industry through the three case studies and through a number of articles on the subject (Kroneberg 1998, 1999a, 1999b, Østvik et al. 1998, Fagerholt and Kroneberg 2000).

As mentioned in the introduction, my experience from working in shipping over the last five years indicates that shipping companies are mainly concerned with day to day operations and that little effort is put into pursuing innovation in a systematic manner. It is my conviction that long range planning will strengthen the competitive force in shipping and therefore, my hope is that results from this thesis may inspire and strengthen the use of scenarios for innovation in shipping.

6 References

Amara, R and Lipinski, A J (1983): *Business Planning for an Uncertain Future - Scenarios and Strategies*, Pergamon Press.

Bartz-Johannesen, S (1996): *Et jevnt år for norsk småskipsfart*, Chairman of the Shortsea shipping group in Norwegian Shipowners' Association, http://www.rederi.no/news2/presse2.html.

Berggren, B, Christensen, A E and Kolltveit, B (1989): *Norsk sjøfart – bind 1*, Dreyers Forlag A/S, Oslo.

Bonnett, T W and Olson, R L (1994): Four Scenarios of State Goverment Services and Regulation in the Year 2010, *Planning Review*, pp. 26-33, No. 4, Vol. 22.

Carter, P L, Melnyk, S A and Handfield, R B (1995): Identifying the Basic Process Strategies for Time-Based Competition, *Production and Inventory Management Journal*, pp. 65-70, No. 1, Vol. 36.

Coasterudvalget (1991): *En fremtid for Coasteren*, Industriministeriet, Denmark.

Diffenbach, J (1983): Corporate Environmental Analysis in Large U.S. Corporations, *Long Range Planning*, pp. 107-116, No. 3, Vol. 16.

Donelly, A and Mazières, J (1999): *Short Sea Shipping: A Viable Alternative to Overland Transport*, AMRIE (The Alliance of Maritime Regional Interests in Europe), http://www.amrie.org/docs/shortsea.htm.

Dosi, G (1982): Technological paradigms and technological trajectories - A suggested interpretation of the determinants and directions of technical change, *Research Policy*, pp. 147-162, No. 11.

Dosi, G (1988a): The nature of the Innovation Process, in Dosi, G, Freeman, C, Nelson, R, Silverberg, G and Soete, L (eds.): *Technical Change and Economic Theory*, Printer Publishers, London.

Dosi, G (1988b): Sources, Procedures, and Microeconomic Effects of Innovation, *Journal of Economic Literature*, pp. 1120-1171, Vol. XXVI.

Duncan, N E and Wack, P (1994): Scenarios Designed to Improve Decision Making, *Planning Review*, pp. 18-25, 46, No. 4, Vol. 22.

Easton, G (1992): Industrial networks: a review, in, Axelsson, B and Easton, G (eds.): *Industrial Networks,* pp. 3-27, Routledge, London.

Eisenhardt, K M (1989): Agency Theory: An Assessment and Review, *Academy of Management Review*, pp. 57-74, No. 1, Vol. 14.

Elias, E (1997): *Recent Trends in Technology Forecasting*, SRI Consulting, Business Intelligence Program, Brief No. B96-0042, Menlo Park, California.

Emerson, R M (1962): Power-Dependence Relations, *American Sociological Review*, pp. 31-41, Vol. 27.

Erichsen, S (1964): Laste/losseprosessene, hvor begynner de, hvor slutter de?, *SFI meddelelse - Rasjonalisering av laste/losseprosessene: Referat fra SFI's laste/lossekonferanse*, S*andefjord 20.-22. May,* No. M56, MARINTEK, Trondheim.

Erichsen, S and Selvig, K (1991): Contractual Margins in Relation to Required Performance, *4th International Marine Systems Design Conference*, The Society of Naval Architects of Japan, The Kansai Society of Naval Architects, Kobe, Japan.

European Commision (1999): *The Development of Short Sea Shipping in Europe: A Dynamic Alternative in a Sustainable Transport Chain*, Communication from the Commision to the European Parliament, The Council, The Economic and Social Committee and the Committee of the Regions, Brussels.

Fagerholt, K and Kroneberg, A (2000): Designing Future Transport Systems by Scenario and Optimisation Techniques, *7th International Marine Design Conference*, The Society of Naval Architechts of Korea, Kyongju, Korea.

Fahey, L (1997): Industry Scenarios, in, Fahey L and Randall R M (Eds.): *Learning from the Future: Competitive Foresight Scenarios,* pp. 22-38, John Wiley & Sons.

Fahey, L and Randall, R M (Eds.) (1997a): *Learning from the Future: Competitive Foresight Scenarios*, John Wiley & Sons.

Fahey, L and Randall, R M (1997b): What is Scenario Learning?, in, Fahey L and Randall R M (Eds.): *Learning from the Future: Competitive Foresight Scenarios*, pp. 3-21, John Wiley & Sons.

Fahey, L and Randall R M (1997c): Integrating Strategy and Scenarios, in, Fahey L and Randall R M (Eds.): *Learning from the Future: Competitive Foresight Scenarios*, pp. 22-38, John Wiley & Sons.

Falkenberg, J (1992): *Cooperation in Shipping: Managing Strategic Alliances*, Stiftelsen for samfunns- og næringslivsforskning, Norges Handelshøyskole, Bergen.

Fergusson, P C (1998): *Euro Scenarios: Boom, Bust, or Bumble along?*, SRI Consulting, Business Intelligence Program, Report No. D98-2133, Menlo Park, California.

Ferguson, R (1995): *Technological Development in Small Firms - A Literature Survey*, Institute for Management of Innovation and Technology, IMIT Report 1995:73, Stockholm.

Fossen, S (1996): *Fra ny teknologi til kommersielle anvendelser - Bedriftssamarbeid for utvikling og kommersialisering av nye produkter*, Doktor Ingeniør avhandling (Ph.D. dissertation) 1996:110, Institutt for industriell økonomi og teknologiledelse, NTNU, Trondheim.

Georgantzas, N C and Acar, W (1995): *Scenario-Driven Planning: Learning to Manage Strategic Uncertainty*, Greenwood Publishing Group.

Godet, M (1983): Reducing the Blunders in Forecasting, *Futures*, pp. 181-192, No. 3, Vol. 15.

Godet, M (1987): *Scenarios and Strategic Management*, Butterworths.

Godet, M (1990): Integration of Scenarios and Strategic Management – Using relevant, consistent and likely scenarios, *Futures*, pp. 730-739, No. 7, Vol. 22.

Hamilton, H R (1981): Scenarios in Corporate Planning, *the Journal of Business Strategy*, pp. 82-87, No. 1, Vol. 2.

Haugland, S A (1996): *Samarbeid, allianser og nettverk*, Tano Aschehoug.

Haugland, S A and Reve, T (1994): Price, Authority and Trust in International Distribution Channel Relationships, *Scandinavian Journal of Management*, No. 3, Vol. 10.

Heirung, E (1964): Hvorledes analyserer man rasjonaliseringsmulighetene for seilende skip og for nybygg?, *SFI meddelelse - Rasjonalisering av laste/losseprosessene: Referat fra SFI's laste/lossekonferanse,* S*andefjord 20.-22. May,* No. M56, MARINTEK, Trondheim.

Håkansson, H and Johanson, J (1992): A model of industrial networks', in, Axelsson, B and Easton, G (eds.), *Industrial Networks*, pp. 28-34, Routledge, London.

Håkansson, H and Snehota, I (1989): No Business is an Island: The Network Concept of Business Strategy, *Scandinavian Journal of Management*, pp. 187-200, No. 3, Vol. 5.

Håkansson, H and Snehota, I (1995): *Developing Relationships in Business Networks*, Routledge, London.

Hompland, A (ed.) (1987): *Scenarier 2000 - Tre framtidsbilder av Norge*, Universitetsforlaget AS, Oslo.

Itami, H (1987): *Mobilizing Invisible Assets*, Harvard University Press, Cambridge, Massachusetts.

Kahn, H and Wiener, A J (1967): *The Year 2000 - A Framework for Speculation on the next Thirty-Three Years*, The Macmillan Company, USA.

Karlsen, A M (1997): Laboratoriene ved NTH - En bro mellom teori og industri?, in Børresen, A K, Kvaal, S, Thomassen, Ø and Østby, P (ed.): *Emner fra norsk teknologihistorie*, Senter for teknologi og samfunn, NTNU, Trondheim.

Klein, B, Crawford, R G and Alchian, A A (1978): Vertical Integration, Appropriable Rents, and the Competitive Contracting Process, *The Journal of Law and Economics*, pp. 297-326, Vol. 21.

Klein, H E and Linneman, R E (1981): The Use of Scenarios in Corporate Planning – Eight Case Histories, *Long Range Planning*, pp. 69-77, No. 5, Vol. 14.

Kline, S J and Rosenberg, N (1986): An Overview of Innovation, in Landau R and Rosenberg, N (eds.), *The Positive Sum Strategy - Harnessing Technology for Economic Growth*, pp. 275-306, National Academy Press, Washington D.C.

Kroneberg, A (1998): Exploring future logistics solutions by the use of scenarios, *CTT and VTS Research days on Transport and Logistics, November 3-4*, Gothenburg.

Kroneberg, A (1999a): A Scenario Based Exploration of Future Innovations in the Container Shipping Industry, *RINA Design and Operation of Containerships Conference*, London.

Kroneberg, A (1999b): Preparing for the future by the use of scenarios: Innovation in short sea shipping, *1st International Congress on Maritime Technological Innovations and Research*, April 21-23, Barcelona.

Kuhn, T (1962): *The Structure of Scientific Revolutions*, Chicago University Press, Chicago.

Leemhuis, J P (1985): Using Scenarios to Develop Strategies, *Long Range Planning*, pp. 30-37, Vol. 18, No. 2.

Levander, K (1994): Possibilities in Ship Design - Trends and Techniques, *Vision Eureka - Efficient and environmentally friendly freight transport. Conference proceedings*, pp. S3.2 1-17, Lillehammer.

Levin, R C, Klevorick, A, Nelson, R and Winter, S (1987): Appropriating the returns from industrial research and development, *Brookings Papers on Economic Activity*, pp. 783-820, No. 3.

Linneman, R E and Klein, H E (1979): The Use of Multiple Scenarios by U.S. Industrial Companies, *Long Range Planning*, pp. 83-90, No. 1, Vol. 12.

Linneman, R E (1983): The Use of Multiple Scenarios by U.S. Industrial Companies: A Comparison Study, 1977-1981, *Long Range Planning*, pp. 94-101, No. 6, Vol. 16.

Listog, B O (1997): Radioaktive vikingeskip - Norsk FoU på kjernefysisk fremdrift av skip 1948-1970, in Børresen, A K, Kvaal, S, Thomassen, Ø and Østby, P (ed.), *Emner fra norsk teknologihistorie*, Senter for teknologi og samfunn, NTNU, Trondheim.

Makridakis, S and Wheelwright, S C (1989): *Forecasting Methods for Management*, John Wiley & Sons, USA.

Mandel, T F and Wilson, I (1993), *How Companies Use Scenarios: Practices and Perception*, SRI International, Business Intelligence Program, Report No. 822, Menlo Park, California.

Mandel, T F (1993): *Scenarios and Corporate Strategy: Planning in Uncertain Times*, SRI International, Business Intelligence Program, Report No. 669, Menlo Park, California.

Mason, D H (1994): Scenario-based Planning: Decision Model for the Learning Organization, *Planning Review*, pp. 6-12, No. 2, Vol. 22.

Mattson, L G (1987): Management of Strategic Change in a ‘Market-as-Networks Perspective, in Pettigrew, A M (ed.): *The Management of Strategic Change*, Basil Blackwell, New York.

McKelvey, M (1993): Innovation Processes: Intertwining technical and market considerations in commercialization of genetic engineering, paper presented at, *The 2nd Workshop on Commercialization of Technology*, Foundation for Research in Economics and Business Administration (SNF), Bergen.

Meek, M (1997): Design and the Designer, *The Sixth International Marine Design Conference*, University of Newcastle.

Mercer, D (1995): Scenarios Made Easy, *Long Range Planning*, pp. 81-86, No. 4, Vol. 28, August 1995.

Miller, G (1956): The Magical Number Seven, Plus or Minus two, *Psychological Review*, pp. 81-97, No.63.

Millett, S M (1997): Futuring Consumer Products: An Illustrative Example of Scenario Analysis, in Fahey L and Randall R M (Eds.): *Learning from the Future: Competitive Foresight Scenarios*, pp. 285-295, John Wiley & Sons.

Mintzberg, H (1994): That's Not "Turbulence", Chicken Little, It's really opportunity, *Planning Review*, pp. 7-9, No. 6, Vol. 22.

Nelson, R R (1992): National Innovation Systems: A Retrospective on a Study, *Industrial and Corporate Change*, pp. 347-374, No. 2, Vol. 1.

Nilsen, R (1999): Review of the world fleet of vehicle carriers, trends and current investment in fleet development, *Global Automotive Trades and Logistics Exhibiton and Conference,* Rotterdam.

Norges forskningsråd – Industri og energi (1996): *Strategi for kompetanseutvikling, innovasjon og FoU for Maritim virksomhet*, Oslo.

Norges forskningsråd (1999): *Prosjektet Aluminium i skip*, offprint from 4/99, Oslo.

Nærings- og energidepartementet (1996): *Utfordringen - Forskning og innovasjon for ny vekst*, Rapport fra utvalg oppnevnt av Nærings- og energidepartementet, Oslo.

Nås, S, Sandven, T O and Smith, K (1994): *Innovasjon og ny teknologi i norsk industri: En oversikt*, STEP rapport 4/94, STEP-gruppen, Oslo.

Ohmae, K (1983): *The mind of the strategist*, Penguin Books.

Peeters, C and Wergeland, T (eds.) (1997): *European Shortsea Shipping. Proceedings from the third European Research Roundtable Conference on Shortsea Shipping in Bergen 1996*, Delft University Press, Delft.

Persson, G and Virum, H (eds.) (1995): *Logistikk for konkurransekraft*, Ad Notam Gyldendal, Oslo.

Porter, M E (1980): *Competitive Strategy - Techniques for Analyzing Industries and Competitors*, The Free Press, New York.

Quinn, L L and Mason, D H (1994): How Digital Uses Scenarios to Rethink the Present, *Planning Review*, pp. 14-17, No. 6, Vol. 22.

Reve, T (1990): The Firm as a Nexus of Internal and External Contracts, in Aoki, M, Gustafsson, B and Williamson, O E (eds.): *The Firm as a Nexus of Treaties*, pp. 133-161, SAGE Publications.

Reve, T (1996): Toward an Integrative Model of Strategy Development: From Dynamic Clusters to Core Competencies, in Falkenberg, J and Haugland, S A (eds.): *Rethinking the Boundaries of Strategy*, pp. 103-122, Handelshøjskolens Forlag, Copenhagen.

Reve, T and Stokke, P R (1996): *Strategisk analyse: Grunnlaget for praktisk strategiutvikling*, Fagbokforlaget, Bergen.

Ringland, G (1998): *Scenario Planning: Managing for the Future*, John Wiley & Sons.

Rogers, E (1983): *Diffusion of Innovations*, The Free Press, New York.

Rosenberg, N (1976): *Perspectives on Technology*, Cambridge University Press, Cambridge.

Schnaars, S P (1987): How to Develop and Use Scenarios, *Long Range Planning*, pp. 105-114, No. 1, Vol. 20.

Schwartz, P (1991): *The Art of the Long View*, Doubleday, New York.

Solberg, S L and Danielsen, A A (eds.) (1992): *Teknologiledelse - Markedsorientert bruk av teknologi*, Tano, Oslo.

Smith, K (1997): *Systems approaches to innovation: Overview and policy issues*, STEP Group, Oslo, Norway.

Statistisk Sentralbyrå (1998a): *Statistisk årbok 1998*, http://www.ssb.no/www-open/aarbok/geotab.shtml.

Statistisk Sentralbyrå (1998b): *Innenlandske transportytelser, 1997, Tabell 2. Innenlandsk godstransport, etter transportmåte*, http://www.ssb.no/www-open/ukens_statistikk/utg/9823/11-2t.txt.

Stokke, P R, Ralston, W K, Boyce, T A and Wilson, I H (1990): Scenario Planning for Norwegian Oil and Gas, *Long Range Planning*, pp. 17-26, No. 2, Vol. 23.

Syed, J R (1996): *From Scenarios to Strategic Action: Bridging the Gap*, SRI Consulting, Business Intelligence Program, Report No. D96-1998, Menlo Park.

Teece, D J (1986): Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy, *Research Policy*, pp. 285-305, No. 6, Vol. 15.

Tenold, S (1995*): Skipsfartskrisen og norske redere – en økonomisk historisk studie 1973-1980*, SNF-rapport 60/95, Senter for internasjonal økonomi og skipsfart, Bergen.

Trondsen, E (ed.) (1998): *Innovation in the Container Industry: A Scenario-based Analysis of Innovation*, SRI Consulting, Menlo Park, California.

Valente, T W (1995): *Network Models of the Diffusion of Innovations*, Hampton Press Inc., New Jersey.

Van Der Heijden, K (1996): *Scenarios: The Art of Strategic Conversation*, John Wiley & Sons.

Wack, P (1985a): Scenarios: uncharted waters ahead, *Harvard Business Review*, pp. 72-89, No. 5.

Wack, P (1985b): Scenarios: shooting the rapids, *Harvard Business Review*, pp. 139-150, No. 6.

Weyergang-Nielsen, A (1994): *Fra seil til damp*, Solum Forlag, Oslo.

Wijnolst, N, van der Hoeven, H B, Kleijwegt, C J and Sjøbris, A (1993a): *Innovation in Shortsea Shipping: Self-loading and -unloading unitload shipsystems*, Delft University Press, Delft.

Wijnolst, N , Peeters, C and Liebman, P (eds.) (1993b): *European Shortsea Shipping. Proceedings from the first European Research Roundtable Conference on Shortsea Shipping in Delft 1992*, Delft University Press, Delft.

Wijnolst, N (1995), *Design Innovation in Shipping*, Delft University Press, Delft.

Wijnolst, N and Peeters, C (eds.) (1995): *European Shortsea Shipping. Proceedings from the second European Research Roundtable Conference on Shortsea Shipping in Athens/ Vouliagmeni 1994*, Delft University Press, Delft.

Williamson, O E (1975): *Markets and Hierarchies*, The Free Press, New York.

Williamson, O E (1985): *The Economic Institutions of Capitalism: Firms, Markets and Relational Contracting*, The Free Press, New York.

Williamson, O E (1993): Transaction Cost Economics and Organization Theory, *Industrial and Corporate Change*, pp. 107-156, No. 2, Vol. 2.

Wilson, I (1992*): Developing a Scenarios-Based Planning Culture: A Blueprint for Implementation,* SRI International, Business Intelligence Program, Report No. D92-1630, Menlo Park, California.

Wilson, I (1997): Mental Maps of the Future: An Intuitive Logics Approach to Scenarios, in, Fahey, L and Randall, R M (Eds.), *Learning from the Future: Competitive Foresight Scenarios*, pp. 81-108, John Wiley & Sons.

Ying, H (1989): *A study of Marketing and Design in Development of Marine Transport Systems*, Dr.Ing. thesis, Department of Marine Design, The Norwegian Institute of Technology, Trondheim.

Zachcial, M (1996): Land/Sea Transport Flows in Europe, in Peeters, C and Wergeland, T (eds.) (1997): *European Shortsea Shipping. Proceedings from the third European Research Roundtable Conference on Shortsea Shipping in Bergen 1996*, Delft University Press, Delft.

Zaman, P A and Wilson, I H (1991): *Scenario Planning in Telecommunications: A Decision-Focused Approach,* SRI International, Business Intelligence Program, Report No. D91-1507, Menlo Park, California.

Østvik, I, Wergeland, T and Kroneberg, A (1998): A Formalised Methodology for a SSS Corridor Study: Western Norway – Continent, *RINA Fast Freight Conference*, London.

Appendix A

Appendix A contains a paper presented at the RINA Design and Operation of Containerships Conference, London, 1999.

TITLE:

A Scenario Based Exploration of Future Innovations in the Container Shipping Industry

AUTHOR:

André Kroneberg – The Norwegian University of Science and Technology, Trondheim

SUMMARY

The paper is based upon the results from a research project, initiated by the Norwegian Marine Technology Research Institute (MARINTEK), which primary aim was to give an analysis of possible future innovations in container shipping [1]. Rather than forecasting specific innovations in a highly uncertain environment - with a very small chance of correctly forecasting such innovations - the project team realised that richer and more useful results would be obtained by the use of a scenario methodology.

Scenarios are alternative stories about how the future might develop. Scenarios are not predictions, but rather descriptions of plausible futures. In this project, scenarios were used as explorative tools for thinking about the future in new ways.

Four structurally different scenarios are established based on two identified key drivers of innovation: Conference Erosion (elimination of the conference system - public policies that grant antitrust immunity to carriers on issues of price and service offerings) and Seamless Systems Integration (full scale adoption and implementation of open architecture information and telecommunications systems). Should these factors, or some combination of these factors occur, carriers would need to develop innovative services and capabilities to remain competitive against their main rivals and other forms for competition.

Taking a supply chain perspective, the paper identifies and discuss the rationale for possible innovations within each of the four scenarios, and specifically address the interface and relations between deepsea and shortsea container shipping.

AUTHORS BIOGRAPHY

André Kroneberg graduated as a Master of Science in marine design from the Norwegian University of Science and Technology in December 1995. He is currently a Ph.D. candidate at the Department of Marine Design at the Norwegian University of Science and Technology, pursuing the topic ‘innovation in shortsea shipping’. Since 1996, he is also working as a Research Engineer at MARINTEK, within the field of shipping and offshore logistics. He has been a visiting fellow at the Business

Intelligence Center (SRI Consulting), Menlo Park, California, and studies scenario techniques.

1 INTRODUCTION

Today, the container shipping industry is characterised by eroding profitability, a fragmented industry structure with a large number of participants of varying size, and competition that is largely based on cost and operational efficiency and/or regulated pricing structures [1, 2].

Change in the container shipping industry takes place slowly, at least in taking actions that can shift the basis of competition (through radical or breakthrough innovations). The container shipping industry has introduced some changes in ship design and size in order to realise economies of scale. Other changes may be related to implementation of tracking software, hub and spoke systems and double stack trains [1].

In general, one could say container carriers today are striving to reduce costs wherever they can. This behaviour is reinforced by the liner conference structure, which sets service and rates at a level to satisfy the least competitive members. In allowing liner conferences, the regulatory regime discourages innovative carrier behaviour by protecting carriers from the risks of competing in open markets [1].

Key structural components of the container shipping industry are, however, undergoing varying degrees of change. The degree of change in these structural components and their impact on future innovations in the container shipping industry can not be known for sure. Scenarios acknowledge this uncertainty by making it possible to take into account structural changes causing the future to deviate radically from observable trends.

First, the paper gives a definition and explanation of scenarios, followed by a presentation of possible benefits which may be gained by the use of scenarios. Thereafter, it outlines a formalised methodology for conducting a scenario analysis. The paper proceeds with presenting results from a scenario based analysis of innovation in the container shipping industry. Finally, some conclusions are drawn.

2 THE NATURE OF SCENARIOS

This chapter will start by explaining the concept of scenarios. Thereafter, possible benefits stemming from the use of scenarios will be described. Finally, a formalised methodology for developing scenarios will be presented, together with some key problems in scenario generation.

2.1 DEFINITION

Scenarios are alternative stories about how the future might develop. Scenarios are not predictions, but rather descriptions of plausible futures. Scenarios reject traditional single point forecasting techniques based on historical data, by making it possible to take into account structural changes causing the future to deviate radically from observable trends. The scenario approach to addressing uncertainty is illustrated in Fig 1. The scenarios are developed in a logical and structural manner as described in chapter 2.3.

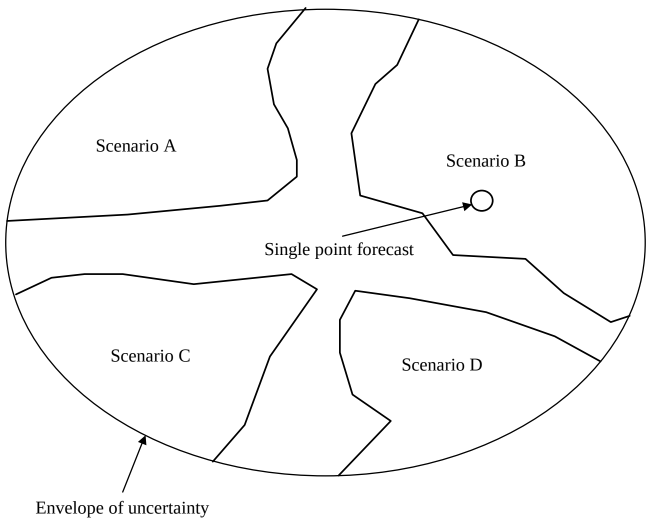


Fig 1 Scenarios bound the envelope of uncertainty [3]

2.2 BENEFITS

Companies report a wide range of benefits stemming from scenario planning [3, 4, 5]:

- A broader framework for strategic planning (helps to avoid blindspots that result from considering isolated trends, solely quantifiable information and purely economic data) - more complete understanding of the dynamics of change, present and future
- Consistent frameworks and language for discussing critical future issues throughout the business
- Encouraging new ways of thinking about and planning for the future (exploratory studies) - an expanded range of strategy options
- More robust and flexible strategies, through the use of scenarios as a testbed for evaluation of strategies
- Identification of major uncertainties so that companies can develop and direct appropriate business-environment scanning and monitoring efforts

The paper is based upon the results from a research project aiming to give an analysis of possible future innovations in the container shipping industry. In this project, scenarios were used as tools for thinking about the future in new ways (exploratory studies).

2.3 A SCENARIO METHODOLOGY

In the following, a methodology for developing scenarios will be presented. This methodology is developed by SRI Consulting. SRI Consulting has used scenario based techniques in a wide range of studies of the future since the mid 1960s. SRI Consulting also played a major role in the research project described in this paper (chapter 3).

The methodology, as illustrated in Fig 2, is based on a six step process that a multidisciplinary team performs in a series of workshops. The six steps will be further commented and exemplified in chapter 3.

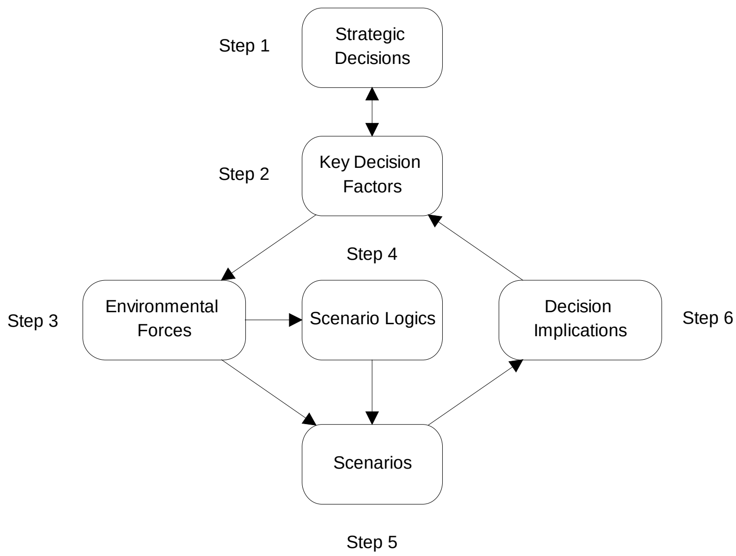


Fig 2 A scenario methodology [5]

The process is decision-focused in that its starting points give a clarification of the strategic decisions the scenarios aim to address and of the key decision factors. Describing the strategic decisions will focus and constrain the subsequent steps in the process. Key decision factors are the matters that the decision makers want more information about, because if this information was available it would enable them to make better decisions.

Step 3 seeks to identify environmental forces that influence the value of the key decision factors. It may be helpful to structure the thinking around micro-environmental forces and macro-environmental forces. Micro-environmental forces may be analysed according to Porter's five competitive forces (competitors, suppliers, buyers, potential entrants, and substitutes) [6]. The macro-environmental forces may be analysed by the help of the SEPT scheme - in which environmental forces are organised in terms of Social, Economic, Political and Technological factors [4]. Following the identification of the environmental forces, the forces have to be analysed in terms of their relative uncertainty and importance for and impact on the key decision factors. The key uncertainties confronting the business - and the sources of difference among the scenarios - lie in the forces grouped in the “high impact/high uncertainty area” [3].

Step 4 may be referred to as “the heart of the scenario process”. The scenario team seeks to identify different scenario logics - organising principles or themes - that will reasonably encompass the “high impact/high uncertainty area” [4]. Structuring scenarios around various combinations of all high impact uncertainties would create an unmanageable number of alternative futures. The team needs to group, or cluster the forces identified in step 3 logically around a limited number of key “axes of uncertainty” that provide a structure for the scenarios and stretch the envelope of uncertainty to its plausible limits [3].

In step 5, the participants describe the scenarios in sufficient detail to identify and explore decision implications. Normally these scenario descriptions will include an extended story line of two to three pages, a tabular description of scenario differences, and selective quantification of key factors. Regardless of how the scenarios eventually are presented, they should always include clear statements of the underlying logics and key assumptions [4, 5].

In the last step, participants analyse and interpret the scenarios to identify their implications for the prospective decision [5].

Even when following a formalised methodology for developing scenarios, there are several factors in scenario generation that tend to make things complicated. These factors must be dealt with in workshops undertaken by the project participants [7]:

- Difficult to limit the number of uncertain factors to be considered (an evaluation of importance of the different factors, and cross-impact methods for developing clusters of factors may reduce this difficulty)
- People tend to be conservative, cannot imagine dramatic shifts (scenarios may, however, be a helpful tool for conservative people as they are forced to think beyond a "most likely" future)
- Difficult to assign probabilities to final scenarios chosen (However, there are dangers associated with attaching probabilities to scenarios. Comprehensive scenarios are quite improbable, due to the fact that each scenario includes much information and many estimates about future condition. For all these conditions to happen as described is quite unlikely. The future that actually occurs will more likely fall within the envelope indicated by a good set of scenarios. As the purpose of scenarios is partly to enrich the understanding of future uncertainties in the business environment, scenarios aim more to examine the interplay and dynamics of forces shaping the future than to identify a most probable scenario)

3 EXPLORING FUTURE INNOVATIONS IN CONTAINER SHIPPING

This chapter presents results from a scenario based analysis of innovation in the container shipping industry. The analysis was undertaken by the Norwegian Marine Technology Research Institute (MARINTEK) in co-operation with SRI Consulting.

The main goal and decision focus for the project was to describe the extent and type of innovations that may emerge in the container shipping industry. However, as this is a first attempt to use scenarios in a shipping context (according to the project team's knowledge), the process and its results should be regarded as a ”demonstrator”. Given the nature and objectives of the SRI-MARINTEK project, a simplified version of SRI's full-blown scenario methodology, as described in chapter 2.3, was chosen. The simplified approach involved the following steps:

- Examining alternative key driving forces that could play a key role in determining the future business environment in container shipping (step 3 in chapter 2.3)
- Selecting the two most important driving forces of the scenarios (step 4 in chapter 2.3)
- Deriving four alternative scenarios based on the two driving forces (step 4 and 5 in chapter 2.3)
- Exploring implications for innovations within each scenario (step 6 in chapter 2.3)

In the following, these steps will be discussed – leading up to a presentation of each of the four scenarios with implications for both deepsea and shortsea container shipping.

3.1 SELECTING KEY DRIVING FORCES AND SCENARIO LOGIC

After a thorough analysis of external forces shaping the future business environment in container shipping, the project team concluded that some of the key structural components of the container shipping industry are undergoing varying degrees of change. The change trigger of greatest importance is the need to satisfy customers that are demanding ever-higher levels of service, in terms of fast and reliable deliveries. The emerging information technologies contribute to a strengthened focus on customer service in terms of real time information and order status. Another structural component of great importance is the regulatory regime which question the carrier conference system due to competitive constraints. The broader issue of national protection of carriers is on the agenda of the next World Trade Organisation discussions. In addition, shippers are also organising to fight the conference system.

With a basis in the analysis of external forces and emerging trends, the two driving forces that the project team believe were most important in determining future innovations in the container shipping industry were identified as:

- Elimination of the conference system (generally, public policies that grant antitrust immunity to carriers on issues of price and service offerings)

- Full-scale adoption and implementation of open architecture information and telecommunications systems

Should these factors, or some combination of these factors occur, carriers will need to develop innovative services and capabilities to remain competitive against their main rivals and other forms of competition. The nature of these innovations will be exploitative rather than explorative. Brand new concepts of container shipping – such as disposable containers or ships that travel on land – are not expected, but rather in the creative implementation and extension of existing ideas, technology and practices. The full flowering of these ideas – in the form of creative and radical approaches to customer relations, competitor alliances, and new service offerings – will not take place until the conference system erodes or changes significantly from its current state and until full-scale adoption of integrated global information systems becomes a reality.

The ocean conference system, although beginning to permit more market-oriented member actions, on the whole still inhibits efficiency and innovation in the container industry. For carriers inside conferences, rules govern prices and services offered to shippers, which to some degree inhibit close carrier-shipper partnerships. In addition, ”creative” pricing to accommodate the individual needs of important shippers is generally not available to carriers. Carriers outside the conference trades enjoy their own form of protection from carriers that compete principally within the conference system. These nonconference carriers are insulated from direct competition with many of the larger, better-equipped and financed global carriers, which are content to operate within conferences to obtain their protective advantages.

Supply chain integration is dependent upon integration of information systems and databases across multiple value chains. In this way, seamless information exchange will become a key enabler that links supply-chain members and drives innovation. However, some barriers to this development remain such as the lack of universal data and communication standards and formats.

A scenario logic based on the two driving forces was established as shown in Fig 3.

		Conference Erosion (CE)	
		Significant	Insignificant
Systems Integration (SI)	Significant	**Scenario 1:** “Interactive Partnerships”	**Scenario 2:** “Turbulent Times”
	Insignificant	**Scenario 3:** “Tailored Partnerships”	**Scenario 4:** “More of the Same”

Fig 3 Scenario Logic

3.2 FOUR SCENARIOS AND THEIR IMPLICATIONS ON FUTURE INNOVATIONS IN THE CONTAINER SHIPPING INDUSTRY

Taking a supply chain perspective, each scenario and its implications for future innovations in the container shipping industry will be discussed. The interface and relations between deepsea and shortsea container shipping will be given special attention.

The identified innovations reflect the project teams accumulated experience of the supply chain arena. Additional in-depth analysis would be necessary to confirm, reject, or modify the conclusions. The resulting scenarios and implications for innovations are very much a function of the selection of the key driving forces. If the two key drivers change significantly, the conclusions could also change significantly.

3.2(a) Scenario 1: ”Interactive Partnerships” (CE: Significant, SI: Significant)

In this scenario, conferences experience significant erosion, removing major competitive constraints from carriers. Significant systems integration takes place, enabling closer links among carriers, suppliers, shippers and receivers and allowing better and more real-time communications and data flow.

Likely supply chain innovations in this scenario are:

- Shippers and carriers join forces in strategic and tactical transport and network planning activities. With a basis in integrated co-operative systems, shippers and carriers will integrate their planning, execution, and analysis systems to maximise profits for each partner
- The number of brokers (or middlemen) is reduced. This trend is already observable in the container shipping industry today. In Europe, Nedlloyd has introduced a “one stop shopping” concept under the tradename of “Nedlloyd Flowmasters” [2]
- Critical interface linkages improve. Integrated information systems among partners will facilitate efficient, highly productive cargo transfers at critical interfaces in the supply chain, such as terminals and intermodal facilities
- Integrated value chains. Each participant is able to understand clearly and immediately the financial, operational, and strategic implications of actions it and other channel members take in the course of doing business

Implications for shortsea carriers in this scenario:

Global ocean carriers, information systems companies such as Microsoft and IBM, and logistic management companies will drive innovations. These big companies will seek other alliance partners who are excellent in their fields, including shortsea carriers. Shortsea carriers will be vital links in the success of moving and storing cargo and information to the final destination, and as feeder vessels working on behalf of the larger channel captain. A considerable customer intimacy is necessary to prosper in this scenario. Big investments in management and information systems will have to be made in order to avoid acquisitions or mergers either by other SSS operators or by the larger channel captain itself.

3.2(b) Scenario 2: ”Turbulent Times” (CE: Insignificant, SI: Significant)

In this scenario, significant systems integration takes place enabling more efficient communication and information flows. No significant conference erosion takes place and the carriers lack the freedom for competitive actions that emerge in scenario 1.

Likely supply chain innovations in this scenario are:

- Financially able conference carriers create interactive planning and tactical systems with shippers. Conflicts will erupt with other conference carriers that rely on traditional methods of setting price and service levels
- Some nonconference carriers will also invest in high-level interactive systems. Some conference carriers will want to create supply-chain alliances with nonconference carriers that share their goals. The desire to reach across conference barriers may result in disharmony among conference members
- Because of the inability to create completely seamless supply chains (due to conference barriers), players will focus on improving internal and external data communications and capabilities
- Certain carriers will use information systems to become specialists in selected operational areas and will sell these services to others, including competitors, in and outside the container shipping industry.

Implications for shortsea carriers in this scenario:

Regional operators would have to invest in high-level systems capabilities. In addition, a great uncertainty will exist due to the fact that shortsea operators will be dragged into experiments of large conference members to reach out to non-conference members to form relationships with carriers best in their fields.

3.2(c) Scenario 3: ”Tailored Partnerships” (CE: Significant, SI: Insignificant)

In this scenario, significant conference erosion takes place, creating a more open competitive environment. But the information technology infrastructure that enables closer linkage between companies is now absent, due to insignificant systems integration.

Likely supply chain innovations in this scenario are:

- Large carriers create close-knit partnerships with selected shippers representing high profit margins. Elimination of conferences will permit this kind of relationships

- Smaller carriers form alliances with large global network providers. More of the small carriers will survive this scenario than in scenarios 1 and 2 because major systems investment will be less
- Many carriers will develop value-added service offerings that are not based on information systems. Without the integrated systems capabilities of scenarios 1 and 2, service differentiation based upon precise transit times, sailing frequencies, and guarantees of service reliability will not be possible. Instead carriers will move into other forms of more basic value added services in such areas as warehousing and distribution

Implications for shortsea carriers in this scenario:

With lower systems investment, shortsea operators could fare well under this scenario. The larger carriers would no longer be insulated from non-conference competition and would want to form alliances with smaller, but highly efficient partners. They would want to form industry-focused supply chains with support from smaller carriers.

3.2(d) Scenario 4: ”More of the Same” (CE: Insignificant, SI: Insignificant)

In this scenario, neither of driving factors – conference erosion or systems integration – changes significantly. Thus, little structural change and little radical innovation can occur.

Likely supply chain innovations in this scenario are:

- Carriers will focus on process improvement initiatives. Most non-ocean industry firms have accepted the value of “process reengineering” to reduce cost and improve efficiencies. In general ocean carriers have been behind other sectors in adopting these tools. With few innovations likely, process reengineering will be the focus of ocean carriers
- More cost driven alliances will occur. Gradually, these alliances will try to include customer service issues as time goes by, but this step will be difficult because of conference rules and non-integrated systems

Implications for shortsea carriers in this scenario:

If shippers could not obtain satisfactory levels of service and product offerings from the container industry, they would obtain it from alternative forms of transport, such as truck, rail and air. Some short sea carriers would survive as niche players by implementing process reengineering programs and investing in quality market segmentation programs. Internal process improvements would be in focus.

4 CONCLUSION

By using a scenario methodology, container carriers may prepare for an uncertain tomorrow. Scenarios capture the envelope of uncertainty and provide carriers with benefits related to more complete understanding of the dynamics of change, common mental frameworks for discussing future issues, creative ideas and robust strategies.

Results stemming from a scenario based analysis of future supply chain innovations in the container shipping industry are presented. Based on the two key drivers – conference erosion and systems integration – four scenarios are developed based on significant and insignificant levels of the key drivers. Broadly, major changes in these two external factors could lead to significant carrier innovation, including integrated strategic planning, mergers and alliances, integrated value chains, new ways to manage information assets and improved customer service.

The resulting scenarios and implications for innovations are very much a function of the selection of the key driving forces. If the two key drivers change significantly, the conclusions could also change significantly.

5 REFERENCES

1. Trondsen, E (ed.): ”Innovation in the Container Industry: A Scenario-based Analysis of Innovation”, SRI Consulting, Menlo Park, California, 1998.

2. Drewry Shipping Consultants Ltd: ”Strategy and profitability in global container shipping”, London, 1991.

3. Zaman, P A and Wilson, I H: ”Scenario Planning in Telecommunications: A Decision-Focused Approach”, SRI International, Menlo Park, California, 1991.

4. Mandel, T F: ”Scenarios and Corporate Strategy: Planning in Uncertain Times”, SRI International, Menlo Park, California, 1993.

5. Mandel, T F and Wilson, I H: ”How Companies Use Scenarios: Practices and Perception”, SRI International, Menlo Park, California, 1993.

6. Porter, M E: ”Competitive Strategy – Techniques for Analyzing Industries and Competitors”, New York, 1980.

7. Østvik, I, Wergeland, T and Kroneberg, A – ”A Formalised Methodology for a SSS Corridor Study: Western Norway – Continent”, RINA Fast Freight Conference, London, 1998.

Appendix B

Appendix B contains a paper presented at the 7th International Marine Design Conference, Korea, 2000.

DESIGNING FUTURE TRANSPORT SYSTEMS BY SCENARIO AND OPTIMISATION TECHNIQUES

KJETIL FAGERHOLT[1] and ANDRÉ KRONEBERG[1]

[1] Norwegian University of Science and Technology

ABSTRACT

In this paper, scenario and optimisation techniques are combined in order to design optimal transport systems for an uncertain future. Scenarios establish a set of future transport requirements, which serve as input to an optimisation algorithm. For each scenario, an optimal transport system is suggested. By analysing these results, one may seek a robust solution meeting requirements of all scenarios. By monitoring certain key drivers of change one may also be able to respond quickly to emerging scenario(s). A simplified case study illustrates the use of the methodology. The case is related to the development of a transport system aiming to maintain the supply to a set of offshore installations today and in the future. The transport system is defined as a fleet of supply vessels, which is characterised by the number and type of each vessel.

1. INTRODUCTION

Designing future transport systems is a challenging task due to ever changing conditions in the business environment. This paper presents a methodology for this purpose that combines and integrates scenario and optimisation techniques. The methodology identifies and analyses key drivers of change in the business environment with a high impact on the transport systems in order to suggest optimal transport policies. To the authors' knowledge, integrating scenario and optimisation techniques is new to the literature.

First, a set of scenarios is developed for the problem considered. Scenarios are defined as images of possible futures, each with a plausible story that accounts for how the scenario develops logically (in a cause/effect way) from the present. The scenarios will establish a set of transport requirements that may vary from one scenario to another. The requirements serve as input to an optimisation algorithm, in which the actual transport problem is modelled and then analysed by a computer. For each scenario, an optimal transport system is suggested. By evaluating these results, one may seek a robust solution meeting requirements of all scenarios. By monitoring key drivers of change one may also be able to respond quickly to emerging scenario(s). Finally, the suggested transport systems may serve as input to a further specification and design of vessels.

A case study from the offshore oil industry will illustrate the use of the methodology. The case is related to the design of a transport system aiming to maintain the supply to a set of offshore installations today and in the future. The transport system is defined as a fleet of supply vessels, which is characterised by the number and type of each vessel. By analysing how changes in the business environment may affect the number of installations to be served, their location and transport demand, a set of scenarios is established. The scenarios then serve as input to the optimisation algorithm and an optimal transport system for each scenario is obtained. The solutions may be a decision support for designing a future transport system.

In chapter 2, a brief overview of both scenario and optimisation techniques is given, and the advantages of integrating these techniques are discussed. Chapter 3 presents the use of the methodology on the case study, while conclusions are given in chapter 4.

2. METHODOLOGY

This chapter provides a short introduction to scenario and optimisation techniques and potential benefits from integrating these techniques.

2.1 Scenario Techniques

Scenarios are structurally different stories about how the future might develop. Scenarios are not predictions, but rather descriptions of plausible futures. Scenarios reject traditional single point forecasting techniques based on historical data, by making it possible to take into account structural changes in the business environment causing the future to deviate radically from observable trends.

Scenarios emerged following World War II, as a method for military planning. The U.S. Air Force tried to imagine what its opponents might do, and prepared alternative counter active strategies [1]. The theoretical and practical foundations for the use of scenarios in business were developed in the 1970s. The importance of using scenarios to address uncertainties in strategic planning was dramatically underlined by the widespread confusion, which followed the oil price shock in 1973 [2].

Companies report a wide range of benefits from scenario planning ([3], [4] and [5]):

- A broader framework for strategic planning. Scenarios help to avoid blind-spots that result from considering isolated trends, solely quantifiable information and purely economic data.
- Consistent frameworks and language for discussing critical future issues throughout the business.
- New ways of thinking about and planning for the future (exploratory studies).
- More robust and flexible strategies through the use of scenarios as a test-bed for evaluation of strategies.
- Identification of major uncertainties so that companies can develop and direct appropriate business-environment scanning and monitoring efforts.

For an introduction to the broad spectrum of various scenario techniques, see for example [6], [7] and [8]. The techniques are mainly of a qualitative and intuitive nature, thus resulting in “story-based” scenarios. The strategic consequences of stories may sometimes be hard to concretise and quantify (e.g. “How many vessels, of what capacity and speed should be bought or chartered if this scenario should occur?”). A lack of clear understanding of strategic consequences derived by scenarios is a potential obstacle for fully realising the benefits from using scenario techniques.

2.2 Optimisation Techniques

A general formulation of a mathematical optimisation problem can be stated as:

$$\min \mathbf{f}(\mathbf{x}), \tag{1}$$

$$\text{Subject to} \quad \mathbf{x} \in \mathbf{X}. \tag{2}$$

Here, **f** is an objective function to be minimised, while **x** is a vector of variables or decisions. **X** is the solution space for the vector **x**, defined by the problem constraints. Various techniques exist to solve optimisation problems defined as in (1) – (2). Examples of such techniques are linear/integer programming, dynamic programming and specialised network algorithms, see for instance [9]. Combinations of these techniques may also be applied to solve optimisation problems. Rule-based search techniques may also be a good approach, especially for combinatorial problems where it is hard to find the supreme optimum, see for instance [10].

It is hard to discuss the applicability of optimisation techniques on a general basis, due to the variety of these techniques. However, there are (at least) two common characteristics for these techniques.

First, one has to make a model of the real problem considered. The optimal solution of a model is however not an optimal solution of a problem unless the model is a perfect representation of the problem, which it never is [11]. When it comes to modelling the real problem, there is often a trade-off between detail level of the model and the ability to solve it. One often has to make simplifications to be able to construct models that can be solved.

Second, most optimisation techniques do not handle uncertainty and stochastic elements in an explicit way. However, in the last decade or so there has been some research effort in developing optimisation techniques for stochastic problems, see for instance [12]. Still, most practical stochastic problems are really hard to solve by optimisation techniques and one may also often question how well the stochastic models succeed in reflecting the uncertainty of the real problem.

Despite this, there are numerous examples of successful applications of optimisation techniques. In problems where the solution space is large, it may often be a good help to let an optimisation routine implemented on a computer search through the solution space. The solutions from an optimisation algorithm may also be a valuable support in understanding strategic consequences of various decisions. In a study of determining optimal routing policies for supply vessels in the oil industry by Fagerholt and Lindstad [13], an optimisation method was applied to evaluate the effect of various decisions. Based on this, the Oil Company changed their fleet of supply vessels, and experienced annual savings of several million dollars.

2.3 Integrating Scenario and Optimisation Techniques

Realising that scenario and optimisation techniques may complement each other, a number of desired benefits might be realised by combining the two.

Optimisation techniques do not handle uncertainty in a satisfactorily way, but "story-based" scenario techniques describe possible structural changes that may cause the future to deviate radically from observable trends. These scenario techniques do not give a complete understanding of strategic consequences, but optimisation techniques will reveal quantifiable consequences of scenario assumptions.

To the authors' knowledge, integrating scenario and optimisation techniques is new to the literature. However, simulation techniques have successfully been applied in scenario planning in order to calculate variables such as revenue, cost, profit and market share over a number of business cycles. Computer simulations also allow for exploration of how key drivers of change interact over time and their resulting strategic implications. For practical suggestions on how to integrate simulation with scenario planning see [14].

3. CASE STUDY

In this chapter, a case study demonstrates how scenario and optimisation techniques may be integrated.

3.1 Problem Description

Today, oil companies are operating a number of various offshore installations around the world. Crucial for an efficient operation is that regular supplies of various commodities (e.g. food, mud, brine, diesel and water) are maintained. Offshore installations are normally served from onshore depots by supply vessels.

In this simplified case, we imagine three offshore installations presently being served from one onshore depot, as illustrated in Figure 1. The task is to design an optimal transport system for serving offshore installations today and in the future. The transport system is defined as a set of supply vessels, which is characterised by the number and type of vessels. In the future, the structure of installations (number, location and demand) depends upon changes in the business environment, which again may influence the need for transport demand. We assume for simplicity that there are only two vessel sizes and two vessel speeds that can be selected. This gives a total of four vessel types: Small/slow, small/fast, large/slow and large/fast. Each vessel type has a given time charter cost.

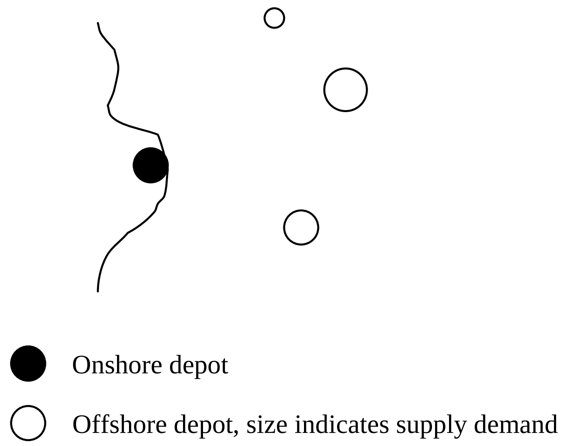


Figure 1: Onshore depot and offshore installations, today

3.2 Development of Scenarios

In order to develop the scenarios, a scenario technique developed by SRI Consulting is applied (refer Figure 2). SRI Consulting has used scenario based techniques in a wide range of studies of the future since the mid 1960s.

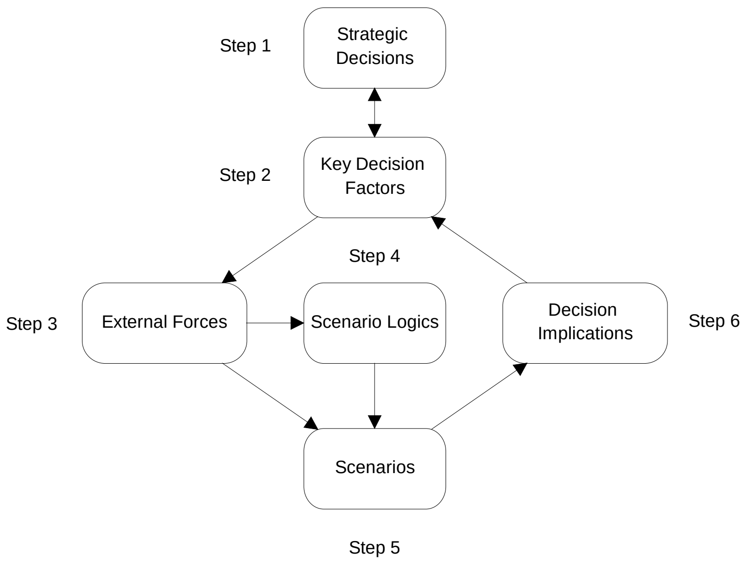


Figure 2: Scenario Technique developed by SRI Consulting [4]

The methodology includes six steps that a multidisciplinary team should perform in a series of workshops. In this case study, however, the purpose is merely to demonstrate benefits from integrating scenario and optimisation techniques. A full-blown scenario process has therefore not been undertaken. A simplified approach was chosen. The authors worked out a set of scenarios in a one-day workshop based on their experience from earlier projects in offshore logistics.

In the following, the results from the one-day workshop are presented by following the six steps in the scenario technique as presented in Figure 2.

The process starts out by identifying the strategic decisions the scenarios should answer. The strategic decision will focus and constrain the subsequent steps in the process. In this case, the strategic decisions were stated as:

Design an optimal transport system for serving a set of offshore installations today and in the future. The transport system is defined as a set of supply vessels, characterised by the number and type of each vessel.

In the second step, a set of key decision factors is identified. Key decision factors are the matters that the decision-makers want more information about, because if this information were available it would enable them to make better decisions. In order to choose an optimal transport system for serving future offshore installations, the authors would like to know more about:

- Client structure – number, location and demand of existing and future installations

The third step seeks to identify external forces that influence the value of the key decision factors. It may be helpful to structure the thinking around micro forces and macro forces. Micro forces may be analysed according to Porter's five competitive forces (competitors, suppliers, buyers, potential entrants, and substitutes) [15]. The macro forces may be analysed by the help of the SEPT scheme - in which external forces are organised in terms of Social, Economic, Political and Technological factors [5]. Normally, 80-100 external forces are identified.

In the fourth step, the forces are analysed in terms of their relative uncertainty and impact on the key decision factors. The key uncertainties confronting the strategic decision - and the sources of difference among the scenarios - lie in the forces grouped in the "high impact/high uncertainty area" [3]. By analysing and clustering "high impact/high uncertainty" forces, key drivers of change are identified and a structure for the scenarios is developed. For the case study, two key drivers of change were established:

1. **The Oil Price**. A key driver with a high impact on the level of exploration activities.
2. **Technology Development**. A key driver influencing the type of new installations to be developed (e.g. sub-sea and floating production).

In selecting the key drivers, we were trying to identify drivers with a high level of independence, in order to achieve structurally different scenarios. Each key driver was assigned two extreme, but plausible, levels of occurrence. In this way, the extreme points of plausible futures could be embraced. Based on the two key drivers a scenario logic was established as shown in Figure 3.

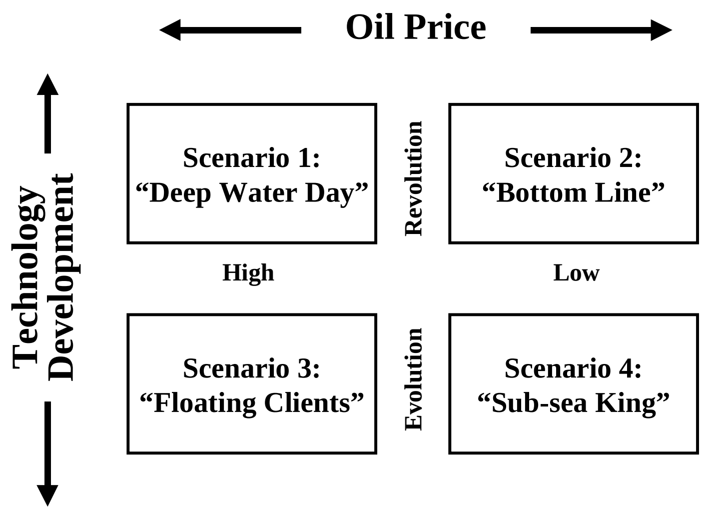
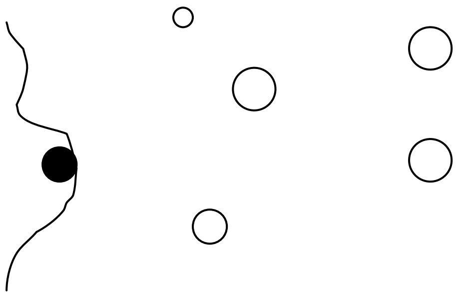
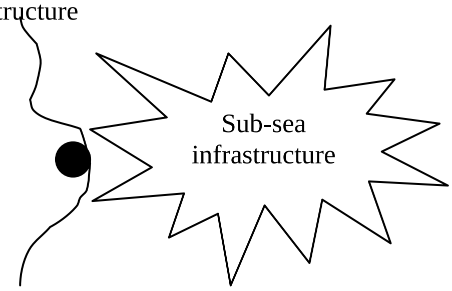
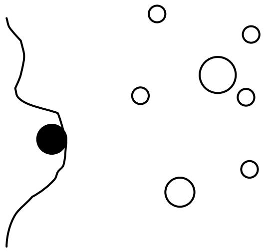
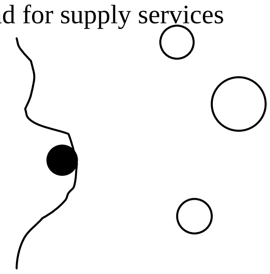


Figure 3: The scenario logic

In Table 1, a short summary (step 5) of the scenarios is given together with their strategic implications (step 6) for the key decision factors (step 2) and the strategic decisions (step 1).

Table 1: Four scenarios

Scenario 1 "Deep Water Day" **(High Oil Price, Revolutionary Technology)**	**Scenario 2 "Bottom Line"** **(Low Oil Price, Revolutionary Technology)**
The scenario is characterised by: • A stable high oil price • Strengthened exploration activities • Breakthroughs in deep water technology enabling exploitation of deep water oil fields Likely strategic implications are: • Development of two major deep water fields with high supply demands, located farther away from shore than existing fields • Continuation of production in existing fields 	The scenario is characterised by: • The oil price resides in a low level • Reduced exploration activities • The low oil price triggers a breakthrough in technologies for separation of oil, allowing for sub-sea production and processing with direct transfer of oil to shore by pipelines Likely strategic implications are: • Close-down of existing fields, due to low oil price • Only minor needs for supply services in order to develop sub-sea installations and infrastructure 
Scenario 3 "Floating Clients" **(High Oil Price, Evolutionary Technology)**	**Scenario 4 "Sub-sea King"** **(Low Oil Price, Evolutionary Technology)**
The scenario is characterised by: • A high oil price ensured by strong self discipline among OPEC members • Strengthened exploration activities • Floating production technology improves as experience from operation is gained Likely strategic implications are: • Continuation of production in existing fields • Oil production in a number of smaller new fields by floating production vessels results in increased supply demand 	The scenario is characterised by: • A steady reduction in the oil price • Reduced exploration activities • Further development of today's sub-sea technology for improving the utilisation of existing fields Likely strategic implications are: • No new installations • Continuation of production in existing fields • Sub-sea production connected to the existing infrastructure results in slightly increased demand for supply services 

3.3 Designing optimal solutions

An optimisation algorithm is developed to determine the optimal fleet of supply vessels for each scenario. However, to determine an optimal fleet, one must also consider the coherent routing policy for the fleet, since the routing influences the optimality of the fleet and vice versa. The algorithm used to determine the optimal fleet therefore also simultaneously calculates the coherent routes for each vessel selected to be in the fleet (although the determination of the routes is not an essential task in this matter). The routes to be performed by the vessels are repetitive with given time intervals. For instance, one may determine routes that are to be repeated with a cycle of one week.

Since a vessel may perform several routes during the cyclic time interval, the underlying routing problem can be considered to be a multi-trip Vehicle Routing Problem (VRP). The classical single-trip VRP is a hard and well-known combinatorial optimisation problem which calls for the determination of the optimal routes for a fleet of vehicles with given capacities, based at a depot, serving a set of customers with given demands. For details on the VRP, see for instance the survey of Toth and Vigo [16]. For the single-trip VRP, it is assumed that each vehicle performs only one trip during the planning period, while this is relaxed in the multi-trip VRP. The multi-trip VRP is studied in [17] and [18].

Determining an optimal fleet together with the coherent routes in a multi-trip VRP has received little attention. A problem having some similarities to the case studied here is given in [19]. However, the solution algorithm developed there requires all vessels to have the same service speed. Fagerholt and Lindstad consider a problem similar to the one presented here, and their solution algorithm allows the vessels to have various speeds [13]. A simplified version of their solution algorithm is used to determine the optimal fleet for each scenario and is described in the following. For details of the solution algorithm, see [13].

The proposed optimisation algorithm works in two phases and combines the use of dynamic and integer programming. By going through the two-phase algorithm for each of the four scenarios, an optimal fleet is suggested for each scenario. Variations of this solution approach have frequently been applied in determining optimal routes for a given fleet, see for instance [20] and [21].

In phase 1, all feasible routes for each of the four vessel types are generated. This is done by systematically working through all possible subsets of offshore installations. For each subset, we check if the selected vessel type has enough capacity compared with the given demand at the installations in the subset. If so, the optimal roundtrip is determined by solving a Travelling Salesman Problem (TSP), which may for instance be done by dynamic programming.

In the second phase, the vessel types to be used and their coherent routes are determined by solving an integer programming model, in which the columns represent the vessel routes generated in phase 1. The integer programming model will be described as follows:

Sets

K	Vessels in the pool, indexed by *k*.
N	Offshore installations, indexed by *i*.
R_k	Schedules for ship *k* (generated in phase 1), indexed by *r*.

Parameters

T_r^k	The duration in hours of schedule *r* for ship *k* (calculated in phase 1).
A_{ir}^k	Constant that is equal to 1 if vessel *k* services installation *i* on schedule *r* and 0 otherwise (derived in phase 1).
T_{MAX}	Length of cycle period.
S_i	Minimum number of services for installation *i* during the period T_{MAX}.
C^k	Cost of using supply vessel *k*.
M	Large number.

Variables

δ^k	Binary variable that is equal to 1 if vessel *k* is used in the optimal solution and 0 otherwise.
x_r^k	Integer variable indicating the number of times per week ship *k* sails its schedule *r*.

The integer programming model of phase 2 in the solution algorithm can now be formulated:

$$\min \sum_{k \in K} C^k \delta^k , \tag{3}$$

$$\sum_{k \in K} \sum_{r \in R_k} A_{ir}^k x_r^k \geq S_i , \qquad \forall i \in N , \tag{4}$$

$$\sum_{r \in R_k} T_r^k x_r^k \leq T_{MAX} , \qquad \forall k \in K , \tag{5}$$

$$\sum_{r \in R_k} x_r^k - M\delta^k \leq 0 , \qquad \forall k \in K , \tag{6}$$

$$x_r^k \text{ integer}, \qquad \forall k \in K, r \in R_k , \tag{7}$$

$$\delta^k \in \{0,1\} , \qquad \forall k \in K . \tag{8}$$

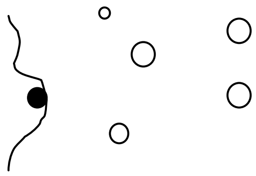
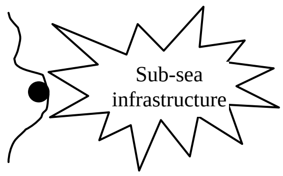
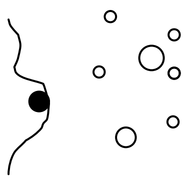
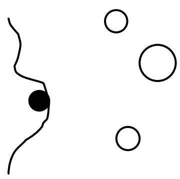
(3) is the objective function and ensures the minimisation of the total cost of using the vessels. The main cost component is the TC-cost, which also reflects the capital costs if

the vessels are owned. Constraints (4) ensure that each offshore installation is served at least the minimum number of times during the cyclic period, which can for instance be one week. This requirement may vary between the four scenarios. Constraints (5) ensure that the sum of the total time of the schedules for a given vessel does not exceed the length of the cyclic period. Then, we determine routes that are repeated every period. Coupling constraints (6) ensure that if at least one route is selected, then the corresponding binary variable for that vessel must be equal to one. (7) and (8) impose integer and binary restrictions on the variables, respectively.

To ensure that several vessels of each type can be selected, one may duplicate the columns for each vessel type before solving the integer programming model given by (3) - (8). The model can now be solved by commercial integer programming software.

By going through the generation of routes (phase 1) and the solution of the integer programming model (phase 2), we can determine an optimal fleet and the vessel routes for each of the four scenarios. Since there are significant variations in the demand and the locations of the oil and gas installations between the scenarios, the solutions will also differ. Table 2 shows what the optimal fleet for the four scenarios can be for the simplified case study.

Table 2: Model solutions

Scenario	Name	Optimal solution
1	<u>**Deep Water Day**</u> 	**2 large/fast and 1 small/slow vessels** Scenario 1 involves two new major deep water installations. Since sailing times compared to service times are higher for the deep water installations than for existing installations, it is optimal to introduce two high speed vessels serving the deep water installations. The small slow speed vessel and some surplus capacity of the two high speed vessels serve the existing installations.
2	<u>**Bottom Line**</u> 	**1 small/slow vessel** Scenario 2 involves a drastic reduction in the demand of supply services and the optimal solution involves only one small slow speed vessel.
3	<u>**Floating Clients**</u> 	**2 small/slow and 1 large/slow vessels** Scenario 3 involves increased demand for supply services due to oil production in some new smaller fields. The optimal solution involves two small slow speed vessels and one large slow speed vessel, which together serve all fields.
4	<u>**Sub-sea King**</u> 	**1 large/slow and 1 small/slow vessels** Scenario 4 gives a slight increase in transport demand due to increased production in existing fields. The optimal solution involves one large slow speed vessel and one small slow speed vessel, which together serve the fields.

3.4 Discussion of Solutions

Before deciding on an optimal transport system for the future, one should address the time horizon of the scenarios and the time required for implementing the optimal transport solution.

Generally, scenarios are developed for time horizons ranging from five to twenty years, with an emphasis on five to ten years. However, whether a certain change in the business environment occurs in three, five or seven years is difficult to say and of less importance. What is important is to understand how the key drivers of change may shape the future, what implications may be expected and in what time. In this way a common mental framework for the future might be developed. By “rehearsing the future”, a company may be able to react to changes faster than its competitors. In the case study, a high oil price and major technological breakthroughs in deep-water technology may trigger a decision to develop two major deep-water fields. The time from the decision to develop the installations until the installations are in operation may take several years. However, if developments in offshore technology are of a more evolutionary kind, and the oil price rises, increased interest in floating production may be expected. Depending on the market for floating production vessels, oil production in a number of smaller fields may start in a relatively short time period.

The time required for implementing the optimal transport system may vary from a couple of weeks to several years. If the charter market has surplus capacity, a new supply vessel may be chartered and made ready for operation in a couple of weeks. However, if there are no suitable vessels available, a new vessel may have to be built. A new-building process may take up to several years depending on the degree of innovation in the design. Scenario and optimisation techniques may also reveal a future need for vessels not available in the market today, for example supply vessels with a speed exceeding 25 knots. If this is the case, one may prepare for such requirements by developing relations to innovative yards and designers.

Based on the discussion above, it is obvious that a monitoring system should be established in order to track the migration towards emerging scenario(s). Key drivers of change that have been identified in the scenario process point to key indicators for monitoring. By monitoring these indicators, one may initiate necessary actions at an early stage in order to establish a new optimal transport system meeting new needs.

It is also possible to identify a robust strategy for the transport system. A robust strategy may be to own a small slow speed vessel, and charter additional vessels on short-term contracts. The reason for owning a small slow speed vessel is that all scenarios require such a vessel. By chartering additional vessels on short-term contracts, flexibility for adapting to emerging scenarios is gained.

A robust strategy combined with a monitoring system may be the best solution for this case study.

4. CONCLUSIONS

This paper describes the design of future transport systems by combining and integrating scenario and optimisation techniques. These two techniques complement each other. Optimisation techniques do not handle uncertainty in a satisfactorily way, but scenario techniques do. Scenario techniques do not give a sufficient basis for strategic decisions, (i.e. quantifiable) but optimisation may contribute in this respect.

The methodology has been illustrated on a simplified case from the oil industry, related to the development of a transport system aiming to maintain the supply services to a set of offshore installations today and in the future. By analysing key drivers of change (e.g. the oil price and development in offshore technology), four scenarios are established, each describing a plausible future. By using optimisation techniques, an optimal fleet of supply vessels for each scenario is suggested. The scenario specific solutions are discussed according to robust elements and how monitoring of key drivers of change may assist in choosing the best solution.

It would be appropriate to perform sensitivity analysis in order to evaluate the robustness of the optimal solutions. This can be done by running several optimisations for each scenario. For each run, we could for instance adjust the demand levels at the oil fields. Another way to evaluate the robustness of an optimal solution is to model the problem by a simulation tool and run simulations.

REFERENCES

1. Schwartz, P. (1991), *The Art of the Long View*, Doubleday, New York.
2. Mercer, D. (1995), Scenarios Made Easy, *Long Range Planning*, Vol. 28(4), pp. 81-86.
3. Zaman, P.A. and Wilson, I.H. (1991), *Scenario Planning in Telecommunications: A Decision-Focused Approach*, SRI International, Business Intelligence Program, Report No. D91-1507, Menlo Park.
4. Mandel, T.F. and Wilson, I.H. (1993), *How Companies Use Scenarios: Practices and Perception*, SRI International, Business Intelligence Program, Report No. 822, Menlo Park.
5. Mandel, T.F. (1993), *Scenarios and Corporate Strategy: Planning in Uncertain Times*, SRI International, Business Intelligence Program, Report No. 669, Menlo Park.
6. Van Der Heijden, K. (1996), *Scenarios: The Art of Strategic Conversation*, John Wiley & Sons.
7. Fahey, L. and Randall, R.M. (Eds.) (1997), *Learning from the Future: Competitive Foresight Scenarios*, John Wiley & Sons.
8. Ringland G. (1998), *Scenario Planning: Managing for the Future*, John Wiley & Sons.
9. Ravindran, A., Phillips, D.T. and Solberg, J.J. (1987), *Operations research. Principles and practice* (second edition), John Wiley & Sons Ltd, Canada.
10. Reeves, C.R. (Eds.) (1995), *Modern Heuristic Techniques for Combinatorial Problems*, McGraw-Hill International Ltd, UK.
11. Ackoff, R.L. (1979), The future of Operational Research is past, *Journal of the Operational Society*, Vol. 30(2), pp. 93-104.
12. Kall, P. and Wallace, S.W. (1994), *Stochastic programming*, John Wiley & Sons Ltd, England.
13. Fagerholt, K. and Lindstad, H. (1999), Optimal policies for maintaining a supply service in the Norwegian Sea, To appear in *OMEGA The International Journal of Management Science*.

14. Paich, M. and Hinton, R. (1997), Industry Scenarios. In *Learning from the Future: Competitive Foresight Scenarios*, pp. 22-38, Fahey L. and Randall R.M. (Eds.), John Wiley & Sons.
15. Porter, M.E. (1980), *Competitive Strategy – Techniques for Analyzing Industries and Competitors*, New York.
16. Toth, P. and Vigo, D. (1998), Exact solution of the vehicle routing problem. In *Fleet management and logistics*, pp. 1-31, Crainic, T.G. and Laporte, G. (Eds.), Kluwer Academic Publishers.
17. Taillard, E.D., Laporte, G. and Gendreau, M. (1996), Vehicle routeing with multiple use of the vehicles, *Journal of the Operational Research Society*, Vol. 47, pp. 1065-1070.
18. Brandão, J. and Mercer, A. (1997), A tabu search algorithm for the multi-trip vehicle routing and scheduling problem, *European Journal of Operational Research*, Vol. 100, pp. 180-191.
19. Fagerholt, K. (1999), Optimal fleet design in a ship routing problem, *International Transactions in Operational Research*, Vol. 6(5), pp. 453-464.
20. Brown, G.G., Graves, G.W. and Ronen, D. (1987), Scheduling ocean transportation of crude oil, *Management Science*, Vol. 33(3), pp. 335-346.
21. Bausch, D.O., Brown, G.G. and Ronen, D. (1998), Scheduling short-term marine transport of bulk products, *Maritime Policy and Management*, Vol. 25(4), pp. 335-348.