Strategic Simulation - Support of Innovation and Operation in Distribution and production Networks

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Resume

Nutidens forretningsmiljø er karakteriseret af a global konkurrence, omskiftelige forhold og usikkerhed. Mange vestlige virksomheder har responderet på dette ved at udvikle globale distributions- og produktionsnetværk. Dette mere og mere udfordrende forretningsmiljø og virksomheders mere komplekse struktur sætter endnu mere fokus på organisationers evner til proaktivt at udvikle og implementere strategier der er dynamiske og gør det muligt for virksomheden at tilpasse sig til og planlægge for de skiftende omstændigheder.

Der eksisterer mange tilgange til strategiudvikling men de fleste af dem er baseret på enten kvalitative eller kvantitative tilgange. Strategisk simulering er en kombination af narrative og numerisk simulering og kan bruges som et værktøj til at understøtte strategisk beslutningstagning gennem forskellige scenarier i kombination med computer simulering. Kernen i the Combined Simulation Approach (CSA) er at gøre det muligt at systematisk teste forskellige outputs af mulige løsninger for beslutningstagere således at de kan forberede sig på fremtidige konsekvenser. Denne systematiske testning kan gøre strategiudviklingen mere robust og skabe en mere refleksiv og kreativ base for beslutningstagning.

Summary

Today's business environment is characterized by global competition, changing conditions, and uncertainty. Many Western companies have responded by developing global distribution and production networks. The increasingly challenging business environment and the more complex structure of companies put great emphasis on organisations' ability to proactively develop and implement strategies that are dynamic and make it possible for the company to adapt to and plan for the changing circumstances.

Many approaches to strategy development exist, but most of them are based on either qualitative or quantitative approaches. Strategic simulation is the combination of narrative and numerical simulation and can be used as a tool to support strategic decision making by providing different scenarios in combination with computer modelling. The core of the combined simulation approach (CSA) is to make it possible for decision makers to systematically test several different outputs of possible solutions in order to prepare for future consequences. This systematic testing can make the strategy development more robust and create a more reflective and creative base for decision making.

The empirical part of the project was carried out as a case in GN Resound which is a Danish manufacturer of hearing aids. The project looked into how the supply chain could be further developed within distribution and production. Three new scenarios and strategies for the future distribution were examined in order to determine which one was the most cost efficient. It was found that the CSA could be used to investigate the different possible futures as well as give the researcher a deeper look into the organisation. The outsourcing and offshoring of production was also examined in order to define the total costs of the current outsourcing / offshoring strategy as well as the possible strategies. It was found that there were hidden costs in relation to outsourcing / offshoring that are significant and important to consider when making decisions. Especially the quality and the costs of poor quality must be taken into consideration.
Acknowledgements

The making of this thesis has been a fascinating process that began in September 2006. The project is based on how the combination of two methods rooted in two different mindsets can possibly enhance the development of robust and dynamic strategies, which I found very interesting to begin with and this interest only became more profound as the project developed also seen in the light of the worldwide financial crisis that seemed to make the project even more relevant. The process has involved several persons that I would like to express my gratitude to and I apologise sincerely for anyone I have forgotten to mention in the following.

First of all I would like to thank my two supervisors Lauge Baungaard Rasmussen and Peter Jacobsen who initially encouraged me to apply for the PhD. Thank you for many interesting conversations who helped me see the overall picture and kept my inspiration flowing. You have both been an inspiration to me for all these years and I value your great support deeply.

Thank you to GN Resound and all the employees for letting me into the company for such a long period of time. It has been a great opportunity and very giving to follow a company over such a long period of time. A special thanks to Morten Andersen for participating over such a long period of time and for seeing new and interesting developments paths.

I would also like to thank my colleagues and fellow PhD students in the Section Work, Technology and Organisation for many interesting meetings and seminars as well as qualified comments. Furthermore, I would like to thank my colleagues in the Section of Innovation Systems and Foresight for your welcoming spirit and for your interest in my project even though I joined you so late in my project. I want to thank Lykke Margot Ricard for making the last period of research both interesting and entertaining.

My two lovely daughters, Selma and Alba, gave me the breaks (maternity leaves) from the project that actually made it possible for me to follow the case company for such a long period of time. You both gave me the at times highly needed distraction from the project as well as the inspiration to finalise the thesis. My beloved husband has at all times supported my journey into the academic world and never doubted my abilities. I am also thankful to my family as well as my extended family for their support.

Mette Sanne Hansen, May 2012, Kgs. Lyngby
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PART I. Strategic Simulation

In Part I an introduction of the project is given. The background of the project is elaborated as well as the aim of the thesis. Based on this the main objective is posed and specified into three more specific research questions that will form the basis of the thesis. Furthermore, the delimitations of the project are stated, the structure of the report is explained, and different definitions used later in the project are made.


Chapter 1. Introduction
This chapter introduces the background of the project in order to explain why the main objective and the research questions were found interesting to investigate. In order to give the reader a sense of how what the thesis consists of and what it contains the structure of the report is also introduced as well as the delimitations and certain definitions.

1.1 Background of the Thesis

Over the last decades globalisation has resulted in a highly competitive business environment. The changing market conditions as well as the evolution of technologies have increased the need for more competitive, dynamic, and robust enterprise strategies (Baramichai, Zimmers Jr et al. 2007) which has been proven as late as in the latest financial crisis. The need to plan for the future and to be able to adapt to changing circumstances seems to be increasingly important. This puts emphasis on the need for alignment between different functions in the organisation so that the organisation pursues the same strategic purpose. Methods and processes are needed to manage the strategy development so that well-informed decisions and actions can be made (Phaal, Farrukh et al. 2010).

Strategy can be developed through the use of many different methods, but typically the methods focus either on narrative perspectives or numerical perspectives. There is a growing concern that the predictive mathematical models conventionally used for understanding the dynamics of business systems (Kljajic, Bernik, & Skraba 2000) are too limiting to serve as tools in future studies, because they cannot reproduce the sudden changes seen in societies. Therefore it is argued that more robust strategic tools emerge from the interaction between the narrative and numerical contributions (Kemp-Benedict 2007). Scenario development as well as mathematical modelling are both methods that has become increasingly applied as strategic tools in management (Hazy, Millhiser, & Solow 2007) as they both have different forces in relation to strategy development. A combination of a narrative and numerical approach can possibly strengthen strategy development as two different methods can put highlight on issues neglected if only one type of approach is used.

The growth of collaboration within firms, but also across firms has developed through the elaboration of complex supply chains (MacDuffie, Helper 2007) and the strategic supply chain continues to be adopted by organisations as the medium for creating and sustaining a competitive advantage(Fawcett, Magnan et al. 2008). This development of the supply chain creates complex networks within organisations, but also across organisations putting emphasis on the ability to plan and mange all parts of the systems. It also put emphasis on the fact that it is important to view strategy not only as something that is developed on the
strategic level, but as something that is developed, implemented, and used across the strategic, tactical, and operational level.

Another element adding to the complexity of organisation and organisational networks is that product companies increasingly outsource production due to reasons such as cost savings. There are many risks of outsourcing multiple aspects of production such as control of the quality of the parts, difficulty in monitoring the outsourced processes, difficulties in communication, and keeping the core competencies close. An alternative to move the manufacturing operation to an external business partner, while still benefitting from it is off shoring. Off shoring differs from an outsourcing activity mainly by the fact that relevant processes are still owned and controlled by the company itself. The motives are in most cases the same as with outsourcing, but off shoring is most likely to be conducted if the company considers it as important to keep the activities in-house (Ang, Inkpen 2008). However, off shoring still poses issues in relation to communication, quality and hidden costs.

1.2 Aim of the Thesis

Based on the above it is clear that both outsourcing and the developing supply chain structures are topics highly relevant for the development of strategies. Furthermore, as strategic development is typically based on an either narrative or numerical approach it is of interest to examine if a combined narrative and numerical simulation can result in a more transparent strategy development process.

Based on this the following main objective was raised:

Can the combination of narrative and numerical simulation methods support and improve strategy development and implementation of effective production- and distribution networks?

In order to answer this objective I have chosen to divide it into three research questions:

1. How can narrative and numerical simulation be applied to enhance the interaction process between the model developer and the model user?
2. How can narrative and numerical simulation be used to explore possible futures for multinational production and distribution networks in accordance with the trends within a certain branch or sector?
3. How can narrative and numerical simulation clarify the strategy and decision making process in multinational companies and make it more transparent?
The research questions are posed in order to examine the different aspects of the main objective. Research question 1 looks into how the combination can improve strategy development, research question 2 examines how the combination can support the strategy development, and research question 3 deals with how the combination can support and improve the implementation of strategy. The questions will be answered following the structure described below.

1.3 Structure of the Thesis

The structure of the thesis is based on the iterative grounded theory approach as this was the basis of how the research was actually carried out. This means that the thesis is structured according to how the research was conducted. Chapter 1 is the introduction to the research and why it was found interesting to examine the combination of narrative and numerical simulation. Chapter 2 deals with the paradigms behind the two different methods as well as the mixed methods approach. Chapter 3 investigates and develops the methodology used in the thesis and also positions the methods. Chapter 4 describes strategic simulation and the two different methods more in depth. Chapter 5 introduces and goes into depth with the case. This chapter is built as a long thick story based on the author’s observations in the company. Based on this case the theoretical framework is developed in chapter 6 and analysed in chapter 7. Some time after the first part of the case was finished the second part of the case was made and this is the basis of chapter 8. Finally chapter 9 discusses the findings and chapter 10 presents the conclusion.

1.4 Delimitations

The overall focus of this thesis is to examine whether narrative and numerical simulation can be combined so that it supports strategy development and implementation in production and distribution networks. This points to the fact that there are two methods that will be examined in depth and that the examination of these methods and the process of using them is the focus of the report. This means that the two methods will be used in a way that will make it possible to test the combination of them and not necessarily in the way they are traditionally used. The project is based on the iterative grounded theory approach and as such this also forms the basis of the structure of the report as mentioned above as well as the delimitations. This means that the case is delimited by the interactions between the researcher and the managers in the way that not all of GN Resound has been investigated, but only the parts of the company that the researcher was in contact with to begin with and the parts that became relevant through the interactions. Furthermore, the whole hearing aid industry has not been examined, but only the trends that were necessary in order to develop the narrative part of the simulation. The methodology also forms the delimitations in relation to the theoretical framework as the interactions between the researcher and the
company has formed the basis of the theoretical framework. This approach has been chosen in order to follow the iterative grounded theory approach as much as possible to give the reader a feeling of how the process in reality developed. In the next chapter some definitions will be given that will be used in the rest of the thesis.

1.5 Definitions

Several terms will be used in the following thesis. In order for the author to be able to use them they are defined in this chapter so that they do not disturb the flow in the chapters where they are used.

The Combined Simulation Approach (CSA) is the combination of narrative and numerical simulation.

Narrative simulation is in this thesis based on scenario analysis.

Numerical simulation is in this thesis based on computer simulation.

Modelling and simulation is based on the fundamental notion that models are approximations for the real-world. Traditionally, modelling and simulation is based on a method that includes making a model that approximates an event. The model is then followed by simulation, which allows for the repeated observation of the model. After one or many observations of this model analysis takes place. Analysis aids in the ability to draw conclusions, verify and validate the research, and make recommendations (Petty 2009, Petty 2009).

Value-added chain: Viewed from a global perspective, a value-added chain is the process by which technology is combined with material and labour inputs, and then processed inputs are assembled, marketed, and distributed. A single firm may consist of only one link in this process, or it may be extensively vertically integrated...” (Kogut 1985).

Production- and Distribution Networks: The varying organisational arrangements between firms. These relations can be intra-organisational network relations among individual organisation members, inter-organisational network relations among individuals from different organisations, and inter-organisational network relations among organisations (Ebers 2001).

Outsourcing: When a company moves tasks previously conducted internally to foreign suppliers (Hira 2005, Whitten, Chakrabarty et al. 2010).

Offshoring: When a company moves internal processes of its business to other geographical locations outside of its residential country (Hira 2005).
Backsourcing: When a company moves activities that have either been outsourced or offshored back to be performed internally or at the original geographical location.

Lean, a production philosophy that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, and waste is very important to eliminate. Waste is activities that absorbs resources, but creates no value, e.g. transport of goods from one place to another without any purpose. It is important to convert waste into value (Womack, Jones 2003).

MRP (material requirements planning) systems, which is a production planning and inventory control system used to manage manufacturing processes (Michelsen 2010).

An ABC analysis is used to define an inventory categorisation technique used in materials management. It is a tool for identifying items that have a significant impact on the overall inventory cost and to identify different categories of materials that demand different handling (Michelsen 2010, Wikipedia 2010).

A push system rely on a predetermined schedule. A pull system rely on customer requests (Russell, Taylor 2003).
PART II. Research Design & Methodology

In this part of the thesis the research design and methodology will be introduced. The research design includes an introduction of the different relevant paradigms as well as the contextualist research design. The methods used in the project are presented, discussed, and reflected upon in order to make my choice of methods clear. This includes the iterative grounded theory approach which includes different methods to collect data. Following this simulation in different forms is introduced as well as the argumentation for the relevance of combining two different forms of simulation. In the end the aspect of verification, validation, and accreditation is introduced.
Chapter 2. Paradigms and Research Design

This chapter will give a scientific framework for the thesis introducing and discussing the relevant paradigms as well as comparing these paradigms.

2.1 Paradigms

The CSA combines two different approaches rooted in two different paradigms. Combining these methods in this way produces a philosophical problem relating to the paradigm incommensurability as described by Kuhn (Morgan 2007, Kuhn 1970). This requires some reflection in order to create a framework for the combination of narrative and numerical simulation as paradigms are the basic belief, which frame our way of thinking and behaving (Rasmussen 2011a). A paradigm may be viewed as a set of basic beliefs that deals with ultimates. It represents a worldview that defines the nature of the “world”, the individual’s place in it, and the possible relationships to that world and its parts (Guba, Lincoln 1994). The scientific stance has consequence for the choice of method, and therefore it is necessary to place the CSA in the paradigmatic discussion, as well as the fact that the CSA combines qualitative and quantitative approaches.

Historically, there has been a heavy emphasis on quantification in positivistic science. The focus is often on efforts to verify and falsify a priori hypotheses, most usefully stated as mathematical propositions that can be easily converted into precise mathematical formulas expressing functional relationships. Strong critiques against quantification have emerged over the years based on the fact that qualitative data can provide contextual information that can be of major importance (Guba, Lincoln 1994). Lincoln & Guba (1994) describes the different paradigms relevant for this thesis as basic belief systems that can be viewed below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Positivism</th>
<th>Post positivism</th>
<th>Constructivism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontology</td>
<td>Naive realism – “real” reality, but apprehendable</td>
<td>Critical realism – “real” reality but only imperfectly and probabilistically apprehendable</td>
<td>Relativism – local specified constructed realities</td>
</tr>
<tr>
<td>Epistemology</td>
<td>Dualist/objectivist, findings true</td>
<td>Modified dualist/objectivist, critical tradition/community, findings probably true</td>
<td>Transactional/subjectivist, created findings</td>
</tr>
<tr>
<td>Methodology</td>
<td>Experimental/manipulative, verification of hypotheses, chiefly quantitative methods</td>
<td>Modified experimental/manipulative, critical multipism, falsification of hypotheses, may include qualitative methods</td>
<td>Hermeneutical/dialectical</td>
</tr>
</tbody>
</table>

*Table 2.1: Basic Beliefs of Paradigms adapted (Guba, Lincoln 1994)*
The above table indicates that there are several differences between the paradigms. The paradigms will be described and discussed in the following.

2.1.1 Positivism and Postpositivism

*Positivism* has its roots in natural science and works within a realistic ontology and an objective, value neutral epistemology. It builds on the assumption that we only have two sources for cognition: Our senses and our logic. The facts can afterwards be quantified and treated statistically so that the researcher can make general conclusions (Thurén 2002). For positivism a tangible reality is assumed to exist, driven by binding laws and mechanisms. Knowledge of the way things are is conventionally summarised in the form of time- and context-free generalisations. The basic position of the paradigm is argued to be both reductionist and deterministic (Guba, Lincoln 1994). The investigator and the investigated object are assumed to be independent units. Furthermore, the investigator is assumed to be able to study the object without influencing it or without being influenced by it, as influence is seen as a threat to validity. Hypotheses are stated in propositional form and subjected to empirical test to verify them (Guba, Lincoln 1994). *Postpositivism* is to be found within the same ontological and epistemology stance as positivism with certain modifications. The differences are especially related to the epistemological part as the postpositivists do not believe that it is possible to obtain one final truth, as new knowledge will arise and challenge the old. The postpositivists do not believe that only pure observations can lead to new knowledge. Instead they argue that hypotheses based on theoretical understanding should be tested. The postpositivist still however have objectivity as the ideal, but understands that this is not entirely possible (Pedersen, Land 2001a). Numerical simulation is rooted in this paradigmatic stance as the intention of the numerical models is to test different hypotheses before making decisions. Furthermore, the aim of such models is to be objective, but it is not entirely possible as the models are made by modellers.

2.1.2 Constructivism

Constructivism is based on the intention to understand. To understand means to identify the subjective intention that underlies a person’s behaviour or actions. Constructivism focuses on the importance of parts and the totality and the interaction between these. The researcher interacts with the subject and the researcher’s set of values are relevant for the interpretation. The researcher is part of the reality and cannot withdraw from it and relate to it objectively. The way scenario analysis is used in this project it is based on constructivism as it is recognised that some sort of interpretation takes place during the research process. The researcher and the object of research are assumed to be interactively linked,
with their values influencing each others. Findings are therefore value mediated. The nature of the inquiry requires a dialogue between the researcher and the subjects of the inquiry. Constructivists argue that time- and context-free generalisations are neither desirable nor possible and that research is value-bound.

Grounded theory is a method to build theory, which emerges systematically from continuous interplay between data collection and analysis (Green, Kao et al. 2010, Punch 2009). Grounded theory was developed by Barney G. Glaser and Anselm L. Strauss and the central function of grounded theory is the construction of empirically grounded theories (Flick 2002, Wagner, Lukassen et al. 2010). This means that theory is developed inductively from data so rather than beginning by researching and developing a hypothesis, the first step of a grounded theory approach is data collection, through the use of different methods. From the data collected, categories are formed, which are the basis for the creation of a theory. This contradicts the traditional model of research, where the researcher chooses a theoretical framework, and only then applies this model to the studied phenomenon. A model of the basic processes in grounded theory can be seen below.

![Figure 2.1: Basic process of the Grounded Theory approach](Wagner, Lukassen et al. 2010)

The figure above illustrates how grounded theory can be carried out. As it can be seen a first collection of data based on an initial research question is carried out. After the first collection of data the analysis begins...
and emerging directions in the analysis will be found that can guide the second collection of data and so on. This is called theoretical sampling. The cycle continues until new data collection does not show new theoretical elements. This resembles the way humans have normally learned by wondering over puzzling situations. The idea is to approach the data as open minded as possibly in order not to be misguided by theory. The idea is to find a core category based on the data. This is done through coding. There are three general types of codes:

1. Substantive codes (open coding) – identify conceptual categories in the data. The idea is to open up for the theoretical possibilities in the data. The main categories from the open coding are interconnected with each other.
2. Theoretical codes (axial coding) – connect the categories.
3. The core code (selective coding) – the higher-order conceptualisation of the theoretical coding, around which the theory is built. The objective is to integrate and pull together the developing analysis (Punch 2009).

Normally constructivism has an inductive approach to research, but the constructivism in this project is very functional and uses an abductive way to research (chapter 2.3).

2.2 Mixed Methods Research

Within organisation studies there is a long tradition of recognising that the contexts within which managerial decisions are made are dynamic and should be acknowledged as an active part of an analysis. Reality is viewed as emergent and in a continuous state of becoming, and research design should include both qualitative and quantitative research methods (Green, Kao et al. 2010). As can be seen from the focus of the project it is intended to examine:

*Can the combination of narrative and numerical simulation methods support and improve strategy development and implementation of effective production- and distribution networks?*

This means that the aim is to combine a qualitative and a quantitative approach in order to support strategy development. To be able to analyse a process or a phenomena in an organisation it is a premise that the researcher has knowledge of the organisation’s many aspects and its context (Kvale 1994). Qualitative and quantitative methods are rooted in different philosophies of science as can be seen above. The qualitative methods seek data regarding processes and meanings and is a more processual approach trying to understand a phenomenon in a certain context, whereas the quantitative methods more attempt
Mixed methods research can be defined as:

*The class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study* (Johnson, Onwuegbuzie 2004).

Methodological purists contend that one should always work within either a qualitative or quantitative paradigm. Both qualitative and quantitative research have many benefits and costs. In some situations the qualitative approach will be more appropriate and in others the quantitative. Mixed methods research argue for an integration of quantitative and qualitative research strategies, and therefore not falls within all of the paradigms described above (Yvonne Feilzer 2010). The essential idea of mixed methods research is to reject the either-or choices and the metaphysical concepts associated with the paradigms wars, and focus on “what works” in getting research questions answered (Punch 2009, Johnson, Onwuegbuzie 2004). It can be said that the truth of an idea needs to be tested. This allows the researcher to be free of mental and practical constraints imposed by the forced choice dichotomy between postpositivism and constructivism. Mixed methods research can be used to observe different layers of a phenomenon as quantitative methods can be used to measure some aspects and qualitative methods for others (Yvonne Feilzer 2010). The idea of mixed methods research is to find a middle ground between philosophical dogmatism and to find a workable solution (Johnson, Onwuegbuzie 2004). Different approaches to mixed methods research exist depending on how the research is carried out. The figure below shows different possible combinations.
From the figure above nine mixed-method designs can be seen. To construct a mixed-method design, the researcher must decide whether to operate within one dominant paradigm or not and whether to conduct the phases concurrently or sequentially. This means that the methods can have either equal status so that both methods are used to the same amount or one method can be more dominant than the other. Furthermore, it means that the methods are either used at the same time or one method is used first and then the other method is used afterwards. To be considered as a mixed-method design, the findings must be mixed or integrated at some point. These nine methods are not abundant. More user specific and complex designs can be developed and the idea is that researchers should make designs that effectively answer their research questions (Johnson, Onwueguzie 2004). It is the intention of the CSA that the two methods should have equal status. This can be difficult in reality as it can be difficult to give each method exactly the same status, but in overall this is the intention. The idea of the CSA is to begin with a narrative simulation followed by a numerical simulation and then iterations between the narrative and numerical simulations. The CSA should be performed sequentially to begin with and then more and more concurrently. This gives input to a new design where the terms narrative and numerical have been incorporated:

\[ \text{NAR} \rightarrow \text{NUM} \rightarrow \text{NAR + NUM} \]

1 “qual” stands for qualitative, “quan” stands for quantitative, “+” stands for concurrent; “→” stands for sequential, capital letters denote high priority or weight, lower case letters denote lower priority or weight (Johnson, Onwueguzie 2004)
As such in nature the two methods must be carried out sequentially as they have to inspire each other, but as the process develops it becomes more concurrently as the process of developing new inputs to the scenarios and simulations is more and more overlapping. This emphasises the fact that the CSA is an iterative process that should be used so that the narratives can add meaning to numbers and so that numbers can add precision to narratives (Kemp-Benedict 2004). The researcher can use the strength of one method to overcome the weaknesses of another method and in that respect seek to answer a broader range of research questions. The idea of mixing methods in this thesis is to see if the combination can provide a robust strategic tool that through the combination can add new insights and understanding. Numerical simulation can when used in combination with narrative simulation also force a clarification of terms and mechanisms. This is due to the fact that if a scenario is to be translated into a numerical model then any ambiguous points have to be clarified and decided upon. This can also expose contradictions in mental models as narratives reflect the mental models of their authors and in the translating of them these contradictions can be exposed. The mixing of the two methods also provides a feel of the scope of possible outcomes within a narrative framework. This means that different possibilities can be examined and tested without having to carry them out in reality and the experience that comes from the numerical simulation can give input to new developments in the narrative simulation (Kemp-Benedict 2004). It must be kept in mind that the carrying out both qualitative and quantitative research can be difficult for a single researcher as the researcher has to learn multiple methods and understand how to mix them. This can make the process very time consuming (Johnson, Onwuegbuzie 2004).

2.3 Positioning Mixed Methods

In order to clarify the approach of mixed method research the table below is suggested.

<table>
<thead>
<tr>
<th>Qualitative Approach</th>
<th>Quantitative Approach</th>
<th>Mixed Method Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection of theory and data</td>
<td>Induction</td>
<td>Deduction</td>
</tr>
<tr>
<td>Relationship to research process</td>
<td>Subjectivity</td>
<td>Objectivity</td>
</tr>
<tr>
<td>Inference from data</td>
<td>Context</td>
<td>Generality</td>
</tr>
</tbody>
</table>

Table 2.2: Positioning Mixed Methods (adapted) (Morgan 2007)

The first row in the table deals with the distinction between induction and deduction, which can be quite useful to explain the differences. Most often research is not carried out in this strict manner. The actual process of moving between theory and data never operates in only one direction. During the actual

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2 “NAR” stands for narrative simulation, “NUM” stands for numerical, “+” stands for concurrent, stands for sequential, capital letters denote high priority or weight, lower case letters denote lower priority or weight
research the process is most often iterative where the researcher moves back and forth between induction and deduction – abduction. Abduction was introduced by C.S. Peirce (Peirce 1903) as he argued that creative ideas do not come from either deduction or induction.

_Deduction proves that something must be; induction shows that something actually is operative; Abduction [. . .] suggests that something may be_ (Peirce 1903, Gold, Walton et al. 2011).

This means that Peirce’s saw induction as an approach that classifies knowledge and deduction as an approach that assumes knowledge and uses it to conclude. Abduction is a hypotheses, interpretation or guess to a given problem that can lead to a new understanding. The process is dynamic as the hypotheses is exploring in nature. The relationship between induction, deduction, and abduction is not static as they overlap and interrelate. An abductive approach is often followed by both deductive and inductive elements as both existing knowledge and theories are used and as experiences from the field are tested (Laursen 2010).

Figure 2.3: The relationship between abduction, induction, and deduction (Laursen 2010)

The table above highlights the relationship between the researcher and the research process, which in practice is often neither completely subjective nor objective. More often researchers need to achieve a mutual understanding with the people who participate in the research, but also realise that within a single “real world” that is being studied all individuals have their own unique interpretations of that world. The mixed method approach takes the stance that knowledge is neither so specific and context dependent that
it cannot be used by others nor so universal and generalised that it can be used in every setting. Instead the mixed methods research argues that we need to investigate whether the results we obtain can be used in another context (Morgan 2007, Johnson, Onwuegbuzie 2004, Yvonne Feilzer 2010)(Morgan 2007).

After placing the project in the paradigmatic discussion it is possible to look further into the methodological approach in order to describe which methodology was used as well as the methods.
Chapter 3. Methodology
In this chapter the chosen methods are introduced and discussed. The choice of methodology is dependent on the theoretical paradigm and the type of project. Different possibilities exist such as action research, ethnography, grounded theory, case studies etc. (Jackson 2000). Based on the focus of the project I chose to use the case study in combination with the iterative grounded theory approach as a methodology for gathering data for the project.

3.1 The Case Study
Case studies are in depth examinations of how people act and interact within their own settings. For studies of organisational changes there is a limited possibility of doing real experiments. The case study researcher is not in a position to control the influence between the group studied and their surroundings. Furthermore, the researcher presence will affect the field studied just by being there. The researcher must also seek to implicate as many sources of data as possible in order to have as many methods of analysis as possible. These can be: (Maaløe 2002)

- Existing documentation such as letters, summaries, minutes, reports etc.
- Records such as organisational charts, legislation acts etc.
- Interviews
- Direct observations of meetings, daily routines, relations etc.
- Physical effects, layout and architecture

Case studies normally include an analysis of a group or an organisation and will typically include document analysis, interviews, and observations. The case study is a way for the researcher to get a deep and profound understanding of the given problem. The context becomes important as well as the internal dynamics as different data sources and observations are the foundation of the descriptions. Case studies typically involve an analysis of a group or an organisation and both quantitative and qualitative methods can be used to collect data. The research is often described as explorative as there often are few theories or limited knowledge related to the research area. The case studies can however also be descriptive, illustrative, experimental, or explanatory (Yin 1989, Collis, Hussey 2003, Andersen 1990).

3.2 Iterative Grounded Theory
The iterative grounded theory approach differs from the grounded theory in the way that it does not engage with empirical data in a theory free or inductive way. It emphasises the fact that researchers should be theoretically sensitive and it also advocates for an iterative process where knowledge is developed from
a constant interplay between empirical data and existing theories (Green, Kao et al. 2010, Orton 1997), in an abductive way (Morgan 2007). An important aspect of the approach is the sensemaking with practitioners, which describes an ongoing process of creating situational awareness and understanding in situations characterised by ambiguity and complexity (Weick 1995, Weick 2006). This includes the ongoing collaboration of practitioners and researchers (Green, Kao et al. 2010).

**Figure 3.1: Iterative Grounded Theory Approach** (Green, Kao et al. 2010)

The figure shows the continuous iteration between the research techniques and also emphasises the iterative process between the theory and data as this is a point that differentiates the approach from traditional grounded theory. (Green, Kao et al. 2010). It can be seen in the box that like grounded theory the iterative approach does go back and forth between data collection and analysis and generates theoretical statements, but it does that in a continuous interplay with existing theories as well as in collaboration with practitioners to get constant feedback. Six research techniques are essential to the iterative grounded theory approach. These techniques can be seen in figure 3.1 and will be described in the following.

### 3.2.1 Semi structured Interviews

The research interview is one of the data gathering methods within qualitative research. According to Kvale it is a specific form of conversation with a purpose and a structure (Kvale 1994). The interview as
a data gathering technique offers the possibility to gain knowledge about an organisation and its context. This is also related to the purpose of this project, which is use the CSA method in relation to strategy development for the future production and distribution of the company.

The aspects of the qualitative interview are that the topic of the qualitative interview is the everyday lived world of the interviewee. The interview seeks to interpret the meaning of central themes in the life world of the subject. The interview seeks qualitative and nuanced knowledge and does not aim at quantifying it. Furthermore, specific situations are extracted and can be used in the analysis of the case. The interview is open to new insights and phenomenon and is focused on specific themes. The statements made in the interview can be ambiguous as they reflect the contradictions in the interviewees’ world as well as the process of being interviewed can produce new insights. The knowledge from the interview is produced through interpersonal interaction and should be a positive experience (Kvale 1996).

According to Alvesson (2003) there are three different positions on interviews: Neopositivism, romanticism, and localism. Neopositivists are eager to establish a text-free truth about reality by following a research protocol and getting responses to it. The interview is a pipeline for transmitting knowledge. The ideal is a transparent research process characterised by objectivity and neutrality. The romantic believes in establishing a trust and commitment between interviewer and interviewee. The goal is to accomplish deeper, fuller conceptualisations of those aspects of the subjects’ lives that are most interesting to understand. The localist position on interviewing emphasises that interview statements must be seen in their social context. An interview is an empirical situation that can be studied as such, and it should not be treated as a tool for collecting data on something existing outside this empirical situation (Alvesson 2003).

There can be different structures of the interview (Kvale 1994). The structure can vary from the organised interview that follows a string of questions to the open interview where certain themes are in focus, but where the questions have no predetermined order or formulation. In the partly structured interview or semi structured interview (Maaløe 2002) the area of research is better known. Typically, theoretical and practical knowledge of the researched phenomenon exists, but the interviewer is open for new points of view and information that the respondent might offer. The semi structured interview was used for the project carried out in this thesis.
3.2.2 Informal Interactions (observations)

An observational study is a way to gather data and there are many forms of observational studies. Most often observations will be part of a complex methodological approach (Kristiansen, Krogstrup 2004).

*Observation is the act of noting a phenomenon, often with instruments, and recording it for scientific purposes* (Angrosino 2007).

There are different typologies of the observational study which can be seen in the figure below.

![Figure 3.2: Typologies of the observational study (Kristiansen, Krogstrup 2004)](image)

The observations carried out in the company were observations in natural surroundings as they took place within the company. Furthermore, the relation between the field of research and the researcher was unstructured as the researcher entered a context that already existed and had to accept that unforeseen and uncontrollable events could take place. It is more difficult to classify the degree of structure in the data collection as it represents an axis with two extremes (Kristiansen, Krogstrup 2004). The structure of the data collection carried out was somewhere in between as some of the observations took place at meetings which was somewhat structured, but the observations also took place outside the meetings which was more unstructured. However, the observations carried out as a result of the numerical simulation could be classified more accordingly to the artificial environment as the numerical simulations are artificially created environments where unforeseen events are sought to be reduced. This is also in accordance with the fact that the thesis is placed in both the positivistic and constructivist paradigm.
In observations without participation the observed actors are objects that are researched from ‘outside’. This means that the researcher is not directly involved in the situations he or she observes and is not a member of the context. In observations with participation the observed actors are viewed as subjects and it is a requisite that the subjects are researched from ‘inside’. This means that the researcher interacts with the field of study and plays an active part. There are four classic researcher roles in observations (Angrosino 2007):

- Complete observer – the researcher is as detached as possible from the setting under study. Observers are neither seen nor noticed.
- Observer-as-participant – the researcher conducts observations for brief periods of time, perhaps in order to set the context for interviews.
- Participant-as-observer – the researcher is more fully integrated into the life of the group under study and is more engaged with the people.
- Complete participant – the researcher disappears completely into the setting and is fully engaged with the people and their activities.

The role as researcher in the observations carried out resembles participant-as-observer as the author was part of the division of the company that was studied. The author worked from the office and was a part of the division for a longer period of time. Furthermore, the author did not only observe, but also participated in the development of the scenarios for the future distribution. The process was interactive and part of it was to develop narrative and numerical simulations and present them as well as discuss them with the department. This means that the result of the narrative and numerical simulation was a product of cooperation between the researcher and the department.

Researchers may use other forms of data collection techniques such as surveys, archival searches and interviews while they are participants in the community under study, but the assumption is that they are still being careful observers of the people and events around them even as they do these other things (Angrosino 2007). Informal interactions are seen as a way of enhancing data collection and improve the understanding of the research context. These informal interactions also include e-mail, telephone conversations, and informal meetings. The social interaction between the researcher and the industry participants are important as it can create valid relationships, offer the possibility to access current thinking, ask specific questions, and get feedback on emergent interpretations (Green, Kao et al. 2010).
3.2.3 Archival Research
Archival research is the process of gathering data relevant to the topic of research. This means collecting data from both published and unpublished sources. This can be public company account reports, publicity materials, unpublished in-house reports, press articles, the Intranet etc (Green, Kao et al. 2010). These sources can hold a large amount of information relevant for the research and they are often a simple way to give a preliminary understanding of the research topic. In relation to the research carried out in this thesis this also included the databases used for collecting quantitative data.

3.2.4 Evolving Literature Review
The iterative grounded theory argues that the literature review is not limited to the beginning of the project, but continues throughout the process. New literature searches are often a result of evolving empirical findings. This evolving literature review is a part of the iterative interaction between data and theory, which is critical to the iterative grounded theory and also relates to the criteria of theoretical sensitivity (Green, Kao et al. 2010).

As the first research activity the author commenced a literature study of the two methods involved in the CSA. The author wanted to gain further knowledge about the area of simulation in order to be able to combine the two methods. Based on the initial literature review of the two methods the case was commenced and throughout the rest of the project the author has been searching through literature, theories, and others research based on the findings in the case. These findings and the theory related to the findings will be discussed in later chapters in order to follow how the project was actually carried out. The primary sources for new knowledge and literature has been from searching databases, searching journals, PhD courses, seminars, conference participation etc.

3.2.5 Feedback Meetings
Another important aspect of the contextualist research design is the practice of offering feedback meetings with the participants in the research were they can share in and contribute to the researcher’s interpretation of the findings. This can help strengthen the validity of the findings and is a way to make sure that key factors are included. The feedback meetings are intended to bring benefit to both the researcher and the participants as the participants also derives new knowledge from these sessions as well as get the possibility to reflect what has already been said and done. Furthermore, the feedback can strengthen the confidence and trust between the researcher and the participants (Green, Kao et al. 2010).
3.2.6 Industry Workshop
Industry workshops can also be used to generate confidence as well as new insights and information based on a larger group of persons. The participation in these workshops is however not limited to the participants in interviews, but can also include participants from other departments that are not part of the project on a daily basis. This means that the workshop can both be used as a validation, but also as a way to get new and additional points of view. Furthermore, active participation in workshops enables practitioners to be part of the research process (Green, Kao et al. 2010). In the industry workshop the SWOT method and causal mapping were used, and therefore they are described below.

3.2.6.1 SWOT
SWOT means the analysis of strengths, weaknesses, opportunities, and threats of an organisation. The aim is to identify the internal and external factors that may affect the desired future outcomes. There are two main parts of the SWOT process. A) The SWOT Inventory gives the participants an overview of the problem situation by using an inventory matrix to point out the internal strengths and weaknesses as well as the external opportunities and threats. B) The SWOT Analysis build upon the results from the SWOT Inventory to find strategies that make use of identified strengths and opportunities to combat weaknesses and threats (Rasmussen 2011a).

3.2.6.2 Causal Mapping
Causal Mapping is a modelling technique used to map, analyse, and represent how a person or group of persons thinks and relates to different issues in causal relationships. Each map consists of two-dimensional graphs of nodes containing text that are linked together according to their causal relationship. An advantage is that large amounts of qualitative data can be structured and systematically analysed (Hansen, Rasmussen 2011). It is basically a cause and effect diagram that can help structure information, experiences, and viewpoints for participatory problem solving. Maps can be developed for both individual interviews as well as for group interviews or workshops. These maps are shown to the participants afterwards in order to get comments and feedback. Causal Mapping can be used for different purposes such as strategy development, sense-making processes, and implementation of change (Hansen, Rasmussen 2011).

3.7 The Research Approach
Based on the iterative grounded theory approach and the method described above the author developed a revised model for the research approach and collection of data in order to adapt it to the actual project. This model can be seen in the figure below.
The process began by a contact to the company and a first meeting, which was important as the basis for the project was made at this meeting. Following the data collection began in constant interplay with the analysis of data. As the project developed a concurrent literature review was carried that was found to be relevant for the project. An important part of the project was also the sensemaking with the practitioners, which was carried out on a weekly basis and often several times a week. The additional part of this model is the part of strategic simulation. This simulation was also a form of analysis of the data found as they had to be used in the simulations. The figure above shows that the research process was iterative and explorative as the area of research was new to the author as well as the case. An important part of the model is also the focus on the informal interactions which characterises the typical research process and give valuable knowledge and data. The different methods of data collection mentioned in the model above have been described, whereas the narrative and numerical simulation will be described in the following chapter.
Chapter 4. Strategic Simulation
This chapter explains the purpose of strategic simulation as well as introduces the two forms of simulation used in this project. Furthermore, the methods are reflected upon and the aspect of verification, validation, and accreditation is introduced.

4.1 The Purpose of Strategic Simulation in this Project
Strategic foresight deals with the long term future and is a trans-disciplinary exercise (Rasmussen, Andersen et al. 2010). Related to strategy making it is a process that involves strategy formulation in combination with the analysis of the likely evolution of the business environment, in order to detect the opportunities and threats that emerges from emerging trends and to deal with them properly (Vecchiato, Roveda 2010). It is a systematic way of managing knowledge, which can be crucial for example for companies in order to gain competitive advantages and cope with the rising challenges of the increasing turbulent business environment (von, Vennemann et al. 2010). The term covers a wide range of approaches and methodologies to improve future-oriented decision-making. There are different phases of foresight describing the evolution of foresight through historical phases. The last phase, open foresight, indicates that the future cannot be either calculated or projected, and therefore different approaches are needed to anticipate it rather than react to it, especially by means of interaction (von, Vennemann et al. 2010). Strategic foresight activities can be classified according to three criteria: the major focus also called the field, the level, and the time horizon (Vecchiato, Roveda 2010).

![Figure 4.1: General classification of strategic foresight activities (Vecchiato, Roveda 2010)]
Strategic foresight can be based on the micro-environment of the firm where the focus is on the forces that originate inside the industry where the firm competes and on the main players within this industry. These activities can be technology trends and competition analysis. It can also be based on the macro-environment in order to examine the political, economic, ecological, societal, and technological landscapes which surround it. The strategic foresight analysis can be targeted to decision makers within the operational level, the business level, and the corporate level at the firm. Typically, the corporate level deals with evaluating the long term attractiveness of different industries and investments. The business level focuses on a specific business area in order to determine which competitive advantage to pursue in the long run. Foresight activities at the operational level focus on a specific organisational unit or project in order to determine how to implement the business strategy successfully. The time horizon expands from short term which is often related to the operational level to long term which is often related to the corporate level (Vecchiato, Roveda 2010).

Strategic simulation can be used within different time horizons as the narrative simulation can have a focus from 1-100 years. In this thesis the strategic simulation was used with a company and their wish for the time horizon was three years as this was a medium to long term horizon for them. The method can also be used to communicate to different levels in the organisation and the intention of the method is that it will not be used solely at one level. The intention is that this method should support a dynamic strategy development and implementation at all three levels. It is also important to notice that the method can cover both the micro- and macro-environment as both the macro-environment trends as well as the forces that originate inside the company can be taken into consideration.

Strategic foresight is a set of methods and techniques developed over a long period of time, that help in revealing and assessing possible futures (Rasmussen, Andersen et al. 2010). Foresight methods can both be described as:

- Qualitative – the use of more or less narrative and discursive texts, and provide meaning to events and perceptions.
- Semi-quantitative – the use of more or less sophisticated probabilistic and statistical principles to manipulate judgements or tacit knowledge
- Quantitative – the analysis of trends and similar data (Popper 2008a, Popper 2008b).

There are a wide range of methods available for foresight processes. The methodological framework used in a foresight project should be tailored to meet the specific objectives of the project and the resources and capabilities that are available. Many of the methods can be used at different stages in a foresight process.
and there is no ideal methodological framework providing the ‘best’ combination of methods (Popper 2008a, Andersen, Rasmussen 2012). New approaches to foresight introduce a concept of corporate foresight which is based on an open and interactive perspective that focuses on the communication process rather than on methodology (von, Vennemann et al. 2010). The foresight diamond can be seen in the figure below giving a practical framework for a number of methods in terms of the core type of knowledge source each method is mainly based on (Popper 2008a).

![Foresight Diamond](image)

**Figure 4.2: The Foresight Diamond** (Popper 2008a)

The knowledge sources are:

- Creativity-based methods are more based on emphasising creativity both classic individual creativity and development of compelling narratives and visions.
- Expert-based methods are more based on expertise and the judgements, opinions, and reasoning of experts.
• Interaction-based methods are more based on bringing together different players to interact in face-to-face or online settings.
• Evidence-based methods are more based on data and the processing of data by statistical methods and modelling (Popper 2008a, Popper 2008b, Andersen, Rasmussen 2012).

The different knowledge sources are not fully independent from one another and a comprehensive foresight process should try to use at least one method from each pole. This means that these methods present different functions and ways of working and brings something different to the process. There is no best way to combine the methods, but it should be adjusted to the given situation and context as well as the resources and capabilities available. Some of the most often used foresight activities techniques in companies are scenario building and roadmapping (Vecchiato, Roveda 2010). This is partly due to the fact that since the oil shock multiple scenario analysis has experienced an increasing interest as a way to deal with the uncertainties of the business environment. It is important to design the foresight process so that it is suitable for the company and so that it can have a direct and effective impact on the strategic decision making.

In the PhD project strategic simulation was used to examine the future development of a supply chain for a company. Strategic simulation is the combination of narrative and numerical simulation. Numerical simulation is used to carry out experiments on a model of a system of interest (Pidd 2004) and can be used to model more-or-less static situations, but it is also ideally suited for exploring dynamic, story-like aspects of scenarios. Elements of stories can be modelled, animated, and simulated depending on the level of details and it is important to clarify terms and conditions in this respect. Simulation can give answers about whether a scenario can be realised given the existing constraints and can be used to evaluate the implications of alternative possible scenarios. A simulation with visible output enables scenarios to be replayed directly to stakeholders and the reaction from stakeholders to the simulation will enable the scenarios to be enhanced and further developed illustrating why scenarios are so valuable (Alexander 2004). This way the use of simulation can explore scenarios. There is a close connection between scenario and simulation, since both explore ways a system would work and both imply the need for an iterative and participative development (Alexander 2004).

4.2 Narrative simulation

The narrative simulation in the CSA is based on Interactive Scenario Analysis or Scenario Planning (Lindgren, Bandhold 2009, Van der Heijden 2005b, Rasmussen 2011b, Rasmussen 2011b) and is concerned with the development of pictures of what might be as well as how to get there by the means of dialogue between
scenario builders and relevant stakeholders. There is no single definition of scenarios, but a scenario is not a forecast or a vision, but more related to views of the future that makes risk management possible and is related to strategic planning (Lindgren, Bandhold 2009). Scenarios can help decision makers, planners and stakeholders to get an overview and deeper insight of the possible outcomes of particular decisions. The special feature of scenario analysis is the long term perspective (1-100 years) as well as the combination of vision making, story-telling, and strategy formation (Rasmussen 2011b). Telling stories about systems helps ensure that stakeholders share a sufficiently wide view to avoid missing vital aspects of problems. Scenarios vary from brief stories to richly structured analyses, but are almost always based on the idea of a sequence of actions. People are very good at reasoning from even quite brief stories, for example detecting inconsistencies, errors, and threats with little effort and this give scenarios their power. Scenarios are applicable to systems of all types, and may be used for different purposes (Alexander 2004). Though scenarios can never be value-free explorations (Kahn, Wiener 1967), they help the users to see the future through various sets of lenses, stretching beyond the ‘conventional wisdom’ or ‘conventional mental map’ (Van der Heijden 2005a). Scenario analysis confronts managers with environmental uncertainties by presenting them with several different outlooks on the future, and scenario analysis is claimed to be an effective strategic management tool as it has different functions:

- Evaluation and selection of strategies – Scenarios can provide a framework within which all the various factors and information can be more effectively and easily judged by decision-makers.
- Integration of various kinds of future-oriented data – besides quantitative data, scenarios can handle qualitative data.
- Exploration of the future and identification of future possibilities – by exploring the future, scenarios can help identify strategic problems and opportunities an organisation might face as well as generate strategic options to deal with them.
- Making managers aware of environmental uncertainties – scenario analysis brings uncertainty into the management process.
- Stretching managers’ mental models – scenarios explicitly confront managers with their own biased viewpoints.
- Triggering and accelerating processes of organisational learning – scenarios are representations of the real world and an area where managers can test and by doing so also learn faster (Bood, Postma 1997).

The coordinators of Interactive Scenario Analysis have various functions from case to case. Sometimes they are behaving as process-guides or facilitators for instance of workshops with no interference in the
contents of the scenarios or strategies (stakeholder-driven approach). In other instances they may conduct content analysis, scenario building or strategy either as consultants or researchers in addition to the facilitating roles (Rasmussen 2011b). The approach of the scenario builder’s role in this particular case will be further described in the following. The Interactive Scenario Analysis was carried out by the author in the phases described below. The phases were adjusted to a continuous case in a company as can be seen below.

- **The constitutive phase**, which includes a definition of the focal issue.
- **The problem-focusing phase**, which consists of information from the stakeholders regarding the situation as well as specification of the focal issue.
- **The scenario building phase**, scenarios are developed through and interactive and iterative process.
- **The back casting phase**, in which development paths are elaborated between the created scenarios and the present situation.
- **The action planning phase**, in which strategies and action plans are developed.

This project used the different phases adapted to the situation where the researcher was actually part of the organisation and to the fact that a scenario workshop was not carried out as such.

### 4.3 Numerical simulation

The term simulation is broad and used in different situations. It can be defined as “an analytical technique in which a mathematical or logical model of a real system is built in order to draw conclusions about the behaviour of the real system by studying the behaviour of the model whose cause-and-effect relationships are the same as (or very similar to) those of the system under study. The experiments are performed in a compressed time.” This refers to simulations, not as replicas that give exact results but instead show trends and indicate consequences of a scenario rather than showing the best solution (Jacobsen 2005). A model is a representation of a system, and it can give a simplified description of the reality or possible futures. It can be used to analyse different solutions and the intention of creating a model is to learn about the system. Therefore, it is also important to point out that a model is a representation of reality and not a replica of a real system and simulation building should strictly adhere to including the relevant factors with respect to the needed results and evaluation (Pidd 2004, Jacobsen 2004, Ross 2002, Harrell, Tumay 1995, Chaharbaghi 1991).

The numerical model was in this context built with ProModel as it is a powerful, but still easy simulation tool that can model all kinds of different systems. Furthermore, ProModel is Windows based and has a
graphical interface that makes it good to use to persons that have not simulated before. It has a modelling base that eliminates the need for programming, which makes it easy to use and easy to share with others. It can be used to simulate and analyse different types of systems and during the simulation the animated illustration of the system is shown and utilisation statistics are collected (Corporation 1999). The model can be built without any predefined order since it is always possible to build and upgrade it. Numerical simulation consists of two aspects; the simulation tool, such as a simulation language, and the “modeller” who uses the simulation tools to build a model and analyse it (see figure 4.3).

Figure 4.3 represents how a simulation planning model is normally built, but this is however not the way it was used in the process of combining the two methods in order to make strategy development. There are many applications possible for numerical simulation, but in this context there will be focused on strategy development, and therefore a model representing the method used is illustrated below.
4.4 The Combination of Narrative and Numerical Simulation

The combination of the numerical and narrative simulation can be used as a tool to support strategic decisions regarding different scenarios. Below a figure illustrating a recommended method and process that developed during this case can be seen.

Compared to the model illustrated before this model emphasises the idea that the two methods should be used in an interactive way. Furthermore, the combination should enhance creativity by working with uncertainties as the idea is to think in an experimental way and not to reflect the current reality. The interaction between the scenarios and the model is important as the idea is to find the narrative points in the numerical simulation. This suits strategy development as strategy description deals with uncertainty. The combination and interaction of the two methods should enhance the clarification for both sides as the idea of the combination is to start with a scenario and then translate this narrative into a computer model, which forces a precision and clarification. However, the combination does not stop there as the important
point is the interaction, which again should help clarify uncertainties and ambiguities in the narrative and the scenario. This combination can also enhance the creativity as the numerical model offers feedback to the narrative model, which then again can be further developed. The narrative model can then again expand the numerical model and in this way create an iterative process. It can be seen how responsive an outcome is to changes in some parameter or condition and exploring the boundaries of the model can provide valuable insight to both the narrative and the numerical model (Kemp-Benedict 2004). This means that many different situations can be researched and adapted as things evolve. A force of the combination is that it opens up for communication as the narrative and numerical models are an opportunity for others to share their insights and critique of the models as they are developed. By making the models explicit it can be subjected to outside review. The model structure can also be reused by either the model builder or the model user (Kemp-Benedict 2004). In this particular case it means that the stakeholders could follow the work of the scenarios as they evolved over time and give concrete feedback on them, especially as the numerical model was also developed in parallel as this gave a visual reflection of the scenarios.

The advantage of combining scenarios with numerical simulation is that the method attempts to look ahead and give an input to how the future may look, without being able to tell. An important aspect is also that the model is never finished – it can be constantly developed and adjusted to new information. The focus should be on the combination of the two methods and on using the narrative part to describe the situation and develop it further and on using the numerical part to show the scenarios and enhance them further. Decisions regarding certain aspects in the narrative part can also be carried out by the stakeholders so that is in agreement and so that the information is concise. In this case much of the identification was done by the author and the author has an insight into supply chain management, but the decisions regarding suppliers and the economic formulas could have been decided by the company itself (Loucopoulos 2004, Kljajic, Bernik et al. 2000, Baldwin, Allen et al. 2010).

Perhaps the most important area for research using mathematical and computational models is combining them with empirical research, since there is a need to validate the models through empirical studies and the models have implications that can be used to generate propositions and hypotheses about real world organisations. These could be studied with empirical methods, both quantitative and qualitative (Kljajic, Bernik et al. 2000, Hazy, Millhiser et al. 2007, Rouse, Boff 2005, Rouse, Boff 2005, Nilsson, Darley 2006, Nilsson, Darley 2006). The project can both be seen from a management perspective in that the company wanted to get a systematic tool they could use in relation to the strategy development as well as from a research perspective of trying to combine the two methods and the interaction between the researcher and the company.
4.5 Method Reflection

The PhD project carried out a foresight process in a company based on the intention to use strategic simulation based on the methods described above. There are many possible methods and combinations of methods in a foresight process. In the PhD project different methods were used in combination. These methods are highlighted with a red circle in the figure below.

![Figure 4.5: Positioning of methods in the thesis (Adapted from Popper).](image)

As it can be seen from the figure the method was a combination of methods from different poles in the diamond meaning that there was a focus on combining different knowledge sources. The methods used were also a combination of both qualitative and quantitative methods. Had Roadmapping and Delphi for example been used it would have meant that semi-quantitative methods had also been incorporated. However, interviews, expert panels (stakeholder panel), a SWOT workshop, causal mapping, and scanning
(observations) were used in combination with scenario analysis to understand the context of the case as well as to identify trends and drivers relevant for the case.

4.5.1 Delphi

The Delphi method is a social research technique that involves repeated polling of the same individuals in order to obtain reliable group opinion using a group of experts (Popper 2008a, Landeta 2006). The method is characterised by:

- Questionnaire based
- Anonymous answers
- Distributed through internet or email
- Controlled feedback
- Repetitive process (Landeta 2006)

Delphi is normally used to obtain viewpoints as to whether and when particular developments may occur, but the technique can be used for any sort of opinion or information. It is a semi-quantitative method in that it applies mathematical principles to manipulate data derived from rational judgements of experts (Popper 2008a). The use of the Delphi method in scenario analysis is an approach that has been recommended, because the Delphi process is easy to integrate into the scenario process and it delivers reliable and valuable data for the scenario enrichment. It can be used to continuously develop expert opinion consensus about future developments (von, Darkow 2010). This way it can provide useful insight to the scenarios especially in the start up phase of the scenario development for example to identify trends by asking an expert panel about their expectations. The risk can be that the experts can be tempted to overestimate the relative importance of their own specialised field of knowledge. Another issue with the Delphi method is that it can be a very difficult and complex task to make the statements in the questionnaire. It can be difficult to make sure that the statements are not too vague or complex and it is difficult to ensure that all respondents understand the statements in the intended way (Andersen, Jofre et al. Forthcoming). The Delphi approach was not used in the project as it was found that qualitative interviews were more appropriate in order to gather data in relation to the narrative simulation. This was based on the fact that the author had limited knowledge about the core business beforehand and would have had difficulties in making the right statements from the start. Furthermore, the qualitative methods (qualitative interviews) were found to be appropriate as it is possible during both the interview and the workshop to get an idea whether the participants understand the questions/context and also to pose elaborating questions that might make the question and answer more clear.
4.5.2 Roadmapping

Roadmapping is a semi-quantitative method, in the sense that it applies mathematical principles to manipulate data, which outlines the future of a field of technology, generating a timeline for development of various interrelated technologies and including factors like regulatory and market structures. The method has also been applied to other areas than technology development and the term is used to describe different sorts of forward planning. The elaboration is not dependent on numbers and statistics, but the outcome is often expressed in terms of quantitative targets (Popper 2008a). Roadmapping is a normative approach and includes backcasting from vision to present status along the pathways to realise the vision. These two approaches are not contradictory but compatible (Kajikawa, Yoshikawa et al. 2008). Roadmapping techniques are used in many organisations to develop strategy, make key decision, and coordinate activities. Roadmaps can be used in combination with scenario analysis as they also are useful related to issues that are characterised by complexity, uncertainty, and ambiguity (Palmer, Phaal 2010). Roadmaps can give a form of structure related to the scenarios that open up for cognitive thinking. This way the roadmap in combination with for example backcasting can structure the information found in scenarios and provide a way to get to the scenario. Roadmapping was not used as a method due to the fact that the focus of both parts of the case was to focus on exploring different possible futures and testing these futures based on the CSA method. The numerical part of the simulation gave a form of structure to the scenarios as the numerical simulation aided in looking at paths for the scenarios. Backcasting is a qualitative method, in that it provides meaning to events and perceptions, which involves working back from an imagined future to establish a path that might take us there from the present. Backcasting is often used in scenario workshops, which involves creating futures and afterwards imagining all necessary events, actions, and milestones in order for that future to be achieved. It can be perceived as a less elaborated version of roadmapping (Popper 2008a). This was the reason that backcasting was chosen as the focus was on making a path back from the future to the present and as backcasting also has some quantification of the which goals to reach when it was appropriate to use this in combination with numerical modelling.

4.6 Verification, Validation, and Accreditation

Verification, validation, and accreditation are important aspects of any simulation project as they are prerequisites to the credibility and reliability of a model. The figure below describes the process of making a simulation and performing verification, validation, and accreditation (Petty 2009).
Figure 4.6: Comparisons in verification, validation, and accreditation (Petty 2009).

The boxes in the figure shows the elements involved in a simulation project and the solid arrows show how one element transforms into another element. The dotted lines between the boxes represent comparisons between the artefacts. In order to understand and use the model some explanations are necessary. **Simuland** means the real-world system of interest which can be an object, process or as in the case in this project a supply chain. The simuland can include parts outside the object of interest that influence this object. For example for the case in question the simuland will contain aspects outside the supply chain. The **conceptual model** documents those aspects of the simuland that are included and those that are absent. In the sense of the strategic simulation the conceptual model can be viewed as the narrative simulation, which can describe aspects of the scenarios that cannot be quantified. The **executable model** is a model that can be executed and represents in this project the numerical simulation. The **results** are the output produced by the executable model and the results are important in the validation. The **requirements** specify which aspects of the simuland that have to be modelled and the level of requirements specify how accurate they must be (Petty 2009).

4.6.1 Verification

In modelling and simulation verification is typically defined as the process of determining if an implemented model is consistent with its specifications. Verification deals with accuracy such as comparing the requirements made in the requirements analysis to the conceptual model in order to verify that they...
are accurately represented in the conceptual model. Furthermore, verification is concerned with how accurately the conceptual model is transformed into an executable model. Verification answers the question whether the model was made right (Petty 2009, Pidd 2004, Ross 2002, Harrell, Tumay 1995, Jacobsen 2005). The questions to be asked in relation to verifying the CSA in the project have been developed to be:

- Does the CSA result in an interaction between the numerical model and the narrative model?
- Does the CSA satisfy the intended use?
- Does the CSA produce results when it is needed and in the required formats.

4.6.2 Validation

In modelling and simulation validation is the process of determining to which degree the model is an accurate representation of the simuland. This means that validation is concerned with comparing the simuland to the conceptual model to see if the simuland is accurately represented. Furthermore, the behaviour of the simuland is compared to the results of the the executable model to establish the accuracy between these two. Validation is answers the question whether the right model was made (Petty 2009, Pidd 2004, Ross 2002, Harrell, Tumay 1995, Jacobsen 2005). The questions to be asked in relation to validating the CSA in the project have been developed to be:

- Is the CSA a correct representation of the simuland and produces valid data?
- Under what range of inputs are the CSA’s results credible and useful?

4.6.3 Accreditation

Accreditation is a decision process and is the official certification by a responsible authority that a model is acceptable for use for a specific purpose. Accreditation is typically based on the findings of the verification and validation process and it compares the requirements made in the requirements analysis to the actual results from the execution of the executable model. Accreditation is concerned with the question whether the model is the right one for the job (Petty 2009, Pidd 2004, Ross 2002, Harrell, Tumay 1995, Jacobsen 2005). The question to be asked in relation to accreditation the CSA in the project has been developed to be:

- Are the capabilities of the CSA and requirements of the planned application consistent?

The points made above in this chapter will be discussed in chapter 9.
4.7 Conclusions

The above shows that the thesis finds itself within both the postpositivistic paradigm and the constructivist paradigm. This is due to the fact that the research design is based on the mixed methods research that uses both qualitative and quantitative methods for data collection and data analysis. The table below shows a summary of the above chapters.

<table>
<thead>
<tr>
<th>Paradigms</th>
<th>Postpositivism</th>
<th>Constructivism</th>
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<td>Case study &amp; Iterative Grounded Theory</td>
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<td>Informal Interactions</td>
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Table 4.1: A structure of the research approach

In the following chapter the case will be described based on data collected through the above methods and analysed through the narrative and numerical simulation.
PART IV. The Case Study & the Model

In this part the distribution part of the case will be described in depth to begin with. Following this the theory found to be relevant through the case will be addressed in order to analyse the case. Then chapter 8 looks into the second part of the case, which focuses on the outsourcing strategy of the company.
Chapter 5. The Case

In this chapter the company GN Resound is described as this was the company where the method of combining numerical and narrative simulation was carried in order to first explore future strategic possibilities for the distribution logistics and later on to explore future possibilities for the outsourcing strategy. The original time horizon for the strategic simulation was from 2007 to 2010. This was however changed to 2012 as GN Resound continued to work with and develop one of the scenarios and as the author also continued to follow what happened in the company.

5.1 The Organisation

GN Resound is a medium sized Danish company that develops, produces, and sells hearing aids. The GN Resound Group is a part of GN Great Nordic, and was founded in 1999. The group is the result of the merger of six of the world’s hearing instrument companies – ReSound Corporation, GN Danavox, Beltone, Philips and Viennatone – and was initially formed on July 6, 1999 through the merger of GN Danavox and ReSound Corporation(www.gnresound-group.com 2010). This makes GN Resound the result of a fusion of six of the most important hearing aid producers. GN Danavox was founded in Copenhagen in 1943 and Resound was founded in California in 1984 and worked with the AT&T Bell laboratories to develop technology for hearing aids. In 1996 a strategic alliance was formed between GN Danavox and Resound to develop more powerful digital technology for hearing aids. In 1999 Beltone bought the hearing aid division of Royal Philips that primarily produced Behind-The-Ear hearing aids. GN Great Nordic, the owners of GN Danavox, bought ReSound the same year becoming the fourth largest producer of hearing aids in the world. In 2000 GN Great Nordic bought Beltone, which primarily focused on In-The-Ear hearing aids. This meant that the company GN Resound was brought together by many different companies with different people, knowledge, and systems. GN Resound has gone from being a Danish hearing aid producer to becoming an international manufacturer with focus on both BTE and ITE hearing aids. In connection with the consolidation of the six companies there was an intensive work in moving and consolidating the production (GN Resounds application for the Danish Logistic Price 2005).

After the consolidation the GN Resound Group consists of two different hearing aid divisions - GN ReSound and Beltone. GN ReSound markets the brands GN ReSound, ReSound, and Danavox and Beltone markets the brands Beltone and Philips. The headquarters is in Ballerup, Denmark and has approximately 3.100 employees (2008). The group is represented through subsidiaries (sales- and service companies) in several countries, through a distributor network in more than 70 countries, and through own production facilities in the world (www.gnresound-group.com 2010, www.gnresound.dk 2010). At the time the PhD project began in 2007 Phonak was looking into buying GN Resound. However, the German competition authorities
decided to put the deal on hold as they looked into it. In the fall of 2007 the German competition authorities prohibited Phonak’s take over of GN Resound resulting in the sale being cancelled.

5.1.1 Structure
The department that was the area of focus in the first part of the case was the Global Supply Chain as this department was relevant due to the fact that it was responsible for the whole supply chain including the distribution and production. The contact person was placed in the division called Global Planning & Customer Service. The structure in 2008 of the department can be seen below.
products according to the launch plan and to make sure that there were no quality issues in the production (GN Resound internal document 2007a, GN Resound internal document 2007c). The persons placed in the boxes above had changed from 2005 to 2007, and changed again during the time the PhD was carried out. This will be further elaborated in the follow up phase. The supply chain in GN Resound was at the beginning of the project time structured as shown in the figure below.

![Diagram](image)

*Figure 5.2: GN Resounds distribution/operations structure at the beginning of the project (GN Resound internal document 2007c)*

The figure shows GN Resounds operations structure. It shows the two production units, one in Xiamen (XMN), China and one in Præstø, Denmark. The two production facilities each have their own competencies. The hearing aid assembly plus some plastic production and spare parts are based in China, where low labour costs ensure the competitive advantage. The production here is relatively labour intensive. The NPI component and hybrids (the intelligence of the hearing aid) production is based in Præstø. NPI components are produced in Præstø until the products are mature for production and then they are transferred to Xiamen or a 3rd party supplier. 3rd party suppliers deliver raw material and components to GN Resound. Præstø also functions as sub supplier to China as the hybrid is produced in Præstø. The hybrid is the hearing aid’s brain and represents a substantial part of the product’s total cost price. The production facility in Præstø is automated to a high degree in order to reduce the effect of the
higher Danish salary level. Part of the production of plastic components, including the tools for producing it, has been outsourced to sub suppliers in China. The assembly of the hearing aids was offshored to China in April 2001 and this happened in one move. The outsourcing of punching of diverse components was done in 2001 and the decoration of parts for hearing aids was offshored to China in 2002. Since 2003 approximately 100 injecting moulding tools (plastic production) have been outsourced and offshored to China (GN Resounds application for the Danish Logistic Price 2005, GN Resounds application for the Danish Logistic Price 2005, GN Resound 2010c, GN Resound 2010b). In each sales company (Subs) there is a production of In-The-Ear hearing aids (ITE), which in contrast to the Behind-The-Ear hearing aid (BTE) is customised for the individual customer. The customisation is based on an adjusted hearing aid based on a mould of the customer’s ear. The hearing aid itself (the faceplate) is produced in China, and the production taking place in the Subs is primarily montage and adjustments (GN Resounds application for the Danish Logistic Price 2005).

As can be seen from the figure above the most part of the spares and hearing instruments is sent to the GDC - generally, 80% of the production is sent to the GDC. From the GDC the products are distributed to the local sales companies that are responsible for the final distribution to the dispensers (hearing aid clinics etc.). The remaining 20% of the total shipments are sent directly from the production in China to the local sale company in China as well as the sale company in Bloomington, USA. In GN Resound there is a set of general rules regarding delivery times from the moment the GDC receives the order from the sales companies until it is delivered. This is directly based on the sales company geographical placement. Due to the products’ size the total cost of shipment is only a marginal cost in comparison to the total logistic costs (app. 750 kg are sent per day). GN Resound finds it more important to sustain the fast delivery time and security of delivery. The freight is outsourced to DHL (GN Resounds application for the Danish Logistic Price 2005).

The distribution situation in GN Resound at the starting point of the project had both strengths and weaknesses. The GDC centralised many decisions in one unit. This meant that there was only one system to handle, which made it less complicated as there was only one quality control and geographical place. However, it also meant that most of the hearing aids and spare parts were sent to the GDC, which then again distributed the goods. This could in certain cases mean that sometimes a supplier from e.g. USA sent goods to the GDC in Ballerup, which then again sent the goods to the sales company in USA. This increased the level of transport, the level of complication, and the inventory.

5.1.2 The Market
There are two different types of hearing loss – sensorineural loss and conductive loss.
Sensorineural loss, the most common type of hearing loss, occurs when the nerve endings in the inner ear are not transmitting sound properly, often as a result of damage to the hair cells in the cochlea. This damage can be caused by a number of things, including noise, or a natural withering of the cells (presbyacusis) that comes with age. Sensorineural loss cannot be cured medically, but it can usually be improved through the use of hearing instruments.

Conductive loss occurs when sound is not being sent properly to the inner ear due to some "mechanical" problem. Conductive loss is often the result of damage or blockage in the middle ear. In most cases, conductive hearing problems can be corrected medically (www.gnresound-group.com 2007d).

The above means that GN Resound’s products are aimed at persons with sensorineural hearing loss. It is possible to suffer from a mixed hearing loss and that can be helped with both surgery and a hearing aid and in this case the hearing aid helps the sensorineural hearing loss (GN Resound 2010a) (www.gnresound.dk 2010, GN Resound 2010a).

A Finnish study showed that there has been a growth in the number of hearing-impaired and it is expected that a doubling of these numbers over the next 15 years. The reasons for hearing loss can be many, but the use of mobile phones, Discmans, l-pods, concerts and so on are some of the reasons causing the increase in the number of younger people with a hearing disability (www.sundesider.dk 2010). All this is resulting in more and more people are wearing some form of device to improve their hearing, leading to continued growth in the hearing healthcare market. In 2008 it was assumed that around 18% of the population in Denmark suffered from a hearing disability, which is approximately 800,000 persons and this can also be related to other western countries. This can be seen from GN Resound’s sales per region in 2010.

![Figure 5.3: GN Resound Sales per Region in 2010](GN Resound Annual Report 2010)

The figure shows that the US and Europe are representing the largest markets for GN Resound, which is also why they were interested in having distribution centres in these part of the world. The markets of hearing aids are very different. The developing countries demand low cost products where as the industrial
countries have a higher demand for functionality and performance (GN Resound 2007c). Both the Chinese and Indian markets are growing as the middle class of both countries are increasing along with their buying power. This could on the longer perspective mean a rising market for hearing aids in these two countries as the population will have the means to buy high quality hearing aids, but also to buy devices that can cause a hearing disability (GN Resound 2010c). This means potentially large markets for hearing aids and these two markets will become bigger than the European and American market, and therefore there can be strategic considerations to be geographically placed close to those markets as it can give a competitive advantage to be present at this market through a distribution centre and a production site.

The expectations for the future market are that the BTE hearing aids will continue to gain market shares, since the BTEs are becoming smaller and the part that goes into the ear is becoming less visible and is soft and comfortable. Furthermore, the part that goes into the ear is small and leaves room for air in the ear, which can reduce the dome hearing experience. There are great demands for the materiel that the ITEs are made of as these are placed inside the ear, and therefore have to endure with more extreme conditions than the BTEs. Currently, the material used for ITEs is harder and this can possibly be less pleasant when for instance chewing. As a result of this the trend for the market is that the BTEs will gain market shares. This could be influenced if the ITEs were further developed so that they were not made of hard material and so that they did not create a dome hearing experience. Another possibility that could affect the BTE and ITE market is if a new form of surgery for hearing disabilities is discovered then it would be a threat. This is however currently still not a possibility for sensorineural loss (GN Resound 2010d).

The hearing aid industry was in 2008 characterised by 6 large players that are responsible for the largest percentage of the market (app. 90%).

---

**GN Resound Group reshaped the industry**

- **Siemens**: -24%
- **Oticon/WDF**: -16%
- **GN Resound Group**: -14%
- **Starkey**: -14%
- **Phonak Group**: -14%
- **Widex**: -8%
- **Resound**: -8%
- **Beltone**: -8%
- **GN Danvox**: -8%
- **Philips**: -8%
- **Viennatone**: -8%
Figure 5.4: An overview of the hearing aid industry (GN Resounds application for the Danish Logistic Price 2005)

As can be seen from the figure GN Resound was placed as number three after Siemens and Oticon. This was changed as GN Resound went through a process of being in a situation where Phonak attempted to buy them, meaning that they had to put new developments on hold for a while. This meant that GN Resound were for a while located as number four, but in 2010 they were again placed as number three (GN Resound 2010d).

5.1.3 Trends
Long-term driving forces of society can have an impact on organisations and networks, and it is important to identify trends and driving forces that can influence the possible futures of the examined area. A trend represents a deeper, long-term change in contrast to a passing fashion (Rasmussen 2011a). A megatrend differs from the more common trends and is defined as a large, social, economic, political, environmental or technological change that is slow to form but continues relentlessly over several economic cycles. Megatrends are those underlying forces that drive trends (Kekomäki, Rehnberg et al. 2010). It is also important to consider trends as unexpected events that can have enormous consequences if they actually occur (Cornish 2004).

5.1.3.1 Demography
There is a general increase in the 50 to 65-year age group. This age group is feeling the effects of heightened noise levels - such as traffic, or loud music resulting in some form of hearing disability. It is estimated that loss of hearing affects more than 500 million people worldwide (www.gnresound.dk 2010). In 2010 the estimate was that 18% of people between 65 and 74 years and 35% over the age of 75 had significant hearing loss. Furthermore, 90% of hearing losses can be helped with hearing instruments, and 10% can be treated medically and/or surgically. However, fewer than 5% of those who could benefit from using a hearing instrument had one in 2010 (www.gnresound-group.com 2010, www.gnresound-group.com 2010). A change of attitude in society is developing as a hearing aid is becoming a thing that does not necessary needs to be hidden. This is partly due to the increasing number of young people that are suffering from hearing loss and choose to have a hearing aid in bright colours so that it more resembles jewellery than an aid. Furthermore, the increasing number of young people with hearing loss also removes the assumption that this is a disability only elderly people experience, and therefore it is not associated as much with getting older as previous. The social interaction today also places greater demands on our ability to communicate. It is therefore reasonable to expect that, in the future, more and more people will need to wear some form of device to improve their hearing.
5.1.3.2 Labour Rate

The development of labour in the world is also of importance when part of the production is outsourced. The production is currently outsourced to China, but the level of salary could rise due to the development of the Chinese market and the increase in the middle class.

“If you look further ahead the salary can become an issue. If you look at engineers, technicians and so on then their salary has increased incredibly and that has happened at a fast rate”, Vice President Component Manufacturing.

This could make it less profitable to have production placed in China in the long run and it could be relevant to consider whether the production or part of the production should be placed elsewhere. Many companies are beginning to outsource to Vietnam and other Asian countries due to lower labour costs, but India is also an option as labour is often more stable and reliable compared to China where the phenomenon of job shopping exists. However, China represents a large market, and therefore there could be a point to keeping part of the production there (Workshop 2007). It also has to be considered whether it is viable to move the production to another low cost country compared to moving it back to Europe.

5.1.3.3 Technologies

The technological development within the information and communication technology moves at a very fast pace. New features of products are introduced and incorporated.

“Suddenly a new technology is introduced. Currently wireless is the hot topic. Two devices can talk together through bluetooth and wireless. Talk to the phone and what other things you can imagine, the television, dvd, mp3. These things come along abruptly” Vice President Component Manufacturing.

The company has to be able to quickly adjust to new customer demands regarding these features. As mentioned earlier it is expected that the BTEs will gain market shares in the future. However, a new technology to make the ITEs better or to implant a hearing aid within the ear itself could be invented. If the ITEs are improved and their market shares would gain instead it would mean that GN Resound would have to integrate a capacity to customise the hearing aids in their distribution strategy as this currently takes place in the GDC or in the sales companies.

If a new technology was developed so that sensorial hearing loss could be aided surgically different aspects had to be considered such as the price and development on the price of surgery, whether everybody was fit for surgery etc. The market would probably swiftly, but on short term it would most likely take some time before an effect could be traced.
The technological development within plastic production is relevant as a large part of this is outsourced. A high technological development resulting in more difficult operations in order to process the hearing aid can have impact on where the production unit is located. This will also affect the level of education and the quality. The equipment as well as the material to produce the plastic material for the hearing aid has a fast development curve.

“We have developed technologically. We now have some equipment that is called electric injection moulding instead of hydraulic and that gives us some advantages. We now work with glass filled materials. We have a system that ensures the process is the same every time. So now we do not have to adjust the process to the tool, but the tool to the process. On the hybrid side we have started a new technology that is called tin technology rather than a technology called gold stop bumping technology” Vice President Component Manufacturing.

Development within robotics can be relevant to consider as new technologies might mean that the hearing aid could be assembled faster and with a higher quality. This can mean that an investment in robotics can be favourable in the long run compared to manual assembling.

Nano technology could be of relevance to look at over a longer period of time as it can influence the way the hearing aid is made. This could mean smaller hearing aids or longer lasting hearing aids due to nano surface technology reducing the wear and tear of the device. This could also affect the location of the production units as the technology could change the way hearing aids are produced currently. An example is that GN Resound is working with nano coating, which means that the hearing aid is dipped in a coating that protects it against dirt and moisture, which is an issue for hearing aids as they are placed behind the ear. They are at the testing and introduction stage of this coating in GN Resound (GN Resound 2010c).

There are a lot of data and systems in GN Resound and more and more system providers offer new software that can make one big system that talk together or a system that can draw data from existing systems. This software or system would also be relevant for GN Resound related to a possible reorganisation. It could be relevant with one system for the whole organisation.

“It would be nice to have one system for the whole organisation, but it would have to be a rather big system” Global Planning Manager (from 2010)Global Planning Manager (from 2010).
5.1.3.4 Supply Chain

GN Resound had a large number of suppliers that were distributed throughout the world. There were suppliers that delivered to the GDC, to the Xiamen production site, to the Præstø production site and to the sales companies as every sales company had its own suppliers besides the ones that GN Resound had (Global Planning Manager (from 2010)). This means that the suppliers were not typically located at certain places, but were found in various areas. However, the suppliers that delivered to the GDC were placed as can be seen in the below table.

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<tr>
<td></td>
<td></td>
<td>US</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grand Total</td>
<td>17</td>
<td>297</td>
<td>82</td>
<td>396</td>
</tr>
</tbody>
</table>

*Table 5.1: The distribution of suppliers (GN Resound internal document 2007b)*

From the table it can be seen that the largest part of suppliers were located in Europe and here the most part were located in Denmark. This was due to the fact that there was both a production site in Denmark that needed material as well as a distribution centre that needed material for packaging. The largest number of suppliers in Asia was found in China as the country code CN and CHI both relates to China. Both spare parts and raw material was delivered. This meant that the suppliers delivered for example granulate for making the plastic components, face plates for making the hybrid, small batteries for the hearing aid to function etc. GN Resound had approximately three suppliers in China that delivered plastic, which the
Præstø manufacturing site also worked with (GN Resound 2010c), but it was a difficult and time demanding task for GN Resound to assess how many suppliers were actually active (GN Resound 2010d). It was assumed that approximately 130 (GN Resound internal document 2007a) suppliers were active at the time the project was made, which is less than the table above suggests.

One problem of having the production placed in China is the Chinese customs as the customs close down when there is a holiday and it is then impossible to get anything out of China. These holidays falls in three periods and effect the shipments. Another issue that GN Resound faced with the production in China was related to the technological development as the Chinese production unit did not have enough knowledge to always follow the technological development within plastic. This meant that some of the production of plastic has to be back sourced to Denmark. Part of this was due to the lack of knowledge which could be another problem as an issue in China was that there is a high risk of losing valuable knowledge due to employees using the knowledge gained at GN Resound to either get a new job or to start a new company. So protection of knowledge was important (GN Resound 2010d). The communication between the two cultures could also be difficult resulting in a lot of time and costs used on travelling between the two different locations and long conference calls on the phone. GN Resound had also experienced problems related to the quality. Both in relation to the quality of the tools when they had to be approved, but also in relation to the granulate that was delivered in a wrong colour.

"Some years ago the Chinese suppliers sourced granulates. And if we needed a white granulate it was not always white then it was something in between. If you attach that to some other part that is a different white then you have a problem with quality. So now we deliver the material" (Vice President Component Manufacturing).

This meant that GN Resound had to back source the function of delivering the materials to make plastic to themselves due to quality issues. These quality issues were also relevant for the tools that were made by suppliers. In 2010 GN Resound experienced quality issues with 22 of the new tools and 13 of the existing tools this meant that approximately 60% of all tools were delayed. The main issue here was not necessarily the delays, but the fact that the tools were not approved when they were finished.

5.2 The first interaction between the researchers and the managers

The first contact to GN Resound was initiated by contacting a former master student employed at GN Resound. She gave the contact information of the relevant person – the Global Planning Manager - in the
department relevant – Global Supply Chain. A mail was sent to the Global Planning Manager indicating what the area of the project could be and why CSA could be relevant for the department. This included:

- Systemisation and evaluation of the positive and negative experiences GN Resound had in relation to establishing an effective knowledge sharing with their outsourcing/offshoring partners.
- Examination whether the CSA could be used as a tool to gain a more effective outsourcing/offshoring and knowledge sharing.

The Global Planning Manager reacted positively to the mail and called back shortly after receiving it. He mentioned that the Global Supply Chain department was currently looking into how the future strategic supply chain should look and they found the above points mentioned in the mail interesting and relevant for the process they were facing. Based on this a meeting was arranged.

The first meeting was held in GN Resound’s headquarters in Ballerup where two persons from the company were present; the President of the Global Supply Chain and the Global Planning Manager. The CSA method was presented in order to give the company an idea of what the method could be used for. Possible variables related to outsourcing and offshoring were also presented in order to give the company an idea of what could be included in the CSA approach. A figure of the presentation can be seen below.

![Figure 5.5: The CSA and variables related to the company.](image)

The figure illustrates the slide showed to the company in order to explain how the CSA was intended to function. The pink circle in the figure illustrates the narrative simulation which contains descriptions of the...
future situation in the company and includes storylines (s1, s2...). This narrative simulation is the starting point of CSA and gives input to the numerical simulation represented by the blue circle. The numerical simulation contains input and output variables that make it possible to quantify the narrative simulation. The whole process is iterative as the arrows indicate and the idea is that the two different forms of simulation give input to each other in a constantly developing process. The variables listed below the two circles were an example of how the author saw that the method could be relevant for GN Resound as they were an example of which variables could be interesting to consider related to the process of offshoring and outsourcing as well as developing the strategic supply chain. The variables were based on a literature review as well as research in the current trends related to strategic issues in supply chains.

Based on this presentation the two stakeholders gave a basic introduction of the company and introduced their current distribution situation, which was based on one distribution centre placed in Denmark. This drawing led to a discussion regarding the scenario that GN Resound had in mind for the future distribution, which was three distribution centres placed in Europe, China and the US. It was a simple drawing that led to many questions such as how the current situation looked and why they thought about making three global distribution centres. One distribution centre centralised many decisions in one unit. This made it less complicated as there was only one quality control and geographical place. However, it also meant that most of the hearing aids and spare parts were sent to the GDC, which then again distributed the goods. This meant that most of the product flow went through the distribution centre and that the decisions were made there. This could in certain cases mean that sometimes a supplier from e.g. USA sent goods to the distribution centre in Denmark, which then again sent the goods to the sales company in USA. This increased the level of transport, the level of complication, and the stocks.

“Sometimes spare parts are sent from a supplier in USA to the GDC in Denmark and then back to a sales company in USA. That is not optimal” (Global Planning Manager).

The drawing and the questions from the team from DTU inspired the President to further elaborate his drawing as to how the scenario could look, and these also sparked ideas regarding other possible scenarios for the future situation. They were working on an idea that GN Resound should have three distribution centres placed in Europe, USA and Asia. Based on this idea and the presentation of the methods an interaction between the group from DTU Management (supervisors and the candidate) and the two stakeholders began. The idea with three distribution centres resulted in questions from the group from DTU regarding which issues GN Resound were experiencing with the current situation and how they imagined the three distribution centres should distribute to different locations. This interaction also
resulted in an idea that one distribution centre placed in China could be interesting to examine. This interaction resulted in the basic ideas behind the scenarios. The current situation would function as a reference scenario to the two other scenarios that had been discussed at the meeting. The more concrete development of all three scenarios was open as well as the axis defining the scenario cross, but the idea behind the axes in the scenario cross started to form at the first meeting. Based on this meeting it was agreed upon that the CSA method could be used to explore possible future distribution structures and make a strategy for the future distribution of the company. As GN Resound is a company placed in an industry that moves fast and their product life cycles are only app. 3 months they found that a time span of three years was as long as it could benefit them to look ahead. From this point on everything was developed in interaction with the company.

5.3 The Scenario Cross

In order to agree with GN Resound on what the scenarios should contain the author decided to make a scenario cross. A scenario cross is a matrix which can help structure the scenarios.

![Figure 5.6: A scenario cross](image)

There are several advantages to building scenarios on a matrix:
- It assures that scenarios are qualitatively different in a logical, non-random way.
- It assures that the identified driving forces or assumptions will be a frame of reference for all the scenarios in the matrix.
- It assures that once the axes of the matrix have been identified, the scenario builder can decide the different scenario features to be included (Rasmussen 2011a).

The scenario cross could help highlight the differences between the different scenarios and to examine which possibilities there were for developing them. The first part of the process was to define the axes of the scenario cross. This process was primarily carried out by the author based on the information given by the two stakeholders at the first meeting and in correspondence with the Global Planning Manager who functioned as the contact person at GN Resound.

5.3.1 The axes
To find the parameters of the scenario cross it will most often be necessary to make an iterative process combining brainstorming, critical discussion and reflection, and ‘trial-and-error’. A careful and profound selection process of the parameters is very useful in the remaining steps of the Interactive Scenario Analysis (Rasmussen 2011b). GN Resound was very focused on the areas of cost and delivery performance, and this combined with the skeletons of the scenarios described at the first meeting led to a brainstorming with the Global Planning Manager and the group from DTU Management regarding the parameters. Much organisational and system research focuses on centralised versus decentralised control (Hazy, Millhiser et al. 2007) and this also reflected the situation in the company, and therefore it also became one of the axes in the matrix:

- Centralised distribution versus decentralised distribution

This parameter was chosen because this was one of the key points of making the scenarios. The current situation had one distribution centre (the distribution is centralised) and one idea was to go towards a situation where there were three distribution centres (the distribution is decentralised). This parameter reflected the focus that the company had on delivery performance. GN Resound assumed that the delivery performance could be increased for customers in the American and Asian region if these regions also had a distribution centre each as the products would be distributed directly from the distribution centre in that area. This also made the scenarios different as two of the scenarios centralised the distribution and the other two decentralised the distribution. Furthermore, this parameter also influenced the costs as there are different costs related to having one or more distribution centres as well as limiting the number of sales
companies. These costs could for instance be related to the number of employees and related salary costs, capacity costs, transport costs, and inventory costs.

The parameter was further discussed with the Global Planning Manager in order to get more feedback and reflection. It was discussed whether the parameter of centralised / decentralised distribution was misleading. In the case where there was one distribution centre there would still be several sales companies. This way the distribution would still be decentralised and the parameter could be misleading. Subsequently, it was changed to:

- Centralised distribution centre versus decentralised distributions centres

This was done in order to emphasise that it was the decentralisation or centralisation of distribution centres that were the area of focus and not the decentralisation or centralisation of sales companies. Otherwise the term decentralised distribution could be confused in the scenario where there was one distribution centres, but many sales companies.

The second parameter used in the scenario cross was whether it was possible to ship directly to end customers in order to possibly enhance the delivery performance as well as reducing the costs of having inventory in sales companies and unnecessary steps in the distribution. It was found that it was only possible in the scenarios where a distribution centre existed in order to organise the distribution and to minimise the difference for each country in regulations, culture, language etc. This parameter was also developed according to the Lean principles. This parameter related to distributing products and spare parts without sending parts through unnecessary steps in the distribution, and thereby minimising costs. Furthermore, the direct shipments to end customers also included limiting the number of sales companies and this could also possible be a way to reduce costs and increase delivery performance. Therefore, the second parameter was called:

- Direct shipments to end customers\(^3\) versus no direct shipments to end customers

The parameter was again discussed with the Global Planning Manager and it was found that the parameter direct shipments to end customers / no direct shipments to end customers was a little to general. For example, the scenario where the centres were removed and distribution took place directly from the manufacturing site, did not support direct shipments to end customers, but required sales companies. Other parameters such as push versus pull were considered, but it was found that the shipments to end

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\(^3\) Dispenser are hearing aid clinics and such who have the contact with the end customers, and therefore they are named end customers in this project as they are GN Resounds end customers.
customers or shipments to subsidiaries were more accurate as it could vary how many countries it was possible to ship directly to end customers according to the scenario. Therefore, the parameters were changed accordingly:

- Shipments to end customers versus shipments to sales companies

After the parameters for the cross had been decided upon it was possible to place the three scenarios in it in order to begin enhancing the scenarios. The cross and parameters as well as the placement of the scenarios can be seen below.

![The scenario cross](image)

When placing the scenarios in the cross it was based on GN Resound's own idea about the three distribution centres as well as the first meetings and talks regarding the scenario cross. Until this point there had been no systematically calculations, but more qualified guesses.

The first scenario that GN Resound described at the meeting with the three distribution centres was called scenario 1 and the others scenario 2 and scenario 3. These names were also the names given to them in the project. Scenario 1 was placed according to the fact that it had three distribution centres placed at three
different locations in the world. This made it possible to reduce some of the sales companies and distribute directly to end customers. Scenario 2 was placed according to the fact that it sustained the current situation and had one distribution centre placed in Europe. This also allowed for direct distribution to end customers as the distribution centre had the existing distribution lines to ship to end customers. Scenario 3 was placed according to the fact that it centralised the distribution centre at the Chinese production site so that only one distribution centre existed. This did not allow for direct shipments to end customers as the distances were far greater in China and as the distribution centre would be located at the production site. During this process a fourth scenario began to develop. This scenario developed as a consequence of the fact that there were only three scenarios in the scenario cross and based on knowledge about GN Resounds production from a former master project. Through this master project there had been contact with the Vice President of Component Manufacturing in Præstø who mentioned that at times Præstø was able to compete with the Chinese plastic production and that they experienced problems with the quality on the tools delivered by Chinese suppliers. This resulted in scenario 4 where focus was on both Præstø and Xiamen as main production sites, and thereby also possible distribution centres.

Based on this the enhancement of the scenarios began. In order to further develop the scenarios and work with the CSA it was necessary to gain a deeper understanding and insight of the organisation and department as well as the hearing aid market and the trends influencing the sector. The process itself can be seen in the figure in chapter 3, which illustrates how the process of working with the CSA and the company took place including the first contact to the company and the first meeting which has already been described. In the following the remaining parts of the process will be described and examined further.

5.4 Data Collection and Analysis

After the first meeting the first skeletons of the scenarios were drawn up, but they were only based on the information given by the company at that first meeting. If research is being conducted in a particular company, it is imperative to ascertain as much relevant knowledge as possible prior to engaging in fieldwork (Green, Kao et al. 2010). This meant that additional data had to be gathered in order to elaborate on the scenarios as well as make the numerical models. The data collection consisted of several different approaches and can be seen in the table below.
<table>
<thead>
<tr>
<th>Data source</th>
<th>Format</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archival Research</td>
<td>Published corporate material</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In-house reports</td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intranet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Databases</td>
<td></td>
<td>Global Planning Manager, Supply Chain Analyst</td>
</tr>
<tr>
<td>Informal interactions</td>
<td>Meetings</td>
<td>Participation in department meetings and phone meetings with the production site in China and sales office in the US</td>
</tr>
<tr>
<td>Observations</td>
<td></td>
<td>Observations of the department and of other departments including the inventory, the GDC, and NPI</td>
</tr>
<tr>
<td>Talks</td>
<td></td>
<td>Informal talks with various people in the Global Supply Chain department both during the daily routines, at lunch and at coffee breaks</td>
</tr>
<tr>
<td>Workshop</td>
<td>Structured Workshop</td>
<td>Vice President Global Supply Chain, Global Planning Manager, Logistics Manager, Supply Chain Development Manager, Global Customer Service Manager</td>
</tr>
<tr>
<td>Interviews</td>
<td>Informal interviews</td>
<td>Global Planning Manager, Supply Chain Analyst, Logistics Manager, Supply Chain Development Manager, Project Manager, NPI Manager, Global Customer Service Manager, Vice President Global Supply Chain, Toolshop Manager and Employees, Employees in the GDC</td>
</tr>
<tr>
<td></td>
<td>Formal semi structured interview</td>
<td>Vice President Component Manufacturing, Global Planning Manager</td>
</tr>
</tbody>
</table>

Table 5.2: Data Collection

The table shows the data collection. As mentioned it was necessary to gain as much data as possible from different sources in order to have as many methods of analysis as possible. A part of collecting the data was also to understand the company itself, the market, and trends. Part of this information was sought through archival research where material about GN Resound relevant for the scenarios was found in internal documents, published and unpublished corporate reports such as GN Resounds application for the Danish Logistic Price in 2005, corporate publicity material, unpublished in-house reports, the Internet, and the Intranet, company databases such as their customer management system, their forecast system, and public articles about the company. This as well as meetings were the basis of creating an overall view of GN Resounds situation related to the process of working with the strategy for a new distribution network. This information gave an initial contextual understanding of the research setting and helped form questions and
background for meetings and interviews. The information during the fieldwork was sought in the company through observations, formal and informal meetings, tours of the different departments such as the GDC and the NPI department, and informal interactions with the department in the company, which also helped enhance the data collection and improved the understanding of the research context. In addition to the data collection an ongoing review of literature was carried out throughout the project, which facilitated the continuous interplay between the data and theory (Green, Kao et al. 2010).

The observations were based on the author working in the company for several days a week during a longer period of time. During this observations were carried out of the company and of the daily routines, it included informal talks during the day and during lunch breaks, participation in meetings and access to different data systems which can be seen in the table below.

<table>
<thead>
<tr>
<th>System</th>
<th>Specifics</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCI</td>
<td>Forecast Intelligence. Made per country. What is used, forecast and sales</td>
</tr>
<tr>
<td>DMI</td>
<td>Demand Managed Inventory. It is run every night and sends signals to China. It indicates if the inventory is above or under max, above or under replenish, below min. It draws n both the inventory in the GDC and China.</td>
</tr>
<tr>
<td>SIS</td>
<td>Supplier Information System. The suppliers delivery performance, how much money is used on them per month and per year</td>
</tr>
<tr>
<td>CSI</td>
<td>Customer Service Interface. Order status, the company’s delivery performance</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicators. The delivery performance in percentages, on time delivery performance</td>
</tr>
<tr>
<td>VMI</td>
<td>Vendor Managed Inventory. The suppliers can see this site and see how much inventory they have at the company’s site and whether they have to replenish.</td>
</tr>
<tr>
<td>GIV</td>
<td>Global Inventory Visibility. The amount of part numbers in the different countries</td>
</tr>
</tbody>
</table>

*Table 5.3: Systems (GN Resound)*

GN Resound makes use of many systems. A meeting with the Global Planning Manager was held to introduce the different systems from the table above in order to see if relevant data could be found there.

The forecast tool was used by the sales companies in relation to the monthly forecast process. The tool gave a total overview of all the historic transactions 12 month back for each product model, as well as the existing forecast 12 months ahead. The tool gave an updated picture of the respective inventory on the active models in the sales company. Each country’s access was limited to its own forecast information, but the supply chain organisation had access to all. The tool supported that the sales companies had easy access to the latest updated information (could be collected through a forecast feedback tool in Navision) and that the countries all had the same frame of reference. The supply chain organisation was involved in the data collection, need calculation, and the business processes, but the responsibility for the data quality
was placed in the line organisation. GN Resound was able to track its delivery performance and order status using a Customer Service Interface (CSI) system. Furthermore, a Key Performance Indicators (KPI) system gave data on the delivery performance in percentage as well as on-time-delivery. The distribution centres used a Demand Managed Inventory (DMI) system that pulled data from both the distribution centres as well as the Xiamen manufacturing site to determine the inventory’s state. This was run every night and meant that if the distribution centres had replenished the end customers a DMI signal would inform Xiamen manufacturing that the distribution centres needed to be replenished. A Vendor Managed Inventory (VMI) solution was used with conciseness stock. The suppliers owned what they had in inventory at GN Resound’s place until GN Resound used the products. GN Resound was able to track the suppliers’ delivery performance and what amount of money was used on the supplier through a Supplier Information System (SIS). To support the planning process as well as the optimisation of the inventories a global inventory visibility (GIV) tool had been developed. This tool gave the Supply Chain organisation a visual online access to the inventories in the sales companies. According to GN Resound this tool had created complete transparency regarding the total level of inventory in the supply chain (GN Resound 2007b). It was the Global Planning Managers evaluation that these systems would still be used within the time frame of the scenarios. In relation to the development of the tools it was imperative to GN Resound that they could be used across the organisation, and therefore the tools were placed on the Intranet so that they were easily accessible. The tools were developed to support the processes and to create the necessary transparency in the supply chain.

The author was also given access to these systems with the help of different employees as the systems were quite complicated and as it was difficult to get an overview of them and be able to use them within a short time frame. The data was vast and somewhat unstructured as it had to be found partly in the systems and partly through different people’s knowledge of where the data was actually placed. For example the systems in the table above were not all linked together as well as the different countries had different platforms for their MRP systems. This resulted in some inconsistency between the data for example the data regarding the weight of the products:

“...You cannot rely of data in the system regarding the weight of the products. Often something that weighs 200 grams is set to 2 kg” (Project Manager in Supply Chain Development Department.)

This meant that information at times had to be found through different sources and it was at times difficult to get structured information as it was not always explicitly available as a lot of the information was personal and tacit. The data in the system regarding the weight was off and it was found through the
Logistics Manager because the Global Planning Manager knew that he had the correct data. As a result of being placed in the company it was easy to get the information from the Logistics Manager when it first had been determined that he possessed the data. The author had been on a tour of the GDC and had been shown around by the Logistics Manager who had also made it clear that if any data or information was needed the author was welcome to ask. This helped in getting the data quickly from the Logistics Manager when it was first discovered where the data could be found. Another example was that the structure of the company and the department was not easily accessed.

“I don’t even know if we have a formal organisational chart” Global Planning Manager.

The organisational chart for the department was therefore explained by the Global Planning Manager and eventually found in a presentation that was being made at the same time as the author was in the company. Due to this it was difficult to rely on the data as well as validate it and it resulted in that the process of gathering data took a significant amount of time, also due to the fact that both quantitative and qualitative data was gathered. Especially in the beginning of the project a lot of time was used on gathering data for example about the company, the distribution structure, the data systems and so on. This took some time as the author was new to the company and had to learn about it to begin with. Approximately two to three months were used to start with to gather data and carry out observations and during this period of time the first basic drafts of the scenarios were also made by the author and validated with the Global Planning Manager. Following this a period of time where the further development of the scenarios were carried out and the first drafts of the numerical simulation were made, which was not as data gathering intensive. The drafts were concurrently discussed with the Global Planning Manager and ideas of what data needed for the numerical simulations started to form. The drafts of the numerical simulation however opened up for the fact that more data was needed and also the numerical drafts clarified more specifically what data was needed, such as the amount and placement of suppliers and sales companies, and this initiated another period of intensive data collection. This period ran for approximately two months as the data at was difficult to locate and verify. For example, the author received many different documents regarding the throughput of spare parts and hearing aids in both the GDC, but also in the sales companies. This data was not consistent with each other which took some time to decipher with the help of a Supply Chain Analyst.

“Our MRP systems do not run on the same platform, which makes it complicated”

(Vice President Component Manufacturing).
The result was that the data input to the models had to be based on the data generated from the GDC and that the data from the sales companies had to be disregarded. An example of how the data was inconsistent was also seen in relation to the inventories.

“I don’t think we have an overview of what is at the inventories at the different sales companies” (Supply Chain Analyst).

The whole process of collecting the data did help to get a deep understanding of the company, its structure and the network of production and distribution and in order to be able to make the first enrichment of the scenarios. It was also done in order to gain an overview of what was needed for the process of working with CSA and what kind of data could be collected and used. The fact that the author could be a part of the department also meant that it was possible to talk to several different persons that could give information. These talks occurred when needed and the relevant persons had time, meaning that they were not scheduled and planned. This meant that the persons opened up rather fast as the author became a weekly part of the department and that this kind of information was quickly accessible. The information found was also used to describe the company and the trends related to the hearing aid industry which can be found in the beginning of this chapter. The findings were in general discussed with the Global Planning Manager in order to verify what was found.

5.5 Strategic Simulation

Based on the initial data collection the strategic simulation process also began. The narrative and numerical simulation was developed concurrently with data collection and literature review and through cooperation with GN Resound, among others the Global Planning Manager, other relevant persons in the department, and at a workshop. This will be described further in the following. The development of scenarios 1, 2, and 3 began and they represented different ways of viewing the future and gave the possibility to prepare for these futures. Information for the narrative simulation of the three scenarios was to begin with found in cooperation with the Global Planning Manager from the sources mentioned above. First the trends of the hearing aid industry were developed in order to look at what could be the influence from the surroundings on the scenarios. These trends have been described in the beginning of this chapter. This information was discussed with the Global Planning Manager in order to verify it. Furthermore, from the former Master Student who had made a project at the Præstø site it was also found that technology and the rapid development within this area was interesting to look into. Information about this was also sought through public sites regarding technology and articles about the development of technology within areas of supply
chains and production. This information was also discussed with the Global Planning Manager who pointed out:

“The BTE will most likely gain an increasing part of the market, because they are being made smaller and smaller and it is more and more difficult to see the part that goes into the ear. This part is also soft and comfortable to wear compared to the ITE which is hard and gives a form of dome (osteklokke) feeling. You can also feel the ITE when chewing” Global Planning Manager.

From talking to both the Global Planning Manager, but also from talks with the Vice President of the Global Supply Chain, it was found that the Supply Chain development itself was interesting to look at as well as the labour rate and development in China. The development of the labour rate would have an impact on the narrative simulation as the rate of salary should be considered and it would also be implemented in the numerical model as the labour rate would be a part of determining the costs of the different scenarios. After determining GN Resound’s current situation it gave a first input to the numerical simulation could be made like the supply chain in GN Resound and then adjusted to the different scenarios. With this in mind and after identifying the trends it was interesting to look at how the scenarios differed from each other. To begin with the author had a basic introduction about how the three scenarios could look, which meant that they had to be elaborated further. To get a deeper insight about them a meeting with the Global Planning Manager was held in order to discuss how the scenarios should be structured. The Global Planning Manager had at that time just been to a meeting in the US where he had introduced the project and the idea behind the three scenarios using a world map which can be seen in the figure below. This presentation was sent to the author who found that the world map could be a way to describe the scenarios due to the fact that it gave a visual representation of the locations of the different sites as well as a visual representation of the information signals’ flows and the products’ flows. Furthermore, it was possible to compare the different scenarios based on the same background. Based on the world map, which can be seen in a developed form in the following for all scenarios the development continued.

5.5.1 Scenario 1
Scenario 1 represented one of the new scenarios described by the company where the distribution centres were decentralised to three distribution centres on different locations; Asia, Europe, and USA. This scenario allowed for direct shipments to end customers from all the distribution centres.
The world map can be seen above. It shows that there are three distribution centres (the green circles) placed in the US, Europe, and China. The blue circle in China represents the production site there and this indicates that the Chinese distribution centre and the Chinese production site are placed at the same location. Furthermore, the orange circle next to the European distribution centre represents a control tower, which is a global database GN Resound found could be interesting to develop in order to gain more transparency related to the data. This system will be able to pull data from all the other systems. The yellow circles represent the end customers placed in different places (clustered). The red lines indicates how the end customers send signals to the three distribution centres when they need products and also how the three distribution centres send signals to the production site when they need products. This is in order to produce according to a pull principle as much as possible. The blue lines represent how the products are sent from the production site to the distribution centres and from the distribution centres to the end customers. The world map was developed from the map that GN Resound had made in order to adjust to the scenario. Some of the changes were for instance placing the end customers instead of having sales companies. This map also indicates why the scenario is placed in the scenario cross the way it was due to the fact that the three distribution centres placed it on the axis of decentralised distribution centres and the possibility of shipping to end customers placed it according to that axis. After adjusting the map the
The author found it could be a good idea to draw the scenario in a way that could give a faster overview, which could be placed in the scenario cross in order to introduce the scenarios using only one page.

Figure 5.9: Scenario 1

This drawing also included the suppliers and systems. The figure shows that the three distribution centres (the green circles) are placed in Asia, Europe, and North America (NA). These distribution centres send the products and spare parts to the end customers (yellow circles) in their region when a product is needed. Then the distribution centres send a DMI signal to the manufacturing in Xiamen (blue circle) which then replenishes the distribution centres and produces new products. The responsibility of the distribution is allocated between the three distribution centres as they all receive signals regarding demand from their regions and then send these signals to the production site. The model shows that each regional supplier delivers to each regional distribution centre, the supplier situation related to scenario 1 will be laborated in chapter 5.6.1. The figure also shows the different systems described earlier in order to give an idea of where they are placed. The future vision of the Control Tower pulling data from all the systems is not placed in this drawing as the Control Tower should encompass all the systems. Another new way to use the systems could be that the FCI system and the DMI system could be interrelated as the FCI system can give an idea of what is to be produced, and thereby helping in planning the production. The two systems could
further be related to the KPI as this measures the delivery performance, which is again related to both the ability to forecast and the DMI signal. The GIV and the SIS system are also related as the suppliers delivery performance is also related to how much they have in stock at GN Resound. This figure was discussed with the Global Planning Manager and it was agreed upon that this represented scenario 1. It was also used to show the supply chain and logistic flow of scenario 1 as this is the area of research. The figure below shows this and was made based on the figure above as well as a figure given by GN Resound showing the current logistic flow.

**Scenario 1 – three distribution centres and direct shipment to dispensers**

The figure shows that the suppliers for this purpose have been categorised after location. There are a collection of suppliers for each region. In this scenario Præstø produces hybrids and NPI components.
Xiamen continues to produce and send to the three distribution centres located in the regions NA, Europe, and Asia. From the distribution centres the products are sent directly to end customers. The figure was made based on meeting with the Global planning Manager where he explained the current situation’s logistic flow. Based on that description a figure of the logistic flow was made and showed to the Global Planning Manager. This inspired the author to make the same kind of figure for all scenarios. This figure gave a basic idea to what flows should be put into the numerical simulation as the product flow could be seen from this. In combination with the world map this figure gave the idea of how the product flow could be put into the world map.

Scenario 1 differed from the current situation in that it operates with three distribution centres instead of one and that it is possible to make direct shipments to end customers. This also meant that the responsibility would be allocated between three distribution centres instead of one. Scenario 1 also operated with the possibility to incorporate a Global Control Tower that could pull data from the different systems currently used in GN Resound. There are different advantages and disadvantages of the scenario and these will be presented in chapter 5.6.3 in a causal map.

5.5.2 Scenario 2

Scenario 2 focused on centralising the distribution into one distribution centre, resembling the then current situation, but with the difference that there were direct shipments to end customers. This meant that there would be one distribution centre supplying the regions in the world alongside the Xiamen manufacturing site.
The world map above shows that there is one distribution centre (the green circle) placed in Europe. The blue circle in China represents the production site. Furthermore, the orange circle next to the European distribution centre represents a control tower placed at the distribution centre. The yellow circles represent the end customers placed in different places (clustered). The red lines indicate how the end customers send signals to the distribution centre when they need products and also how the distribution centre sends signals to the production site when it needs products. The blue lines represent how the products are sent from the production site to the distribution centre and from the distribution centre to the end customers. The world map has been developed from the map that GN Resound had made in order to adjust to the scenario. Some of the changes were for instance placing the end customers instead of having sales companies. This map also indicates why the scenario is placed in the scenario cross the way it was due to the fact that the distribution centres placed it on the axis of centralised distribution centres and the possibility of shipping to end customers placed it according to that axis. As for scenario 1 a new drawing of the scenario was also made for scenario 2 by the author.
Figure 5.12: Scenario 2

The figure shows that the one distribution centres (the green circle) is placed in Europe. This distribution centre sends products and spares to the end customers (yellow circles) when a product is needed. The systems are placed accordingly to the earlier description of the systems. The responsibility for distribution is placed at one central location, namely the distribution centre as the demand go through the distribution centre. This can also partly be seen from the figure, which gives another image of the scenario and the relevant systems. The systems are only placed at one connection to demonstrate where the information can be found and who are responsible for it, but the systems are placed at all according arrows. The systems are the same as for Scenario 1. The logistic flow of scenario 2 can be seen in the figure below.
The figure above shows that the suppliers also in this scenario have been categorized after location. There are a collection of suppliers for each region. In this scenario Præstø produces hybrids and NPI components. Xiamen continues to produce and send to the European distribution centre. From the European distribution centre the products are sent directly to end customers in Europe and the subsidiaries in Brazil, Asia and North America. As mentioned under scenario 1 this figure helped give a basic idea to what flows should be put into the numerical simulation in combination with the world map. Therefore, the figure was also made for this scenario.

Scenario 2 differed from the current situation in that it was possible to make direct shipments to end customers and it also operated with the possibility to incorporate a Global Control Tower that could pull data from the different systems currently used in GN Resound. There are different advantages and disadvantages of the scenario and these can be seen in Appendix 3 in a causal map.

5.5.3 Scenario 3

Scenario 3 focused on centralising the distribution into the Xiamen manufacturing site, and thereby eliminating the distribution centre. This meant that there would be one location for distribution and one type of intermediary would be removed thereby reducing the supply chain. This scenario did not allow for direct shipments to end customers, but only through sales companies. A model of the idea behind scenario 3 can be seen in the figure below.
The world map above shows that the distribution has been centralised to the production site in China (the blue circle). The control tower (the orange circle) is still placed in Europe in this scenario as there still will be some management and other departments in Europe. The red circles represent the sales companies placed in different places. The red lines indicate how the sales companies send signals to the distribution centre / production site when they need products. The blue lines represent how the products are sent from the production site to the sales companies. The world map has been developed from the map that GN Resound had made in order to adjust to the scenario. This map also indicates why the scenario is placed in the scenario cross the way it was due to the fact that the distribution centres is centralised to one place and that there is no possibility of shipping to end customers. After adjusting the map the author made a drawing of the scenario as in the other scenarios.
The figure shows that the one manufacturing and distribution site (the blue circle) is placed in Xiamen, China. This manufacturing and distribution site receives signals from the sales companies (red circles) in the different countries when a product is needed and then the Xiamen site replenishes the sales companies. There is no direct distribution to end customers in this case. The figure also gives an image of the relevant systems. The systems are only placed at one connection to demonstrate where the information can be found and who are responsible for it, but the systems are placed at all according arrows. Scenario 3 eliminates the distribution centres and focuses on centralising the distribution in Xiamen. It is assumed that this scenario does not support direct shipments to end customers as no distribution centre exists, and therefore direct distribution is not possible to handle. The same systems as mentioned in the other scenarios are present here, but the difference is that it will be very important with a control tower with global overview as many smaller inventories exist here. Furthermore, the GIV system is placed at each sales company in order to track what the inventory is. The logistic flow of scenario 3 can be seen in the figure below.
Figure 5.16: Scenario 3’s Distribution Flow

The possible logistics flow for Scenario 3 can be seen in the figure above. The figure shows that the suppliers all deliver to Xiamen manufacturing site as this is the link to the subsidiaries. In this scenario Præstø produces hybrids and NPI products. Xiamen continues to produce but also sends directly to the sales companies. The sales companies then send to the end customers. As mentioned under scenario 1 this figure helped give a basic idea to what flows should be put into the numerical simulation in combination with the world map. Therefore, the figure was also made for this scenario.

Scenario 3 differed from the current situation in that it did not have a distribution centre placed in Europe and it distributed directly from the manufacturing site. It was not possible to make direct shipments in this scenario, but that was not a change from the current situation. It also operated with the possibility to incorporate a Global Control Tower that could pull data from the different systems currently used in GN Resound which was very important in this scenario as there was only one distribution centre that was placed in China. There were different advantages and disadvantages of the scenario and these can be seen in Appendix 3 in a causal map.

5.5.4 Scenario 4

Scenario 4 focused on decentralising the distribution into the Xiamen manufacturing site and Præstø, the Danish production site. This meant that there would be two locations for distribution and one type of intermediary will be removed thereby reducing the supply chain. Scenario 4 was a scenario that was
suggested by the author. A figure of the scenario was made using a world map to be able to compare the scenario with the other three scenarios.

**Scenario 4:** DMI signals from subsidiary to mfg does not support direct ship to dispenser

![Figure 5.17: World map of scenario 4](image)

The world map above shows that the distribution has been decentralised to the production site in China and the Production site in Denmark (the blue circles). The control tower (the orange circle) is placed in Europe in this scenario and it can for example be placed at the Danish production site. The red circles represent the sales companies placed in different countries. The red lines indicate how the sales customers send signals to the production sites when they need products. The blue lines represent how the products are sent from the production sites to the sales companies. This map also indicates why the scenario is placed in the scenario cross the way it was due to the fact that the distribution centres are decentralised to two places and that there is no possibility of shipping to end customers. This scenario is also sketched out as the other scenarios.
Figure 5.18: Scenario 4

The figure shows that the two manufacturing sites (the blue circles) are placed in Xiamen, China and in Præstø, Denmark. These manufacturing sites receive signals from the sales companies in the different countries when a product is needed and then the sites replenish the sales companies. There is no direct distribution to end customers in this case. Scenario 4 eliminates the distribution centres and focuses on decentralising the distribution in Xiamen and Præstø. It is assumed that this scenario does not support direct shipments to end customers as no distribution centre exists, and therefore direct distribution is not possible to handle. The same systems as mentioned in the other scenarios are present here, but the difference is that it will be very important with a control tool with global overview as many smaller inventories exist here. The logistic flow of scenario 4 can be seen in the figure below.
Scenario 4 – No DMI Hubs

The possible logistics flow for Scenario 4 can be seen in the figure above. The figure shows that the suppliers all deliver to Xiamen and Præstø manufacturing sites as these are the link to the subsidiaries. The sales companies then send to the end customers. As mentioned under scenario 1 this figure helped give a basic idea to what flows should be put into the numerical simulation in combination with the world map. Therefore, the figure was also made for this scenario.

Scenario 4 differs from the current situation in that it operates with distribution from two production sites. This also means that the responsibility will be allocated between the two production sites instead of at the GDC. Scenario 4 also operates with the Global Control Tower that can pull data from the different systems currently used in GN Resound, which is very important in this scenario as there will be much need to coordinate between the two production sites and the sales companies. Scenario 4 was shown to the Global Planning Manager who said it was not interesting for GN Resound to look into, as the Global Supply Chain did not find it relevant that there could be a production unit in Denmark due to the fact that there is a lot of manual work in making a hearing aid and that would not be economical feasible in Denmark. Therefore this scenario was not pursued together with GN Resound and Præstø is not taken into the numerical simulation in the other three scenarios as it was more or less assumed by the Global Planning Manager that Præstø would be closed within a short timeframe. He was of the opinion that however, the scenario does have some interesting and relevant point and these will be described and dealt with in chapter 8.
The four scenarios were hereafter placed in the scenario cross according to the parameters. The matrix has been used to build the scenarios, as it helps make sure that the scenarios are qualitatively different in a logical and none randomly way and used to identify assumptions. Furthermore, it creates a reference for all the scenarios in the matrix. When the axes are identified one can decide which scenario features should be included (Rasmussen 2011b).

![The Scenario Cross](image)

**Figure 5.20: The Scenario Cross**

The blue hexagon represents the production site in Asia (and one in Europe for Scenario 4), the green circle represents the Distribution Centre (DC) in the various countries, the red square represents the Sales Companies (SC) in the various countries, and the yellow rhomb represented the End Customers (EC) in the various countries.

This matrix and first draft of the scenarios was introduced to the Global Planning Manager and the Vice President of the Global Supply Chain at a meeting. This was necessary partly to agree on the scenarios, but
also as there was much information to be collected in the beginning and as the information was gathered from many different persons it was not always in agreement. So the meetings with the stakeholders were a way to try to delimit the complexity of the system. At the meeting an example of a simulation was shown in order to give the stakeholders an idea of what the simulation could be used for, such as tracking the transport costs, evaluate the number of logistics worker needed, compare the scenarios based on certain parameters. This visual image of the scenarios as well as a visual example of a simulation resulted in both the Vice President and the Global Planning Manager being very enthusiastic regarding the possibilities of the combination. Based on the presentation the Vice President of the Global Supply Chain also started to get ideas about how the narrative simulation could include issues such as political implications, custom implications, the company situation etc so that it would not only be the cost factors determining which scenario was the one to pursue, but also other issues that GN Resound dealt with in their work as the ones mentioned above. This made the two stakeholders appreciate that the combination of narrative and numerical simulation can enhance and explain strengths and weaknesses regarding the different simulations that cannot be shown in the simulations at the same time that it makes it possible to evaluate the scenarios based on numbers so that the alternatives are evaluated on both quantitative and qualitative aspects.

“It could be interesting to be able to evaluate the scenarios not only based on numbers, but also from a more qualitatively aspect, as the scenarios can show strengths and weaknesses of the different simulations” (Vice President Global Supply Chain).

This also supports the idea that the narrative simulations help create pictures of which routes should be studied and give an overview of the situation. The Vice President and the Global Planning Manager were very enthusiastic about the methods, but were as mentioned not interested in pursuing scenario 4. At the meeting a first idea of input and output parameters to the numerical simulation was also presented, these parameters had been developed at a meeting between the author and the Global Planning Manager.
The list was a result of a brainstorming with the Global Planning Manager of what his ideas of what parameters were interesting regarding the numerical model in addition with the authors ideas of what parameters could be relevant related to the scenarios. The Global Planning Manager was primarily interested in comparing the above shown costs of the three scenarios and the figure above was a result of this. Part of the process of creating these parameters also came from the author’s preliminary work with considering how the numerical models should look and what they should contain as this was an ongoing process that started already with the first development of the scenarios. Ideas such as how to make direct shipments to the end customers in some of the scenarios, whether to simulate one product’s flow through the system or the flow of products itself, how many logistics workers are needed and costs of transport all gave ideas to the parameters. These input and output parameters were also agreed upon on the meeting with the Vice President. Based on these first drafts of the scenarios it was possible to begin the numerical simulations.

5.6 The Numerical Simulation

Initially it was difficult to imagine how the simulations should be carried out and what should be simulated on, but the idea that the narratives create pictures, which make it more clear what to simulate helped. This resulted in a closer look at the scenarios meaning that the author looked at how the three scenarios had already been described and what could be simulated in a way that made it possible to compare them. For example it is important to consider the system that is under consideration. In this case it was the supply chain that was under research and a way to examine the supply chain was to look at how a product travels through it. The product flows were revealed from the scenario skeletons and as mentioned above the figures described under the scenarios gave an idea of how the product can travel through the system. The parameters gave an idea as to how the process of following the product flow in the different scenarios.
should be. Consideration regarding how to make the visual part of the simulation ended up in the idea that
the world map shown in the previous figures could be used as a background for simulating the product flow
as world maps for all three scenarios existed and in combination with the other figures made under the
scenarios gave a good visual image of how products and spare parts were sent and where the sales
companies and end customers were located. This also meant that certain areas in the scenarios had to be
developed as the more specific location of sales companies and end customers had to be found and
described as well as how the product and spare parts travel through GN Resound.

This became the basic idea of the simulation so that the relevant sites from the scenarios such as the
manufacturing site, the distribution centres, the sales companies, and the end customers could be placed
accordingly in a world map in the model. In order to continue with the strategic simulation further
information about variables was needed. This gave new input to the author of what kind of information
was needed for the numerical simulation and the author created a list based on how the supply chain
looked in the scenarios and the model already developed with the input and output parameters. This list
was sent to the Global Planning Manager and can be seen in Appendix 1.

The work on the list also gave the author ideas as to what had to be further described in the narrative
simulations such as how many sales companies are there, how do GN Resound ship their products, how do
the GDC look physically and the production site in China, how do they cooperate and so on. This meant that
making a brutto list of the parameters for the numerical models gave new ideas as to what had to be
elaborated in the narrative part. After receiving the list a meeting was held with the Global Planning
Manager. At this meeting the above need for data was discussed. The main area of interest for the
company regarding the numerical simulations was costs as the Global Planning Manager pointed out that
they were primarily cost-driven. This meant that the parameters basically regarded costs, but also had to
be related to the delivery performance, and for the company in question it was important to consider the
number of products and spares that went into the simulation. The information can be characterised (and
was further specified) in the categories of: Throughput of spares, throughput of products, inventory,
number of shipments, amount of shipments, locations of suppliers, number of suppliers, location of sales
companies, number of sales companies, location of end customers, number of end customers, cost of
shipments, number of resources, shipping principles. These parameters were found to be relevant as they
were related to the costs of logistics and transportation as well as the delivery performance. An excel ark/
questionnaire was developed based on the information need so that the different departments could
answer it consistently. The input and output data were the same for each scenario as it would make it
possible to compare the scenarios. The spreadsheets had to be made as much of the details needed in
order to enhance the scenarios could not be found in the systems for instance data regarding rent, number of employees, customer base, salary, logistics cost per employee, incoming lines, outgoing lines and so on. This questionnaire was made for all the subsidiaries as well as the global distribution sites and the production sites in order to get this information. The questionnaire was sent out by the Global Planning Manager with the support of the Vice President of the Global Supply Chain. However, the questionnaires were never returned in spite of many reminders. The locations all excused themselves with being too busy. Therefore, the information had to be found otherwise.

Simple data such as the number and location of sales companies was difficult to retrieve as the information was not the same in the different systems. Several systems, such as the MRP systems of the different countries, had to be checked and these systems were not easily accessible. This meant that the Supply Chain Analyst had to be a part of the searching process in finding the sales companies and their location and the information that was sought. The Supply Chain Analyst helped in order to access the systems and to explain the data that was generated from the systems. During this process it was obvious that the subsidiaries in the system did not correspond to the first list of subsidiaries given to the author. The supply Chain Analyst could not explain it.

“This gives an image of how many sales companies and where they are located, but it is not necessarily accurate” (Supply Chain Analyst).

Therefore the Global Planning Manager was asked. He said that the list handed to the author should be followed, because the system had some incorrect information. This was due to the fact that the system had more sales companies, but some of these had a different status, and therefore they were not included as sales companies. It was agreed with the Global Planning Manager that the overall list should be used in the simulation.

During this data pull from the system it became evident that the data from the system could not be trusted. Therefore, it was agreed that the data regarding input and output to the different locations should come from the main system showing what was sent to and from the global distribution centre. This decision was made as it became clear that the data was unstructured and inconsistent.

“I would say that if we had an MRP system so that we globally could talk together, that would help” (Vice President Component Manufacturing).

Observations of the Global Distribution Centre also showed that the systems were not always correct. The products were not always placed where they were supposed to be or the amount of stock was not always
correct. As the products are so small, it is even more imperative that the systems are correct and up to
date in order to have a correct inventory status. The problem of making sure that every part number is
accounted for is one of the ideas of the systems. The have different MRP systems in the organisation, and
therefore the systems do not speak with each other.

The above also gives an idea of the time used on finding the data in the company. It was a long process and
the data also had to be analysed in order to be used for the project. This was due to the fact that the data
came in enormous excel sheets containing thousands of lines and many rows. This data had to be sorted so
that it was the needed data that stood out such as the product number, whether it was a spare part or a
hearing aid, the suppliers’ locations, the sales companies’ location and so on. This could be done by making
a pivot table where you can choose which data you want to see. But because the data in the different
databases did not include everything, several systems had to be compared and checked. For example in an
excel sheet with the throughput of hearing aids there would also be a sales company code, but not the
name and location of the sales company. This list then had to be compared with the list of sales companies
and their codes, and this did not always correspond as the list of sales companies given to the author was
not complete – GN Resound did not have an updated list electronically, but it was given to the author by
the Global Planning Manager. Furthermore, the codes used in the excel sheet was sometimes outdated.
This also meant that in order to analyse all these data help was needed from the employees in the
department. The company was very often busy and meetings were often postponed or cancelled due to the
fact that other meetings had to be held in order to find a solution to important problems. This meant that
sometimes meetings (sense making with the practitioners) had to be delayed or cancelled and this made
the process of gathering and analysing the data somewhat longer.

Based on the list of sales companies a first simple model of the system could be made.
Figure 5.22: A visual image of the numeric simulation for Scenario 1

To begin with a simple model of scenario 1 was made. This was done as it was assumed that lessons would be learned from making the first model that would give input to the other two models. A simple model was made where the distribution centres were placed, including the Xiamen manufacturing site, as well as the sales companies, which can be seen in the above figure. Simple coding in this model sending one product from the Xiamen manufacturing site to a Global Distribution Centre to a customer was the first run. This simple start made it clear that the world map could be used to show the products way through the supply chain. From the model above it can be seen that the American distribution centre is placed as a red dot and the Xiamen manufacturing site including the Asian distribution centre and the European distribution centre are grey squares. The model above made it clear that more data was needed in order to continue with the numerical simulation.

As mentioned the system did not include data of salary and number of persons working at the sales companies. This meant that the salary had to be an estimate and the number of people had to be related to the need for resources in the models. This information was not available through the contact persons in the company. As also mentioned the data of sales of hearing aids in the different sales companies were not consistent with each other. This was both due to the fact that the different locations did not use the same systems and the headquarters had no idea of what was in stock in the different locations.
“...we have about 52 million spares of inventory and I guess about 20 million of them can be thrown out” (Supply chain Analyst)

This resulted in the data taken from the sales companies was not necessarily representative. It was agreed that the data needed would be pulled from the GDC where it could be seen what was shipped to the different locations. The pull of data from the GDC showed a vast amount of information. The company has many part numbers – around 6000 – which makes it quite complicated to get a clear overview of. It was also pointed out by a Supply Chain Analyst that it would be a good idea not to simulate on all 6000 part numbers. All the 6000 part numbers are not active and maybe only one is requested per year. This is due to the fact that the product life cycle is very short, and therefore the product is quickly phased out. Based on this it was agreed that an ABC analysis should be made, so that all the part numbers would not be included, but only the high runners. This meant that data regarding hearing aids and spares going in to and out of the global distribution centre was drawn from the systems. From this data it was possible to, together with the Supply Chain Analyst, look into which products were the high runners, and therefore interesting. This meant that the spares also had to be looked at, and thereby the suppliers.

5.6.1 The Supplier Situation

The company also had a vast amount of suppliers, which would mean it could be quite difficult to get a meaningful simulation based on all the suppliers. It was suggested by both the Supply Chain Analyst and the Global Planning Manager that the suppliers could be combined in clusters like the end customers.

“Maybe you should gather the suppliers and customers in clusters and then make a statement that we ship to them at that and that price...” (Supply Chain Analyst)

The suppliers had to be placed in the model and at a meeting with the Global Planning Manager an idea was developed about gathering suppliers in clusters related to regions. This meant that not all the suppliers were simulated upon, since the number of suppliers was rather large, but instead a location in the model represented all the suppliers in a specific region. It was agreed that the suppliers could be clustered in three regions: USA, Europe and Asia. This was also chosen based on the parameter centralised distribution centre/ decentralised distribution centres as much of the spare parts would go through here and it was important to focus on which region the suppliers are located in and where the supplier ships to. The same assumption was made for end customers as the shipments to the end customers could just be simulated and this would mean a lot for the scenarios as this would reduce the company’s inventory due to the fact that GN Resound would reduce the inventory placed at the sales companies and would not be responsible for the inventory at the end customers.
The reason for grouping the suppliers in the three categories is that for scenario 2 and 3 the spares coming from the suppliers has to go through the distribution centre (scenario 2) or the Xiamen manufacturing site (scenario 3) in order to get to the sales companies and end customers. However, in scenario 1 it is interesting to look at how the suppliers should deliver to the three distribution centres, whether there is one global purchase department or three purchase departments. This meant that the numerical model gave new ideas as to what had to be dealt with in the narrative as the supplier situation in scenario 1 had to be decided upon in order to model it.

There were three scenarios for the supplier situation in Scenario 1. The first represents a situation where there are three purchasing departments, one in each distribution centre. Each distribution centre can buy from the regional suppliers as can be seen in the figure.

![Figure 5.23 Supplier situation 1](image.png)

The advantages of this situation is that according to Lean this scenario reduces unnecessary transportation as the suppliers send directly to the distribution centre that has demanded the goods. However, this situation as it looks above implies that each purchasing department has to have the competences to deal with different suppliers in different parts of the world, which can be culturally more difficult. Furthermore, there are the costs of having a purchasing department in three locations.

The second situation represents one purchasing department responsible for purchasing from all suppliers. This means that for example the purchasing department is placed in the European distribution centre and then the European distribution centre sends the spares to the other distribution centres. This can be seen in the figure.
The advantage of this scenario is that the complexity is reduced as the purchasing department is placed centrally, and this could enhance the visibility of what is stored at which location. Furthermore, it makes a corporate purchasing power and policy possible and uniform as well as gathering the competences in one location that is able to deal with suppliers from different parts of the world. This also means that there only are the costs of one purchasing department and it could also make the system more transparent for the suppliers. The transportation is however not in accordance with Lean as this situation calls for non-value creating transportation from for example Asian suppliers to the European distribution centre and then back again to the Asian distribution centre. Furthermore, it gives the risk of decreasing the delivery performance as the spares have to travel over a greater distance and has to go through more systems and it does not take the cultural aspects of dealing with the local suppliers into consideration.

The third represents a situation where there are three purchasing departments, but where each distribution centre only purchases from their regional suppliers, meaning that the European distribution centre only purchases from the European suppliers, and then they can send the spares and goods to the other distribution centres. This can be seen in the figure.
Figure 5.25 Supplier situation 3

This situation also emphasises the cultural aspect as only the local purchasing department deals with the local suppliers, and thereby the culture of negotiating is familiar to the purchaser as well as personal relationships are kept intact.

“There can be issues when one culture has to deal with a supplier from a different culture, both in the way they do business, but also in the way they communicate.

So a situation where local purchasing departments deal with local suppliers could be interesting” Global Planning Manager.

However, this situation neither follows the principles of Lean as there is non-value creating transportation in the fact that the US suppliers’ goods have to go through the US distribution centre so that it can send it to the other distribution centres. Furthermore, the system also increases the complexity as the goods have to move around several locations and as the purchasing from the different regional suppliers has to be coordinated. The situation also represents the need for competences in three purchasing departments as well as the costs of having three departments.

Based on the above the first situation is recommended as this is the situation with the least non-value creating steps (Womack, Jones 2003). However, the situation can be adapted to incorporate local relationships between the regional distribution centres and their suppliers. This can be done as the ordering way can go through the distribution centres as illustrated in the figure below.
The above shows a situation where there are three purchasing departments, but the competences are used in a way so that the local purchasing departments can use their knowledge in their local market as indicated by the red lines, for instance the US and the European distribution centres send their orders for goods from an Asian supplier to the Asian distribution centre. The Asian distribution centre deals with the Asian supplier on behalf of the other distribution centres and then the goods are shipped directly to them. This can also mean that the system will seem less complex to the suppliers as they will often deal with the same person. This is an enhancement of the first supplier situation as it is also possible that the ordering way can go through the different distribution centres (as indicated by the red arrows), but the shipments from the suppliers are still direct. This made it clear that the narrative simulation had to be elaborated in regards to the suppliers, which let to a change in the simulation model as it was possible to incorporate this in the numerical model.

Based on the decisions regarding the suppliers a new draft of the model for scenario 1 could be made where the distribution centres, manufacturing centres, suppliers and end customers were represented. The difference was that the suppliers were clustered according to regions, but each supplier could send products to each distribution centre which can be seen on the lines from the pink circles below to the three distribution centres indicated with green circles. This way the suppliers were placed in the model as well as the way they send products. The reason for clustering the suppliers in regions was again that so many suppliers existed that it would give a confusing image if all the suppliers had to be visually presented as well as the fact that GN Resound wished to treat the suppliers according to regions in order to follow the chosen supplier situation above. This was also based on the logistic flow described under scenario 1.
Figure 5.27: Final model of scenario 1.

The model above also shows how the visual image of scenario 1 looked. The yellow circles represent the end customers, the pink circles represent the suppliers, and green circles are the distribution sites as well as the Xiamen manufacturing site. Based on this model it was necessary to decide how the spare parts and the hearing aids should enter the system. The most logical way was to let the spare parts enter the system at either one of the three suppliers represented by the pink circles in the image above. From there the spare parts could move from the supplier to either the Xiamen production/distribution centre (XMN), the GDC distribution centre (GDC), or the US distribution centre (US). These are located within the green circles in the image above. From here the spare parts are distributed to the end customers. Some of the spare parts will also be used in the production, but as this is black boxed this will not be looked into further. The HI products enters the system at the Xiamen production site (XMN), which in the image above is represented by the green circle at Xiamen. From here the products go to the either the GDC distribution centre which sends to the European and Brazil customers, to the US distribution centre that ships to the US and Canadian customers or to the end customers (dispenses) in either China, Japan, Australia or New Zealand. The idea of the system was to build it in a way so that the demand comes from the customers and then the products are sent to them when needed. This makes the system future oriented as one object is to introduce the pull concept as far up the stream as possible.
5.6.2 Transportation Costs

This draft of the numerical model made it obvious that formulas for calculation were necessary to measure transport costs, inventory costs, and resource costs in order to compare the different scenarios. These calculations were not easy to find within the company.

“We normally only use formulas in relation to projects/budgets etc. – nothing advanced, so maybe we should put in what is theoretically relevant” (Global Planning Manager).

Another point of view regarding the matter came from the Supply Chain Analyst:

“...as you can see the formulas are not always after the book here” (Supply Chain Analyst)

The supplier situation also brought the attention to the transportation and distance between the locations. For the distance between the different locations it was in the first draft of the scenarios first considered that the distance should represent the actual distance between the locations. However, inspiration from a former case with simulation gave the idea that the specific distance may not be needed as a cost function can be used instead. This meant that instead of calculating the transportation costs based on km, the transportation costs were based on weight, quantity, and whether it was shipped to mainland or overseas. This also represents how many transportation companies calculate the costs of sending parcels and it had to be examined further with the logistics department of the company before the numerical model could be developed further in that area as they have a precise way of calculating transportation. This was done through a meeting with a Project Manager in the logistics department who were responsible for the freight. At this meeting it was determined how the transportation costs should be calculated.

“The most important thing is to be able to compare the different scenarios” (Project Manager in Supply Chain Development).

This meant that it was important to make the calculation usable in the comparison of the different scenarios. The basic idea of this is that products are shipped every day within the same region in order to give the customers the best service. Then it can be assumed that for the most part less than 60 kg is shipped every day and this is then shipped with courier. The Project Manager told that then the cost of shipping would be 20 DKK per Kg. If there should be shipped more than 60 Kg, which was seldom the costs would rise to 80 DKK per Kg. If the products are shipped to customers overseas the shipping method is by plane and the cost of 30 DKK per Kg. The cost function then represents the actual costs of sending products
and spares and this is not based on distance, but on weight and whether the receiver is placed overseas or not. As mentioned earlier the Project Manager pointed out that the weight in the systems were not always correct.

“You have to estimate it. And I can validate it for you (Project Manager in Supply Chain Development).

Based on this information it was found that it was somewhat difficult to estimate the weight, and therefore a meeting was held with the Global Planning Manager. He contacted the Logistics Manager who had data regarding the weight of the hearing aids and spare parts that were suitable to be used in the model and the Logistics Manager made an excel file containing this data which he sent.

5.6.3 Workshop (industry workshop)

The variables for the scenarios were not limited to costs, but also included system complexity, the flow of products, culture, and closeness to market. The status of the numerical and narrative models was presented to the Global Planning Manager and it was decided that it was a good idea to bring the stakeholders together in order to get some feedback on both the narrative and numerical models. Therefore, a workshop regarding the threats and possibilities of the different scenarios was held in order to clarify all the possibilities with the stakeholders as they have more knowledge of the area and the everyday situations. This was also a part of the work process developed in accordance with the iterative grounded theory. This sense making with practitioners was quite important in relation to developing the strategic simulation.

Figure 5.28: The work process of using narrative and numerical simulation to support strategic decisions
The workshop was arranged as a partly SWOT-inventory. The SWOT-inventory method has both an internal and an external part. The internal part focuses on evaluating the strengths and weaknesses of the scenarios and the external part focuses on evaluating the opportunities and threats of the scenarios. As the internal part of the scenarios were covered concurrently at meetings and discussions it was decided to focus on the external part only, such as threats and possibilities, due to time constraints of the workshop. The purpose of the workshop was to give the stakeholders an overview of the scenarios as well as to enrich the scenarios further with the knowledge possessed by the participants both as individuals, but also as a group.

When it was decided that a workshop should be held an invitation was send out to the participants through Microsoft Outlook. For the workshop it was decided that five people should participate to give their input on the threats and opportunities. The participants were all from the Global Supply Chain division and they were:

- Vice President
- Logistics Manager
- Global Planning Manager
- Global Customer Service Manager
- Supply Chain Development Manager

The time frame for the workshop was 1½ hours and a meeting room at the company was used for the workshop. The author made an introduction to the workshop on PowerPoint showing the scenarios so that everybody agreed upon them. Furthermore, the simulation model drafts were shown and this resulted in a clarification of scenario 2 due to the fact that many persons with input were gathered in the same place. The clarification was that in scenario 2 the direct distribution was only possible to the end customers in Europe as only one global distribution centre existed. This made the scenario more clear and applicable as it had been somewhat difficult to get exact knowledge as to how this scenario would handle the direct distribution from the Global Planning Manager. It was clarified by the Vice President and the Logistics Manager as they said it would not be possible to handle direct distribution to end customers outside Europe. The Vice President had as mentioned seen the drawing before, so it was actually by bringing more people together that it was clarified. It can be seen in the scenario in the figure below.
Figure 5.29: Scenario 2 before and after

The new drawing of scenario 2 shows that direct shipments are only possible to end customers in Europe whereas in the first draft of the scenario there had been direct shipments to end customers in all regions from the distribution centre. This also influenced the other drawings of the scenarios and made changes in the simulation as this meant that there could only be a product flow from the distribution centre to sales companies in Asia and the US and from them there could be shipped to end customers. This also placed the scenario closer to the middle of the axis.

The presentation of the workshop also explained the purpose of the workshop and the rules. The author had chosen to use a magic chart (an A2 paper that can hang on the wall without tape) for each scenario that could hang on the wall. The magic chart was divided into two columns. In the presentation it was also stated that the focus would be on one scenario at a time. After the presentation post-its and markers were handed out to the participants and they brainstormed about the threats and possibilities first for scenario 1 then for scenario 2 and finally for scenario 3. The result of the workshop can be seen in the causal maps described in the following and in Appendix 3. The magic chart, post-its, and brainstorming method were chosen, because these were elements not usually used in the company. The participants in the workshop asked about how the magic chart worked and they were surprised to find post its and markers on the table in the meeting room. This meant that even though the workshop took place in a meeting room in the company it still opened up for creativity, so that the participants could think out of the box, as the process was different than normally. Furthermore, the magic charts can easily be taken by the author after the meeting and used. The Global Planning Manager afterwards commented that it had been an interesting workshop using methods they normally did not use.

“It is interesting to learn new methods and in this way we also learn something new”, Global Planning Manager.
The idea was that the participants should write down their suggestions on post-its and place them on the magic charts. To begin with the participants were a bit hesitant, and the author had in advance come up with a few suggestions in order to spark ideas, such as the possibility of new technologies, political decisions in China that could influence the supply chain structure, and new competition from new entrants to the market. This helped and the Vice President also became very productive initiating the others to come up with more ideas as he started writing down all his ideas and getting up to place them on the magic charts. After all ideas had been placed they were discussed, systemised and clustered as some of them were overlapping. Some example of ideas can be seen below and in Appendix 2:

- Customs in China is a problem
- Good knowledge of local requirements
- Growing middle class in China can influence labour costs

The output of the workshop ended up in being both internal and external factors. The increased complexity for GN Resound and good contingency are factors related to the internal situation in GN Resound. The author made a causal map of each of the scenario highlighting the advantages and disadvantages and the two mentioned were perceived as both threats and possibilities as the scenarios were placed in the future. When one scenario was done the next was taken. This resulted in a filled magic chart for each scenario, which the author could take and use for an analysis of the scenarios. The participants found the process was inspiring as they liked trying out new methods and as they found that the concept of brainstorming together gave new input they might not have thought of themselves. The output of the workshop was for each scenario a causal map. The causal map of the scenario 1 can be seen below and the other two causal maps can be seen in Appendix 3. The three maps are all structured in the same way. In the middle of the map a box with the distribution situation (three distribution centres, one distribution centre, and distribution from Xiamen Manufacturing Site) is placed. From this box there are arrows going to boxes ending (most of the boxes) in how this will affect the global inventories and the delivery performance. These are put in as statements:

- Decreased global inventories
- Increase delivery performance

These two statements were used as they were of high priority at the workshop and also in the narrative and numerical simulations. The same boxes are used in all three causal maps, but the difference is the number of minus (and plusses). The minuses indicate that the prior statement will not lead to a decrease of global inventories, but more likely an increase of global inventories. A minus on the arrow from the former
box leading to the ‘increase in delivery performance’ box will mean that the former statement will not lead to an increase in delivery performance, but rather a decrease in delivery performance. This means that the three causal maps can also be compared based on the number of minuses leading to the two statements.

Figure 5.30: A causal map of scenario 1.
The figure above shows what effect three distribution centres (the box in the middle) will have on global inventories (top left corner) and the delivery performance (bottom right corner). The arrows indicate how the boxes influence the next box, and a minus means that the box does not influence the next box in the way that is written. For example ‘Inventory in more places’ does not mean a ‘decrease of global inventories’. Based on the above map the three distribution centres will both result in an increase in inventory due to the fact that there will be 3 distribution centres with inventory, however the three distribution centres will also mean that there can be a reduction of subsidiaries, and thereby a decrease of global inventories. The scenario supports direct shipments to end customers and it makes it possible to store products close to customers, which reduces the time needed to ship the goods. It could result in less transport from the distribution centre as the three distribution centres are located close to the end customers. But it also means more transport routes from the Xiamen manufacturing site as it has to ship to three distribution centres as opposed to one distribution centre. From the causal map it seems that the delivery performance is affected positively in this scenario as the end customers are closer and as the contingency is high if one distribution centre fails to operate. The scenario also points out the fact that it can be an advantage to be placed close to the growing market in China, which will also reduce the complexity with importing to China as the distribution centre is placed there. However, there can be cultural issues of dealing with dispenser in every country as this is a task currently performed by the sales companies. The cost of labour could also increase as there will be three distribution centres instead of one. Another issue is the culture is relevant when considering the three scenarios as for example a Chinese distribution centre would have to deal directly with a Japanese sale company, which could give some issues (GN Resound 2007a), on the other hand the Chinese will also have to take care of the other Asian end customers and Chinese customs, which then again can give some advantages (GN Resound 2007a).

The causal maps showed the output of the workshop, and as it can be seen from the three causal maps there were different issues leading to whether the there would be a decrease in global inventories and an increase in delivery performance. It seemed from the causal maps that scenario 1 would be the scenario with the most increase in delivery performance as there would be direct distribution to end customers and as distribution centres were placed in three regions of the world. Regarding the decrease in the global inventories there were issues related to all scenarios as it was likely that scenario 1 would result in an increase in global inventories as there would be three distribution centres with inventory.

**5.6.4 Data Input to the Numerical Models**

The data regarding the products and spare parts represented an enormous amount of information and it was considered whether the data should be based on a three month period in order to limit the data.
Therefore, it was necessary to figure out how to get the data into the model without complicating it too much and slowing it down. It was found that an Arrivals File is a good way to define the arrival of products and spare parts in the system. An Arrivals File is an Excel file containing arrival information for the model. It can contain as many lines of data as there is in an Excel sheet and can be used to make the products and spare parts in the system arrive and at the same time allocate them specific product numbers and specific spare part numbers so that they are recognisable. Furthermore, the amount that arrives and time of arrival will also be specified. This simplified the model because it was possible to only specify the product and the spare part one time in the model instead of defining it for all products and spare parts. Instead the product was called from the arrival file where it was given a location of arrival, a destination, quantity, weight, and product number. The arrival file was a good choice for a large amount of data as the arrival file was basically an excel sheet. This made it easy to structure the data and this is often the form in which numerical data is generated, so it is adaptable. An example of an arrival file used in the modelling can be seen below.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Hi</td>
<td>XMN</td>
<td>N(10,1)</td>
<td>3</td>
<td>N(1,1)</td>
<td>N(10,1)</td>
<td>0.502</td>
<td>DISP_DE2</td>
<td>xx</td>
</tr>
<tr>
<td>3</td>
<td>Hi</td>
<td>XMN</td>
<td>N(10,1)</td>
<td>1</td>
<td>N(1,1)</td>
<td>N(10,1)</td>
<td>0.502</td>
<td>DISP_ES1</td>
<td>xx</td>
</tr>
<tr>
<td>4</td>
<td>Hi</td>
<td>XMN</td>
<td>N(15,1)</td>
<td>1</td>
<td>N(1,1)</td>
<td>N(15,1)</td>
<td>0.502</td>
<td>DISP_AT</td>
<td>xx</td>
</tr>
<tr>
<td>5</td>
<td>Hi</td>
<td>XMN</td>
<td>N(63,34)</td>
<td>1</td>
<td>N(1,1)</td>
<td>N(63,34)</td>
<td>0.502</td>
<td>DISP_BE</td>
<td>xx</td>
</tr>
<tr>
<td>6</td>
<td>Hi</td>
<td>XMN</td>
<td>N(18,8,118)</td>
<td>2</td>
<td>N(26,26)</td>
<td>N(18,8,118)</td>
<td>0.502</td>
<td>DISP_CN</td>
<td>xx</td>
</tr>
<tr>
<td>7</td>
<td>Hi</td>
<td>XMN</td>
<td>N(69,51)</td>
<td>2</td>
<td>N(6,1)</td>
<td>N(69,51)</td>
<td>0.502</td>
<td>DISP_DK2</td>
<td>xx</td>
</tr>
</tbody>
</table>

*Figure 5.31: Screen dump of Arrivals File*

As can be seen there are four columns where product specific elements are described, namely destination, number, the quantity, and the weight. This makes it possible to identify the product in the simulation and to calculate upon and send it the right places. The product destination is also allocated in the arrival file which ensures that the products are sent to the right customer.

Making the arrival file work was a long process and it was found that it was necessary to start with a test model and making it work there so that the full scale model was not tampered with and it was also too complicated to test something in the full scale model. To begin with all the data was analysed, and even though an arrival file makes it possible to handle more data the total sale of products from the global distribution centre for three months seemed too large an amount of data for the task at hand, and therefore it was decided with the Global Planning Manager that an average month should be determined as well as a normal distribution for this average month. This was possible as the product is not affected by season and as the life cycle is very short.
This still generated a lot of data in an Excel sheet and the excel sheet was imported into the model, but the model would however not read it. To find out what was wrong a test model was made and a limited amount of data in an arrival file was used. This way it was possible to detect errors such as wrong product numbers or wrong coding in the model itself in the test model and in the test data sheet in order to correct the full scale model. Once the test model worked and could read the arrival file without problems, the experiences could be used in the full scale model. Some of the errors made that caused the full scale model not to work were issues such as filling out all the mandatory columns otherwise the model would not read the arrival file. Another issue was making sure that the different data put in were in identical with the definitions in the programming in the model as the programming in the model would otherwise not recognise the data in the arrival file. These issues were easier to find in a test model as it did not have as much programming and elements as the full scale model. Furthermore, the test model was not concerned with the graphic as it was only used to test the programming, and therefore it was more simple and manageable.

To make the numerical models the input and output data were based on the possible logistics flows described in the scenarios and have been described above. However, the variables changed during the process as they developed and reflected the data that was actually available both from interactions with the different persons in the company such as the Global Planning Manager, the Supply Chain Analyst, and the Project Manager, but also from the workshops as this all generated ideas of what could go into the model. This changed the original input/output matrix to the table shown below.

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>High runner Products</td>
<td>Inventory Costs</td>
</tr>
<tr>
<td>High Runner Spare Parts</td>
<td>Resource Costs</td>
</tr>
<tr>
<td>Transport Costs</td>
<td>Logistic Costs</td>
</tr>
<tr>
<td>Number of Suppliers</td>
<td>Supply Performance</td>
</tr>
<tr>
<td>Placement of Suppliers</td>
<td>The Use of Resources</td>
</tr>
<tr>
<td>Number of Subsidiaries</td>
<td>Utilisation Degree</td>
</tr>
<tr>
<td>Placement of Subsidiaries</td>
<td></td>
</tr>
<tr>
<td>Number of End Customers</td>
<td></td>
</tr>
<tr>
<td>Placement of End Customers</td>
<td></td>
</tr>
<tr>
<td>Resources at Distribution Centre</td>
<td></td>
</tr>
<tr>
<td>Resources at Subsidiaries</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>---</td>
</tr>
<tr>
<td>Number of Shipments</td>
<td></td>
</tr>
<tr>
<td>Volume of Shipments</td>
<td></td>
</tr>
<tr>
<td>Salary</td>
<td></td>
</tr>
</tbody>
</table>

*Table 5.4: The changed input and output variables.*

In the first model the input and output parameters were found to be linked with arrows in a certain way, this was also attempted with this second addition, but it quickly turned out that it would be too confusing to show the dependency between the input and output parameters this way, as most of the parameters were dependent and it would become too unclear with all the arrows overlapping. In the first draft the number of lines was found to be relevant, but this changed during as it turned out that the high runner products and spare parts, meaning the products that were responsible for the largest part of the revenue found through an ABC analysis, were more relevant to use. Furthermore, the salary was still important, but this was not possible to locate in the systems of the company, so the salaries ended up being an estimate that the Global Planning Manager and the author decided upon. The delivery performance (in) and (out) was not used as an input parameter as it was found that it was interesting to look at it as an output parameter and as GN Resound did not have the numbers in the system to support this, it was agreed with the Global Planning Manager that the delivery performance could be set at a given percentage, but as these percentages would be set to the same for all three scenarios it was agreed upon that it was not necessary to put it in the models, but instead take it into account in the narrative part how the different scenarios would affect the delivery performance. Furthermore, the capacity costs as an output parameter did not go into the model, as the Global Planning Manager found that the whole capacity costs had to be considered meaning that not only the distribution would be responsible for the capacity costs, but it would also be related to production, management, R&D, etc. and therefore it would not be descriptive. The focus of the company was primarily on costs such as distribution costs and inventory costs, and therefore the data for the numerical simulation was chosen to be primarily based on measurable costs as this also added a measurable part to the scenarios.

### 5.6.5 The output

Part of the numerical simulation was also to be able to compare the three scenarios in order to determine which one was the most cost effective. To do this different output forms from the numerical models were used such as inventory costs, transport costs, and resource costs. The first graph made for comparison was a graph of inventory costs. Normally the classic Wilson formula will look like the below (Michelsen 2010).
Figure 5.32: Inventory profile based on Wilsons formula (Michelsen 2010)

As GN Resound was interested in being able to compare the three scenarios based on the total costs it was found that it would be more fitting to calculate the accumulated inventory costs for each scenario as figures as the above would be more difficult to compare based on the fact that the numerical models showed a representation of how much spares and hearing aids goes through the different distribution centres and sales companies. It was decided that the inventory should be compared as to how much went through the different inventories and compared based on this as the cost of inventory should be based on both carrying costs, ordering costs, and shortage costs. It was discussed whether the carrying costs should be used, but as the carrying costs can be based on the length of time an item is held, and also related to rent, heating, cooling, lighting, loans, depreciation and so on (Russell, Taylor 2003) this was not used as this data was very difficult to get a hold on especially for the sales companies. Based on this it was agreed with the Global Planning Manager that the stock consumption would not be shown and calculated as only the cost of incoming inventory was calculated. It was also found in cooperation with the Global Planning Manager that the idea was to compare the scenarios, and therefore the accumulated inventory would be a way to compare them as it was assumed that the more inventory the higher the costs. This was agreed on during several meetings where it became clear that the data needed was not available from the sales companies. This meant that it was not possible to get the data needed to calculate the costs, the scenarios would be compared based on how much inventory there was in each scenario. Furthermore, the data put into the model was not based on all products in GN Resound, but taken from an ABC analysis and this could cause the inventory profile to be somewhat misleading. The results below are all based on the output of the simulations.
The models resulted in a graph indicating the accumulated inventory costs which can be seen for scenario 1 below and for scenario 2 and 3 in Appendix 4.

![Inventory Level Graph](image)

**Figure 5.33 Accumulated Inventory Level Scenario 1**

The idea with the graph shown above and in the appendix is that it represents the accumulated inventory level in order to compare the three scenarios. From the figure it can be seen that the scenarios have run in full length. The result of the simulations is that the inventory based on the numbers going in and the amount of time used on it is approximately 281,671 for scenario 1, approximately 444,235 for scenario 2, and approximately 582,262 for scenario 3. This means that the accumulated inventory level based on an ABC analysis are lowest for scenario 1. This result could be due to the fact that scenario 1 has inventory in three distribution centres whereas scenario 2 has inventory in one distribution centre and some sales companies and scenario 3 has inventory in one distribution centre and several sales companies.

The transportation costs of the three scenarios were also calculated in order to compare them. The system was built in a way that the suppliers were clustered and then they could ship to the distribution centres and furthermore the distribution centres shipped to either end customers or sales companies, and then the sales companies shipped to end customers. Based on this the cost of transport was put in every time a product or spare part was sent and calculated. The output graph for the transport costs in scenario 1 can be seen below and the graphs for scenario 2 and 3 can be seen in Appendix 5.
The graphs show that the transport cost is app. MDKK 2.69 for scenario 1, app. MDKK 3.65 for scenario 2, and app. MDKK 3.54 for scenario 3. This means that the transport costs are the lowest for scenario 1. This was expected as the amount of transport is based on the transport from the suppliers to the distribution centres and from the distribution centres to the end customers, whereas the two other scenarios also have transport to the sales companies and from the sales companies to the end customers.

The resources were also examined, both the use of resources and the utilisation degree of resources. In the simulation a guess of how many resources were necessary in the different locations were made, and as the numerical simulations were run it was possible to see the utilisation degree of the resources. This meant that if the resource was not used at all or used 100% the number of resources had to be changed. This also resulted in changes in the narrative part of the simulation as the idea of how the changes in the distribution network would affect the logistics workers had to be described and changed accordingly. It also had to be taken into consideration in the narrative part that the total amount of products and spare parts were not simulated upon, but only a representative part. This meant that in the narrative part it had to be described how the scenarios would mean different changes according to numbers of logistics workers and other workers. The number of resources is allocated according to the number of products and spares simulated in the model.
RESOURCES COSTING

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Units</th>
<th>$/Unit</th>
<th>%</th>
<th>$/Usage</th>
<th>%</th>
<th>$/Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution worker XMN.1</td>
<td>1</td>
<td>955.33</td>
<td>0.02</td>
<td>28670.00</td>
<td>0.36</td>
<td>29625.33</td>
<td>0.24</td>
</tr>
<tr>
<td>Distribution worker XMN.2</td>
<td>1</td>
<td>955.33</td>
<td>0.02</td>
<td>28670.00</td>
<td>0.36</td>
<td>29625.33</td>
<td>0.24</td>
</tr>
<tr>
<td>Distribution worker XMN.3</td>
<td>1</td>
<td>975.33</td>
<td>0.02</td>
<td>28650.00</td>
<td>0.36</td>
<td>29625.33</td>
<td>0.24</td>
</tr>
<tr>
<td>Distribution worker US.15</td>
<td>1</td>
<td>99227.31</td>
<td>2.30</td>
<td>108150.00</td>
<td>1.35</td>
<td>207377.31</td>
<td>1.69</td>
</tr>
<tr>
<td>Distribution worker US</td>
<td>15</td>
<td>1280124.72</td>
<td>29.72</td>
<td>1830535.00</td>
<td>22.92</td>
<td>3110659.72</td>
<td>25.30</td>
</tr>
<tr>
<td>SUM</td>
<td>-</td>
<td>4307517.22</td>
<td>100.00</td>
<td>7905995.00</td>
<td>100.00</td>
<td>12291512.22</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Figure 5.35: Resource Costs Scenario 1

The figure above represents how the resource costs are estimated as theses are based as a cost function, and therefore not seen as a graph. The resource costs for scenario 2 and 3 can be seen in Appendix 6. The resource costs of interest for this scenario were the logistics workers in the different locations which for this scenario were in the XMN site, the GDC site, and the US site. The costs of logistic workers for scenario 1 were app. MDKK 8, app. MDKK 15 for scenario 2, and app. DKK 9 for scenario 3. These three numbers vary a lot, which is due to the fact that even though scenario 1 has logistics workers in three distribution centres it has no sales companies, whereas scenario 2 and scenario 3 has sales companies that are also located in countries with high wages such as Europe and the US. The resource costs are based on the fact that the distribution worker uses app. 30 minutes on handling spares and HI. This cost cannot always be related to a specific spare part or HI, but as the cost is used for comparing it is found that it shows the difference of the three scenarios.

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Inventories</td>
<td>Increase in inventory in distribution centres, but decrease in inventories in sales companies</td>
<td>Status quo in inventory in distribution centres, but decrease in inventories in sales companies</td>
</tr>
<tr>
<td>Transportation costs</td>
<td>Transportation regionally from the distribution centres. Lower than scenario 2 and 3.</td>
<td>Transportation through the European distribution centre. Higher than scenario 1 and 3.</td>
</tr>
<tr>
<td>Inventory level</td>
<td>Inventory level lower than scenario 2 and 3.</td>
<td>Inventory level lower than scenario 3 – higher than scenario 1.</td>
</tr>
</tbody>
</table>
Resource costs lower than scenario 2 and 3. | Resource costs higher than scenario 1 and 3. | Resource costs higher than scenario 1 and lower than scenario 2.

**Table 5.5: Comparison of the results**

The development of the three scenarios and the numerical simulations were used by GN Resound to support their decision regarding the distribution strategy. The process showed that based on the input parameters from GN Resound then scenario 1 was the preferred solution. This was in accordance with what the managers in Global Supply Chain had assumed before the project began, but they found that they could use the CSA to support these assumptions.

The narrative and numerical models were verified through constant interaction with the managers at GN Resound both through meetings, but also through the workshop and presentations by the author. This was also done to accreditate the models so that they were officially certified that they were acceptable to use for the purpose of determining the distribution strategy.

The data in the model was also validated. This was done through checking whether all products and spares leaves the system, and this could be seen by the fact that the number of products going in equaled the number of products going out. The numerical models were also checked in run time to see if the products followed the expected course.

Verification, validation, and accreditation in relation to strategic simulation will be discussed further in chapter 9.

### 5.7 The Future Use of the Models

The CSA helped the decision makers test different solutions possibilities before making the decision of what scenario to pursue. The different parameters were tested in order to compare and examine different possible futures of the distribution. The CSA supported their assumption of what scenario would be the most sensible and it gave them a tool that supported their indications with calculations of both qualitative and quantitative parameters. A comparison of the different parameters can be seen below.

<table>
<thead>
<tr>
<th>Contingency</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contingency</td>
<td>3 distribution centres + contingency</td>
<td>Distribution from GDC – % contingency</td>
<td>Distribution from XMN – % contingency</td>
</tr>
<tr>
<td>Delivery performance</td>
<td>↓ Delivery time to end customers from</td>
<td>Different delivery time to different customers.</td>
<td>Different delivery time to different customers.</td>
</tr>
</tbody>
</table>
distribution centres. Increase in delivery performance to all end customers due to distribution centres in three areas and direct shipments.

Delivery performance to European customers high due to the distribution centre and direct shipments. Differentiation of customers.

Delivery performance to Asian customers high due to the Asian distribution centre. Delivery through subsidiaries.

<table>
<thead>
<tr>
<th>Closeness to market</th>
<th>System Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution centres close to markets</td>
<td>Inventory in 3 distribution centres Clear reversed logistics</td>
</tr>
<tr>
<td>Distribution centre close to customers in Europe</td>
<td>One distribution centre – easier to control Partly clear reversed logistics</td>
</tr>
<tr>
<td>Xiamen manufacturing site close to customers in Asia</td>
<td>Simpler supply chain Less clear reverse logistics</td>
</tr>
</tbody>
</table>

Table 5.6: Comparison of the three scenarios

The causal mapping also opened up for clarifying what further information was needed. The numerical simulation highlighted issues that had not been represented in the scenarios and that needed to be solved before it was possible to continue working with the numerical model. These issues were amongst others how the direct distribution took place in scenario 2 – whether there was direct distribution to end customers in the whole world or only to the European end customers. This meant that based on the numerical simulation it was possible to develop the narrative simulation further in order to describe in scenario 2 how the distribution was differentiated according to the fact that direct shipments to end customers were only possible from the global distribution centre to European customers. This meant a further description of the distribution and changes in the figures made for the scenario. Furthermore, the influence on the inventories had to be described. After developing the narrative part so that it described this structure of distribution it also had to be changed in the numerical model accordingly. In this way the narrative and numerical model influenced each other and resulted in further development of each other and helped clarify issues that were somewhat unclear.

5.8 Follow up

After the results of the above were presented in January 2008 to the vice President of the supply Chain and the Global Planning Manager the project continued in GN Resound, which also meant that the project was neither finished for the author. After a period of time the author took contact to GN Resound to hear how the project was coming about. The follow up phase was carried out from September 2009 to March 2011. During the follow up phase informal talks and mails with the Global Planning Manager showed that GN
Resound continued to work with the implementation of Scenario 1. These informal talks happened from
the fall 2009 to the spring 2010. In May 2010 an interview with the Vice President of Component
Manufacturing was carried out. This interview showed that Præstø is still able to compete with the Chinese
in some areas related to plastic production due to the fast technological development. Based on this the
author found that it was possible to look into scenario 4 in cooperation with the Præstø production site
(chapter8). This interview also informed the author that most of the managers in the Global Supply Chain
department had almost all been replaced with new persons. This information in combination with the
interview with the Vice President of Component Manufacturing resulted in a new interview with the Global
Planning Manager (from 2010) who had taken over after the former Global Planning Manager. The
interview with the Global Planning Manager (from 2010) showed that GN Resound was still in a phase of
implementing scenario 1 and that it had been a very turbulent phase with many changes in management
and departments.

“There has been a lot of changes in management and I do not think we have seen
the last changes yet” (Global Planning Manager (from 2010)).

The process of implementing scenario 1 had also shown some few changes in how the scenario looked to
begin with, which can be seen in the figure below.

Figure 5.36: Scenario 1 in 2010
As can be seen from the model the Chinese distribution centre is called CN DC. And a Danish distribution centre still exists, but the plan is to terminate this. Instead the European and American distribution centres two Regional Operations Centres (ROC) and one American are made. The plan is however to only have one European ROC in the long run.

“It has been made official that the distribution centre in Ballerup will be closed in the long run. The idea is to have one distribution centre in London, some regional centres in other locations, and then some drop shipments from China”, Vice President Component Manufacturing.

The Chinese distribution centre will ship to many destinations such as sales companies in India, Brazil, Japan, and Australia as these destinations are placed too far away to drop ship to them. Furthermore, it will drop ship to some end customers in China and other specific customers. GN Resound is also developing a system called Control Tower, which is a data base that can draw information and data from different systems, the old Navision systems. This system is in the making. This system will simplify how the information is retrieved and how they are shared.

The follow up showed that GN Resound is still working with scenario 1 and during the follow up the methods were introduced to the company again. GN Resound is still interested in the methods for testing different scenarios related to the continuous development of scenario 1.
Chapter 6. Theoretical Framework
During the case different issues arose that gave input to the literature study. These issues as well as the literature study were examined concurrently and will form the basis of the theoretical framework in the following.

6.1 Globalisation

Over the last decades, globalisation has resulted in a highly competitive business environment. The changing market conditions as well as the evolution of technologies have increased the need for more competitive enterprise strategies (Baramichai, Zimmers Jr et al. 2007). A global economy is an economy whose core activities work as a unit in real time on a worldwide scale. Thus capital markets are interconnected worldwide, so that savings and investment in all countries, even if most of them are not globally invested, depend for their performance on the evolution and behaviour of global financial markets. Multinational corporations, in manufacturing, services, and finance, with their additional networks of small and medium businesses, constitute the world economy. Globalisation is multidimensional and inscribed in processes of restructuring, innovation and competition, and is enacted through the medium of new information and communication technologies (Castells 2004). The availability and use of information and communication technologies are a prerequisite for economic and social development. There is a close relationship between the spreading of information technology, productivity, and competitiveness for countries, industries and firms. Information and communication technologies allow countries and companies to modernise their production systems and increase their competitiveness faster than in the past. To fully benefit from the possibilities of information and communication technologies an interrelated system of flexible organizations is required (Castells 2004).

The networking organisation stands in contrast to the large factory dedicated to mass production and the industrial age. A network is simply a set of interconnected nodes. It may have a hierarchy, but it has no centre. Relationships between nodes are asymmetrical, but they are all necessary for the functioning of the network. The networks are interacting. With new information and communication technology, the network is both centralized and decentralized. It can be co-ordinated without a centre. Large multinational corporations function internally as decentralized networks, whose elements are given considerable autonomy. Each element of these networks is usually a part of other networks, some of them formed by ancillary small and medium businesses; other networks link up with other large corporations, around specific projects and tasks, with specific time and spatial frames. Nevertheless their fundamental weakness is the difficulty of co-ordination towards a common objective that requires concentration of resources in space and time within large organizations and vertically organized corporations (Castells 2004). Networks
are the appropriate organization for the relentless adaptation and the extreme flexibility that is required by an interconnected, global economy. By changing economic demand and constantly innovating technology, and by the multiple strategies (individual, cultural, political) deployed by various actors, which create an unstable social system at an increasing level of complexity. To be sure, networks have always existed in human organization. The strength of networks is their flexibility, their decentralizing capacity, their variable geometry, adapting to new tasks and demands without destroying their basic organizational rules or changing their overarching goals. Globalisation is considered as an economic process where production and markets are becoming increasingly interdependent due to dynamic flows of products, capital, and technology. Organisations and the industries and markets they operate within can be defined as networks of specialised nodes that perform specific activities required to achieve a common purpose. These nodes are united through relationships that manage interdependencies (Ebers 2001, Heckscher, Adler 2007, Heckscher, Adler 2007).

The growth of collaboration has occurred over the last few decades not only within firms, but also across firms, though elaboration of complex supply chain and alliance relationships (MacDuffie, Helper 2007). Viewed from a global perspective, a value-added chain is the process by which technology is combined with material and labour inputs, and then processed inputs are assembled, marketed, and distributed. A single firm may consist of only one link in this process, or it may be extensively vertically integrated (Kogut 1985). The growth of collaboration within firms, but also across firms has developed through the elaboration of complex supply chains (MacDuffie, Helper 2007) and the strategic supply chain continues to be adopted by organisations as the medium for creating and sustaining a competitive advantage (Fawcett, Magnan et al. 2008). Because of this level of unpredictability and complexity, the networks in which all firms, large or small, are anchored, move along, readapt, form and reform, in an endless variation. This can also be seen by the increase in outsourcing and offshoring in many companies where everything from production to design to customer service is either outsourced or offshored to another country.

### 6.2 Outsourcing / Offshoring

When a company chooses to buy products or services it used to produce from an outside party, it is called outsourcing (Amaral, Billington et al. 2006). Offshoring differs from outsourcing mainly by the fact that the relevant processes are still owned and controlled by the company itself (Hira 2005). Offshoring involves transferring or sharing management control and/or decision making of a business function to a supplier in a different country, which entails a degree of two-way information exchange, coordination and trust between the overseas supplier and its client (Kumar, Kwong et al. 2009).
6.2.1 Reasons for Outsourcing and Offshoring

Outsourcing / offshoring can help firms focus on those activities deemed core competencies for their strategic significance. By focusing on the core competencies and converting some fixed costs to variable costs, the firm can obtain operational flexibility, and improve its return on assets (Amaral, Billington et al. 2006). The motives for offshoring are in most cases the same as with outsourcing, but offshoring is most likely to be conducted if the company considers it as important to keep the activities in-house (Ang, Inkpen 2008).

*Offshoring is when companies don’t want to buy the services from the supplier, but want to take advantage of low-cost labour overseas* (Hira 2005).

John Stephen (2006) defines three general business drivers that justify an outsourcing strategy. The first is cost saving which also relates to the Transaction Costs Economics (Massini, Perm-Ajchariyawong et al. 2010, Kamann, Van Nieulande 2010) that finds that the reason for outsourcing is typically to reduce the cost level including a reduction of the salary level and other costs. The rationale is that the management sees outsourcing and offshoring as a quick way to improve efficiency. The apprehension is that savings will occur over time as set-up costs can be reduced and as reinvestments do not have to be made. The second and the third are free time to focus on core activities, and lack off in-house resources needed to perform the operation according to time, quality, and cost criteria. This is also related to the resource based theories (Massini, Perm-Ajchariyawong et al. 2010, Kamann, Van Nieulande 2010) that believes that the reason for outsourcing is that the company can then focus on its core competencies, simplify the tasks in the company and thereby become more competitive. Through a globalisation perspective outsourcing and offshoring strategies can also result in access to new technologies that are not present in the home market (Massini, Perm-Ajchariyawong et al. 2010).

Furthermore, John Stephen (2006) recognises four major types of outsourcing:

1. “Commodity like” activities are outsourced where the primary motivation is cost savings. Little innovation is expected or required and the goal for the company is to achieve the best price and retain control.
2. “Customised activities” are outsourced where company specific characteristics are incorporated in the service. The outsource provider must know the company’s internal processes to some degree.
3. “Business process outsourcing “has significant customisation and flexibility in designing and delivering the outsourced service. This kind of outsourcing requires close collaboration for both parties.

4. “Strategic outsourcing” includes full, or near full, integration of the process or services provided with appropriate level of shared responsibility for success or failure (Stephen 2006)

Kamann (2010) finds that there are five reasons to outsource and that it is the combination of these factors that cause so many companies to take this decision even though the expected reduction of costs is one of the most important (Kamann, Van Nieulande 2010). The reasons can be seen in the figure below.

![Figure 6.1: Reasons to offshore or outsource adapted from Kamann (2010)](image)

The changing environment is also related to the costs as these changes can increase the international competition and result in shorter life cycles and added pressure to reduce costs. The changing demand can be based on the fact that some supplies or products are no longer available in domestic markets. The access to better resources can give a competitive advantage if the company by outsourcing or offshoring actually gets better quality or technology. It can be easier to gain access to a new market if the production is located close to that market in order to adapt to the needs of the new market (Kamann, Van Nieulande 2010).
6.2.2 Total Costs of Outsourcing / Offshoring

Some researchers have found that the above perspectives are inadequate to use as a basis for supplier selection. They argue that selection of suppliers should be made based on a total cost perspective rather than just focusing on the price of using that supplier. This is also in accordance with the fact that in recent years many companies have experienced that outsourcing or offshoring has not given the expected reduction in cost (McClenahen 2005). One of the pitfalls is not to take all costs into consideration (Carmel, Tjia 2005). A model for Total Cost of Ownership (Platts, Song 2010, Song, Platts et al. 2007) contains a developing list of costs that together are basis for the total costs. The list can be seen in Appendix 7. The costs can both be setup costs which mostly occur one time such as building a factory, restructuring the organisation, switching costs and so on. The running costs are relevant on a continuous basis and can be travel costs, communication costs, shipping costs, unexpected costs in relation to production and so on. For GN Resounds case the setup costs will not be used as the factory in Xiamen has been there for several years so the setup costs have already been made. This means that adapting a Total Cost of Ownership (Kamann, Van Nieulande 2010, Platts, Song 2010, Song, Platts et al. 2007) point of view will give new input as to whether it is economically viable to outsource or offshore as the total costs often shows a more complex and complicated picture.

6.2.3 Risks of Outsourcing / Offshoring

There are many risks related to outsourcing and offshoring and any one of these risks can turn an attractive potential saving into a costly venture (McClenahen 2005). By outsourcing / off shoring firms can sacrifice critical capabilities, knowledge, and long-term relationships. Furthermore, communication between internal and outsourced / off shored functions can be difficult. The firms can be subject to the service providers’ performance and must trust the provider to not use their product or process knowledge to benefit the firms’ competitors or even themselves becoming competitors. Some risks of outsourcing / off shoring are due to the complexity it creates in an organisation when part of an organisation is moved abroad (Kumar, Kwong et al. 2009). The decision making becomes more discontinuous and the information flow is irregular as the organisation is more decentralised. This can be helped by redesigning processes and improving information technologies. Other risks can derive from deliberate actions by service providers that are not in their clients’ best interests (Amaral, Billington et al. 2006)(Amaral, Billington et al. 2006). A problem often found with outsourcing / off shoring to amongst other China is the risk of having your core competencies exposed. This makes it necessary to consider what part of your business can be outsourced / off shored. Part of the problem in China is the high employee turnover. Skilled Chinese workers often only stay with one company for a short period of time as they use it as a stepping stone to get better jobs and better salaries. This means that the employee loyalty to the company is not very profound. At times the
employees also take important information with them from the company in order to get the next job, this puts the company in a very vulnerable situation.

In addition to traditional outsourcing risks, offshoring introduces new dimensions of complexity related to operations across countries. These risks can also be segregated according to the three potentially critical areas of competency: delivery, transformation, and relationship competencies (Kumar, Kwong et al. 2009). A fishbone diagram of the different risks and their causes can be seen in the figure below.

![Fishbone Diagram](image)

Figure 6.2: Offshoring risks cause effect fishbone diagram (Kumar, Kwong et al. 2009)

Delivery competency involves strategic, operational, and credit risks as estimated delivery time increases with a proportional increase in these risks. Some of the causes of these risks can be business decisions, process and technology transfer with knowledge transfer. In relation to this it is important to determine the competency level of the outsourcing and offshoring partner prior to investing in either. Transformation competency is determined by the factors such as technology transfer, people risk involved during transfer of material. Relationship competency would be influenced by reputation risks, country risks, and compliance risks (Kumar, Kwong et al. 2009).

6.2.3.1 Cultural risks

The cultures of different countries and organizations can have a great impact on the success of outsourcing and offshoring. There are many cultural differences between European and Asian employees and one of the most important can be power orientation (Carmel, Tjia 2005). Power orientation describes the employee's relation to the closest manager and to possible subordinates. High-power cultures, such as China and other Asian countries, typically have more autocratic managers whereas low-power cultures,
such as Northwest European countries, typically uses a more involving form of management. In low-power cultures the employees more often express their disagreement while employees in high-power cultures are more comfortable with the responsibility for decisions aising allocated to the management and feedback is not typical in the high-power culture (Carmel, Tjia 2005).

The business culture in China is known for being complex and affected by the political system in China. The interpretation of rules and results is often unpredictable and corruption is a significant problem. This can make it very difficult to examine the quality, cost, and reliability level at suppliers. The relationship between customers and suppliers is often characterized by anonymity where the buyer is reluctant to share the identity of their suppliers out of fear for the competitors will seek them out. This is especially true if investments have been made in training, qualifying, and development of the workforce. This relationship based business system increases the risks of corruption, misunderstandings, conflicts, and disagreements (Enderwick 2009).

6.2.4 Backsourcing

In recent times several examples of backsourcing have been seen where the expectations of either outsourcing or offshoring were not met and therefore the company chose to backsource. Kinkel (2009) examined why German producers offshored their production and also why they backsourced it in relevant cases. The three main reasons for backsourcing were:

- Lack of flexibility in production
- Quality issues
- Higher costs than expected in relation to the coordination of work (Kinkel, Maloca 2009)

The main reason for offshoring was the possibility of reducing salaries whereas the backsourcing was related to corrections of misunderstandings and misinterpretations in the offshoring decisions more than it was related to changed conditions in the country that was offshored to. Up to 27% of the German companies had backsourced part of the activities or all the activities within 5 years (Kinkel, Maloca 2009). Outsourcing and offshoring as well as the globalisation of the market and suppliers make it necessary for managers to view the company as a network and as operating within a network. The development means that the traditional industrial mode of production is rapidly changed to a much more complex and diversified mode of knowledge production. This also means that an organisational paradigm is also needed to meet the rising complexity that organisations experience.
6.3 Two Organisational Paradigms for Organisational Development

Strategic management is a vast area of information and it is important to understand the different approaches to organisational development. The theories that developed over the years can be grouped into two organisational paradigms (Van der Heijden 2005a). These paradigms are organisational paradigms and are used in relation to the comprehension of how the ideal organisational structure looks. This means that this type of paradigm differs from the ones described in chapter 2.

- The rationalist organisational paradigm
- The processual organisational paradigm (Van der Heijden 2005a)(Rasmussen 2009)

The two paradigms are both complementary and contradictory. Both organisational paradigms are presented and discussed.

6.3.1 The rationalist organisational paradigm

The rationalist perspective operates with the assumption that there is one right answer and the strategic task is to find that answer or to get as close as possible. The rationalist paradigm is based on various theories that assume that there is a fixed connection between two factors and that a change in one of them is necessary for the result of the other. The paradigm is based on forecasting and in that way assumes that the future can be predicted if the necessary data exists. The starting point is the company's purpose, also called mission, and the next step is to identify strategies that can realise the mission. A series of alternative strategies are evaluated in order to choose the most effective which is then sought implemented in the organisation. For this an evaluation of the future is needed and is based on predictions (Van der Heijden 2005a). The purpose of rational strategic management is to come as close to the right answer as possible. The strategist works out an optimal strategy as a process of searching for maximum utility among a number of options. All forecasts in the rationalist paradigm are based on the assumption that the past and the present can be extended into the future either through statistical extrapolation of selected parameters or by the means of a numerical simulation model based on defined relationships between certain input and output variables. The methods associated with the rationalist paradigm are for instance expert-driven SWOT analysis, value stream mapping analysis, accounting performance measurement, numeric forecasts as well as various logistic methods (Rasmussen 2009)(Rasmussen 2011a).

The rationalist organisational paradigm is also related to the machine view of organisations and the bureaucracy with a hierarchical structure, fixed division of tasks, maximum specialisation and specification, exact execution of orders, individual responsibility, and vertical organisation and alignment (Rasmussen 2011a, Van der Heijden 2005b, Morgan 2006). This is also in accordance with the fact that according to this
paradigm change presupposes a mission defined by top management as well as a set of strategic objectives.

A problem with the rationalist paradigm is that it is assumed that if all parts of the organisation think rationally then they will come to the same conclusion for what is best for the organisation as there basically only exists one best solution. The assumption that the future can be predicted makes the organisation vulnerable to changes in the expected. Mintzberg (Mintzberg 2000) lists a number of underlying assumptions that rationalist strategic management takes for given and which can be the cause of why rational strategic planning at times fails. The assumptions are:

- **Predictability** – If the planner collects sufficient data, it is possible to make an exact forecast of the future environment
- **Transparency** – The objectives, selected options, and operations are fully known and understandable throughout the organisation
- **Independency** – The strategy should be made by the experts independent of the people who are supposed to implement and use the outcomes
- **Discipline** – people are assumed to act precisely as prescribed by the strategy based on quantitative calculations of optimal performances (Rasmussen 2011a)

### 6.3.2 The processual organisational paradigm

The processual paradigm is based on a process theory that allows managers to think about how to intervene in the process, in order to improve the chances of success in the future, which is the basis of the processual school of strategy (Van der Heijden 2005a). It does not assume as the rationalist paradigm that one right answer exists to each problem. The processual paradigm assumes that the world is unpredictable and it seeks to prepare the organisation for the future by making different scenarios and then try to effect the organisation’s development through these scenarios. Furthermore, the paradigm takes the inner factors in organisations into account (Van der Heijden 2005a) as the organisation is viewed as composites of separate parts and is assumed to be the sum of its parts. The relation between whole and part is more complicated because the organisation is seen as a holographic system rather than a mechanical system which is the case for the rationalist paradigm (Rasmussen 2011a). The processual paradigm sees the organisation as an organism and as a complex adaptive system. The basic assumption of the processual paradigm is that one best solution to strategy does not exist, but the strategy planning can be improved by making different scenarios. The paradigm is based on Kolb’s ‘learning loop’ where an ongoing development of experience takes place so that the organisation continuously gets better at adjusting to the surrounding environment. This takes place as continuous development and improvement and does not agree with one
best solution (Van der Heijden 2005a). The processual paradigm assumes that strategy is necessary, but also that the future cannot be predicted exactly which makes it necessary to work with different scenarios so that the organisation can prepare for and learn about possible futures. Characteristics for the theories within this organisational paradigm are that they:

- Are plural essential – the human world is not determined
- Are pluralistic – our knowledge is not a direct reflection of any reality
- See knowledge as historical and cultural specific
- See language as a precondition for thinking
- Have focus on the human interaction and their social practice
- Have focus on processes over structures (Pedersen, Land 2001b)

6.3.3 The View of the Organisation

In the rationalistic organisational paradigm the organisation is viewed more as composites of separate parts and an organisation is assumed to be the sum of its parts. In the processual organisational paradigm the relationship between sum and part is more complicated as it is more the connectivity between the parts that are viewed. It sees the organisation as a complex adaptive system that develops within itself and in that way also becomes more complex (Van der Heijden 2005b). The explicate order meaning the behaviour observed in everyday life is only the surface of the more or less hidden processes of the implicate orders.

![Figure 6.3: The three levels of culture](Rasmussen 2011a, Schein 2010)
Schein’s model of culture shows that the artifacts are the explicate orders such as visual organisational structures and processes for example formal rules, procedures, and material equipment. Beneath artifacts are the espoused values that also belong to the explicate order, which are formal missions, strategies, and goals. Beneath the values are the underlying assumptions that belong to the implicate order, which are difficult to discern because they exist at a largely unconscious level. At each of the level the members of the organisation is influenced in order for the system to reorganise itself in accordance with the changing demands from the environment (Rasmussen 2011a, Van der Heijden 2005b, Schein 2010). There are differentiations in organisations where different people have different views and interpret the situation in their own way. This means that both the organisational paradigms have their role in organisational development as traits from both paradigms can be found in practical reality. The ideal is that the two are complementary so that for example in processual driven organisations critical situations can result in the rationalistic organisational paradigm is useful in the fact that leaders need to take fast decisions and give orders. Due to the increased complexity of the world many organisations are however trying to transform into the processual mind set (Rasmussen 2011a). Organisations with strong cultures have moderately uniform values across various work groups where organisations with weak cultures can experience a range of subcultures which operate independently, which makes it more difficult to build collective practices and processes (Debowski 2006). The culture is also important in relation to knowledge creation as the creation of effective organisational knowledge depends on many things. First, the sources of knowledge need to be known, available, and useful. This means that corporate knowledge systems should be updated and managed so that they contribute to organisational knowledge creation and use. Knowledge culture enablers are those influences that contribute to the creation of an effective and positive knowledge community and can be found on several levels of the organisation. These enablers can be seen in the figure below.
The knowledge culture enablers help align the core values, organisational structures, systems and processes, and individual behaviours to build a positive and effective knowledge culture (Debowski 2006). These enablers are important as trust and tolerance, openness, cross-boundary communication, knowledge sharing, knowledge creation, and knowledge accumulation are important for organisational development also in relation to strategy development. It is assumed in the processual paradigm that both mental and organisational obstacles can be overcome by using interactive methods, but most organisational situations are too complex to analyse in its entity.

Figure 6.4: Knowledge culture enablers (Debowski 2006)
According to the processual paradigm an effective strategy is one that triggers a successful launch into a learning loop. (Rasmussen 2011a, Van der Heijden 2005b, Van der Heijden 1996). Kolb (1991) introduced the learning loop, which is an integrative learning model and can be seen below (Van der Heijden 2005b, Kolb, Rubin 1991).

![Figure 6.5: Kolb’s learning loop](Kolb, Rubin 1991)

The loop above is based on the fact that we have experiences. Some of these experiences we relate to our previous actions. The experiences are reflected upon as to what these actions have created in relation to other events. The product of this reflection is a growing awareness of new patterns and trends in events we did not perceive before. The reflection is related to our ability to differentiate between our existing mental model and perception of a different reality. Based on observation and reflection we develop new theories on how our ideas about the world need to change. The old mental model and the new reality are integrated in a new theory. Then these new theories are used to plan new steps and actions testing the implications of the new theory in new situations. This brings the loop back to the top where new experiences are related to actions and the loop can start over (Van der Heijden 2005b, Kolb, Rubin 1991).

Learning can be defined as the process of developing new skills, abilities, and competences at individual and organisational levels and the question is whether organisations are able to learn in an ongoing way. Single loop learning is the ability to detect and correct errors in relation to a given set of operating norms where as double loop learning, or learning to learn (Argyris, Schön 1996) is the ability to take a double look at the situation by questioning the relevance of operating norms. Triple loop learning can create a shift in
understanding and patterns as the underlying values and norms are changed (Rasmussen 2011a, Morgan 2006, Argyris, Schön 1996). Many organisations are capable of single loop learning, whereas double loop and triple loop learning can be more difficult. This is also true for organisations within the rationalist organisational paradigm as the bureaucratic organising principle in a way can obstruct the learning process. If hierarchical and horizontal divisions are strong it is more rare that information and knowledge flow in a free manner. Different sectors of the organisation can often operate on the basis of different pictures of the total situation, pursuing subunit goals without the overall goal in mind resulting in sub optimisation (Morgan 2006).

Van der Heijden also operates with a third paradigm which is the evolutionary paradigm. The paradigm is based on the idea that organisations develop on an evolutionary basis, which means that they evolve away from constraints and resistance rather than towards a fixed goal. The evolutionary paradigm raises the question of how much analysis can be trusted. Decisions are made through ongoing negotiations and compromises and in this way uncertainty is made more manageable and decisions are made more robust. This means that high value is placed on consensus-seeking behaviour. The problem with the evolutionary paradigm can be a form of ‘groupthink’. When negotiations and compromises lead to consensus and strong mental models it means that the organisation can become vulnerable to unpredicted changes in the surroundings. The evolutionists believe that the future cannot be predicted and a long term strategy therefore is unnecessary (Van der Heijden 2005a). In this thesis the evolutionary paradigm is seen as an outer state of the processual paradigm, and therefore it will not be described further.

6.4 Strategy

As mentioned above the globalisation, the risks of outsourcing, and the developing supply chain as well as turbulence, unpredictability, and intense competition in the global business environment are just some of the factors that make strategies important. Strategy has been defined in a number and it can be seen as a transition process where the system or organisation is directed towards a common goals (Kumar, Zampogna et al. 2011). This indicates that it can be discussed whether (successful) strategies are planned or emerge (Lindgren, Bandhold 2009). Broadly defined strategy is the means by which individuals or organisations achieve their objectives (Grant 2010). A way to define strategy is:

“Top management’s plans to attain outcomes consistent with the organisation’s mission and goals” (Mintzberg, Ahlstrand et al. 1998)

This means that strategy is focused on achieving certain goals (Grant 2010) and this way of viewing strategy is also coherent with how strategy was viewed in GN Resound. Strategy can have several roles especially
within an organisation. It can be used for decision support, as a coordinating device, and as a target. The intention of CSA is that it can be used for supporting decision making and that it can be used as a forward looking tool as it is both concerned with visions for the future and how these are reached in the way that it seeks to clarify the future possibilities of the company as well as the development paths towards them. The method seeks to find a link between short term and long term goals as it involves both the operational, tactical, and strategic level in the planning. Strategy development involves planning as planning is one of the means to realise the objectives.

*Planning is a formalised procedure to produce an articulated result, in the form of an integrated system of decisions* (Mintzberg 2000).

However, the business environment has become more unstable and unpredictable, and therefore strategy has become less concerned with detailed plans, but has shifted to focus on strategy as having a clear idea of what to accomplish and how to accomplish it. Based on this a way to define strategy can also be:

*The planned or actual coordination of the firm’s major goals and actions, in time and space, that continuously co-align the firm with its environment* (Farjoun 2002).

This emphasis in strategy as a direction is important in a turbulent environment as the strategy must encompass flexibility and responsiveness (Grant 2010). Strategic planning often spoils strategic thinking, causing managers to confuse real vision with the manipulation of numbers (Mintzberg 1994). Companies need to make profit in order to survive over the longer term and to achieve this it is necessary for organisations to both a corporate strategy and a business strategy. A corporate strategy defines which industries the organisation should be in and a business strategy defines how the organisation should compete (Grant 2010). Strategy can be perceived both as a result of rational analysis, but also as a result as an adaptation to the changing circumstances (Grant 2010). Mintzberg (Mintzberg 2000) is a leading critic of rational approaches to strategy design. He distinguishes between intended, realised, and emergent strategies.

- Intended strategy is strategy as conceived by top management. It is mostly a product of negotiation, bargaining, and compromise.
- Realised strategy is the actual strategy that is implemented. It is only partly related to what was intended.
- Emergent strategy is the primary determinant of the realised strategy. It is decisions that emerge when the company adapts to the changing external circumstances (Mintzberg 2000, Grant 2010).
Mintzberg finds that rational design of strategy tends to be inaccurate and an unfortunate way of making strategy.

“Strategies can develop inadvertently, without the conscious intention of senior management, often through a process of learning” (Mintzberg 1994).

The emergent approaches to strategy making permit adaptation and learning through continuous interaction between strategy formulation and strategy implementation in which strategy is constantly being adjusted and revised in light of experience. In practice, strategy making almost always involves a combination of centrally driven design and decentralised adaptation (Grant 2010).

The above can be used to create a working definition for strategy related to the CSA.

“The planned or actual means by which an organisation realises its objectives and co-aligns with its environment through a process of learning”

This expresses the focus of the CSA as the method is intended to investigate different futures so that the organisation is prepared for these futures and can plan for them. This investigation and planning allows for the company to adapt to its environment and learn how to react to different possible situations and changes. The CSA includes different elements in strategy as can be seen in the figure below.

*Figure 6.6: The CSA’s elements of strategy* (Thompson 2003)
Strategy can be seen in a visionary context in that the CSA uses narrative simulation to depict possible future strategies. In this way the strategy can be seen as a vision for the organisation giving a direction and a purpose, but without the detail worked out. However, the CSA also sees planning as being part of the strategy as backcasting including milestones and numerical simulations can be made for each scenario. This means that managers can plan how to get to a future strategy from the current situation, which relates to the term position. The position is the idea of freezing time momentarily in order to clarify the current situation so that future changes are based on clear knowledge (Thompson 2003), and this is also what can be done in the numerical simulation. However, the numerical simulation is also used for looking ahead and testing different possible futures to learn about them and how to react.

6.5 Conclusions
The above introduces the theoretical framework based on findings in the case as the case study at GN Resound the data collection gave inspiration to the above described theoretical framework. It was found that GN Resound finds themselves in a global world that affects both distribution and production network. Globalisation can often lead to the question of whether a company should outsource and offshore and these decisions will affect the distribution and production strategies. Strategy can be seen as a form of organisational development and the above showed that two organisational paradigms can be used to understand this. In the following the theoretical framework will be used in the analysis. The theoretical framework regarding outsourcing will be used for the second part of the case in chapter 8.
Chapter 7. Analysis
In this chapter the case from chapter 5 will be analysed. The analysis will be based on different themes from the case put in relation to the theoretical framework. The overall focus of the analysis is the two organisational paradigms for organisational development. These will be related throughout the analysis in relation to specific areas. The outsourcing / offshoring part will be dealt with in a chapter for itself as the case developed further in that direction.

7.1 The Organisational Structure
GN Resound was at the start of the project a very rationally formed organisation with a hierarchical structure and formal operational systems and tools, which was observed in the Global Supply Chain department (chapter 5). The primary area of focus in the supply chain was based on the company’s strategic challenges as well as an optimisation of the supply chain flow.

“It is characteristic for the process that we have focused on goals and objectives for each project. A part of the exercise has been to buy or develop operational tools that can support the process” (GN Resounds application for the Danish Logistic Price 2005).

This indicates that the Global Supply Chain department worked according to the mission and vision of the company and also used formalised systems.

“The point of this tool (web interface to give the customer access to the order related transactions) is to eliminate non value creating transactions and create transparency in our supply chain” (GN Resounds application for the Danish Logistic Price 2005).

There seemed to be a biased focus on costs and quantification in the department and on getting results from the PhD project that could indicate which direction was the most appropriate to pursue in relation to the future distribution. This was indicated by the Global Planning Manager as he was primarily interested in having calculations made for each scenario so that it was possible to choose the one that seemed most profitable.

“The visual part of the simulation is not so important” (Global Planning Manager).

The Global Planning Manager at times indicated that he was not as open towards the idea that several paths could be examined as he at occasions pointed out that he hoped the simulations would prove that the preferred scenario was the ‘best’.
The Global Planning Manager was focused on cost and the quantification of data. This meant that the data used and prioritised in the numerical simulation was primarily located in the systems in GN Resound. During meetings with the Global Planning Manager the parameters for the numerical simulation were discussed based on the ideas of the author which can be seen in chapter 5. The author had developed these parameters based on the initial idea of what costs were relevant. The Global Planning Manager gave his input such as what parameters he found relevant for example how many square meters there were in the different sales companies and the customer base. Based on these talks between the author and the Global Planning Manager the parameters were developed further by the author. The more extensive list of what was found by the author to be relevant parameters can be seen in chapter 5. This data need was to begin with the reason for making a questionnaire to the sales companies in cooperation with the Global Planning Manager. The questionnaire was sent by the Global Planning Manager to the sales companies, but as mentioned in chapter 5 the questionnaires were never returned in spite of several reminders. This can puzzle a bit as GN Resound has a hierarchical structure and as it was a manager from the Global Supply Chain that sent out the questionnaires. However, even though the structure in GN Resound appeared to be typically hierarchical the fact that the Global Planning Manager at one point questions the fact whether they have an organisational chart also seems contradicting. It therefore seems difficult to locate who are actually responsible for the sales companies and that could be a reason for why they did not answer the questionnaires. The responsibility for the sales companies can have been allocated to the department level, but never have been dedicated to a specific person. It can also be due to the fact that two departments have shared the responsibility, and therefore the responsibility is not clear. This comes from the fact that it has actually not been possible to find the sales companies in the Global Supply Chain organisation chart indicating that the formal responsibility is also difficult to locate. On new organisational charts (2011) the regional operational centres are located in the Global Supply Chain division now under the overall term Operations. It is however very important according to Weber (Morgan 2006, Fuglsang, Olsen 2004) that the formal responsibility is in accordance with the actual responsibility, as it otherwise can create confusions to who has the responsibility.

The reason could also be that it was more a request and this could result in the sales companies prioritising their daily function over filling out a questionnaire in order to save time. However, it is puzzling that the Global Planning Manager did not put more power behind the request as he was very interested in getting some of the data, for example the suppliers that each sales company had, as this data did not exist in the systems already or was not updated. Based on this interest it could have been imagined that the Global Planning Manager would have insisted more on getting the questionnaires back and if he did not possess
the necessary authority himself then get the Vice President to support the return of the filled out questionnaires.

In the rationalist paradigm the management of the organisation assumes that if all parts of the organisation think rationally then they will come to the same conclusion. As problems continued to exist there seemed to be some issues related to how the data was updated. During the implementation of the tools it was mentioned in GN Resound that even though the supply chain organisation was involved in the data collection and treatment it was the line organisation that was responsible for the data quality. This is important as the responsibility for the quality of data had been allocated in the company. However, during the CSA process the author found no indication that someone was responsible for the data quality as it was mentioned that the data from the sales companies and their inventory was not useful. This indicates that even though there had been an allocation of responsibility this was not followed. This could be due to the fact that management was often changed resulting in the fact that the responsible persons were no longer present in the company. As they did not have an overview or clear structure of all the systems the responsibility could quickly be lost due to the fact that the systems were not transparent.

7.2 The Systems

The first introduction to the systems in GN Resound indicated that the formal systems functioned as intended and were able to provide accurate data. The Global Planning Manager was the one who introduced and explained the systems and said that the systems were a help, because you could extract data from them. In his opinion the future could be predicted by these data correctly especially through the use of forecasts.

The tools and systems mentioned in chapter 5 indicate that GN Resound several times introduced new systems and electronic tools to handle problems with data collection. According to GN Resound the above systems were intended to help data collection as well as make the organisation less complex. Data used in forecast can be quantified, which can be a powerful tool, but also places great dependency on the quality of the data as well as the predictability and stability of the trends. This was very relevant related to the data issues in GN Resound as the data proved to be outdated several times.

"The tool (GIV – Global Inventory Visibility) gives the supply chain department online visually access to the inventory in the sales companies and can also be used as an item finder if delivery problems in the different countries exist. With this tool we have achieved total transparency in relation to the global inventory level" (GN Resounds application for the Danish Logistic Price 2005).
This shows that according to GN Resound the development of the GIV tool made them successful in creating a complete transparency related to the inventories in their supply chain, but as it was encountered during the PhD project the data related to inventory in the sales companies was outdated and could not be used. As late as in the follow up phase the Global Planning Manager (from 2010) stated in the fall of 2010 that she was only just beginning to get an overview of the inventory in the sales companies and the process of getting that overview was very difficult. This is contradictory to what was the intention of all the systems. Simply finding the number, location and other important data about the sales companies was very difficult. This highlights how time consuming it was for the employees in the company to find relevant data. It was not only time consuming, but the fact that data was not always correct also presented a risk as to whether the results from using this data were correct. This shows that there were problematic issues related to the use of the systems in the company. The intention of implementing the systems was to ease the work processes and to gain more transparency. A way to solve the data collection problems was to incorporate more systems.

The intention of the systems was found not to be fulfilled during the project as it was pointed out that the process of finding data was still long and difficult and especially as an item finder it did not help as several systems had to be searched.

“One of our challenges is that when I have to find out what went wrong in for instance Japan, then I have to look in Japan’s system then I have to look in the GDC system, and in the manufacturing system, because if something is not delivered then it can be anywhere in the chain. Then it is very complicated to find out why a piece has not been delivered” (Global Planning Manager (from 2010)).

This point was made in 2010 after the implementation of all the systems and indicates that the subsystems are still not connected making it difficult to get updated and accurate data. It shows that they were still using different subsystems that were not interlinked and it also shows that they did not have an overview of their own systems. Complexity theory has impressed on the world the view that many phenomena taking place in nature are unpredictable not just because we lack the requisite analytical knowledge and capacity, but because they are unpredictable in principle. Complexity science for organisations can be summarised as that human activity that involves the interaction of many participants, such as in organisations, generates the possibility of emergent behaviour. Emergence is defined as the appearance of unpredictable or incalculable behaviour resulting from the interaction of many simple components that cannot be derived from knowledge of what each component of the system do in isolation (Van der Heijden.
This is not in correspondence with the rationalist organisational paradigm as the problem with the data accuracy and the individual sub systems means that the necessary data was not always accessible.

As mentioned the process of getting the data from the sales companies quickly proved difficult to get, as the questionnaires send out to the sales companies were not returned. Therefore, a Supply Chain Analyst helped in searching the systems for the data. During this process it became evident for the Supply Chain Analyst that the data in the different systems (the systems of the sales companies and the system of the Global Supply Chain) did not correspond, which surprised the Supply Chain Analyst. Before being involved in the CSA method he was not aware of the fact that the data in the systems were not correct or updated. This also meant that this uncertainty in the company related to the data regarding for example the level of inventory in the sales companies, the amount of products and spare parts going into and out of the sales companies had to be discussed with several persons regarding the content of the CSA. Another example was the amount and location of the sales companies in order to know what and where to search in the systems. The Supply Chain Analyst was not sure about this information and the Global Planning Manager had to be asked as to which sales companies in the systems were the ones to use. Several discussions regarding what kind of data was needed took place and how to get the data also included talks with many different persons in the company, meaning that data such as the weight of the hearing aids and the transport costs seemed to be personal and tacit.

“You can find some of the data in the systems, but I have to verify for you” (Project Manager Supply Chain Development Department).

This showed that there did not seem to be open access to all relevant information and inconsistency existed for many of the systems. In contradiction to the rationalist organisational structure the quantitative data such as numbers seemed to be the data that was the most difficult to find as they had sub optimised their systems in such a way that they themselves had difficulties in finding this.

The more qualitative data based on discussions and interviews and different descriptions of the company was more easy to find and all employees approached during the project were more than willing to help in getting the data and using time on the project. This also seemed to be in contrast to the intention of the systems as these systems were intended to create easy and partly open access to all relevant information for both the central supply chain as well as the sales companies.

“In relation to the development of the tools it has been of outmost importance that these can be used across the organisation. Therefore they have been placed
on the Intranet so that they are easily accessible” (GN Resounds application for the Danish Logistic Price 2005, GN Resound 2005).

However, as this stored information is not frequently updated it makes the data obsolete. In spite of several attempts to incorporate data collection and storage systems the company still found itself in a non transparent situation. This can be a difficult situation to be found in as the company actually had systems, but they did not function in the intended way. It can be argued that it can be a worse scenario to have incorrect systems than to have no systems. The sub optimisation of systems can create more chaos as employees do not necessarily know that the systems are not updated, and therefore the data is incorrect.

It was also mentioned in the application for the Logistic Award 2005 that it is important that the systems can be used across the organisation. This was however not the case as the systems were not all connected and again not updated. A reason for the lack of updates in the sales companies’ inventory could be a reaction from the sales companies toward the increased surveillance the forecast systems have brought. Part of the forecast tool was that it was also a subsidiary forecast performance tool as the tool was intended to aid the supply chain organisation in getting a detailed overview of the relation between forecast and actual sales and inventory in the sales companies.

“Through a visual approach the tool can help the supply chain organisation to challenge the sales companies on a qualified level in relation to the respective forecasts” (GN Resounds application for the Danish Logistic Price 2005).

This means that the tools could be perceived as a way for the headquarters to control how the sales companies conduct business and this was not necessarily apprehended as a good thing by the sales companies who were not used to being monitored. However, it can also be a result of the fact that perhaps the sales companies were not ordered to update the systems, but merely asked to do it. Then the sales companies could down prioritise the updating of the data in order to save time. It is also important to consider the fact that the sales companies were located in many different countries with different cultures related to how business is conducted as well as how orders and guidelines are apprehended. This means that the different sales companies would need different orders depending on their national culture.

7.3 Culture

There were many different approaches to how things should be done in GN Resound, which indicates that different cultures existed in GN Resound both based on the department, the geographical location, the
education. This could stem from the fact that GN Resound is a combination of many different companies with employees from different company cultures.

“That shows a little about that even though we went to the same schools or think somewhat alike, we still have different perceptions on how things should be done”
(Vice President component Manufacturing).

Scheins model of culture (Rasmussen 2011a, Schein 2010) can be used to explain the different approaches to strategy making in the company as it is an example of interaction between obvious and hidden layers. The artifact layer in GN Resound was the visual organisational structure, which was a typical rationalistic hierarchy as well as the systems that were based on a quantitative approach. Beneath this layer the espoused values were found, which represents the formal strategies and goals and, which in this case was to choose the optimal scenario for the distribution in the Global Supply Chain department. However, beneath this the underlying assumptions were found and they were more difficult to determine as they exist at a more implicit level (Rasmussen 2011a, Schein 2010). This level in GN Resound represented a complex combination of different underlying assumptions and values rooted in the culture and environment as the company is a merger of six organisations. Furthermore, the different departments and locations all can add to the difference in assumptions. It was found that the different departments had different approaches to both strategy development and the daily operation. This indicates that different assumptions were present in different departments as well as sometimes within the same department. These assumptions were also related to the rationalistic and processual organisational paradigm as some of the participants showed interest in testing different paths of the future whereas others found it irrelevant to discuss such paths and found that the chosen strategy should be pursued. In order to pursue the same goal and strategy it is necessary that the underlying assumptions are not conflicting.

GN Resound was aware of the culture in the department as they worked with it in relation to the implementation of new systems.

“If we want a globally rooted company we are obliged to understand and coordinate work tasks and project with consideration to culture and attitudes”
(GN Resounds application for the Danish Logistic Price 2005)

They mention that they have tried to develop a common attitude towards the supply chain task. They were aware that there were a difference in attitudes and culture between for example the Danish and Chinese organisation and that it was important to create understanding and accept of the work methods and the hierarchical organisation, which they also believed they had. A way they did this was through informal
rotations where employees from the respective supply chain organisations had been stationed for a shorter or longer period in the individual production units. It seems however that the considerations are made primarily towards the artifact layer such as work methods and organisational structure, and even though they do mention that attitudes were an important aspect they did not mention how to overcome these at a deeper level. Even though it can be a good idea to be stationed at other departments to see how they work it seems that it was only the supply chain employees that had been stationed. It could have been a good idea if the employees from the production units also had been stationed at the supply chain department or the R&D department and vice versa to get an idea about how they work as well as their espoused values and underlying assumptions. Issues between the different departments as to how the systems should be used were also seen in GN Resound and could also be related to the different cultures in the departments.

“We disagreed profoundly. In the end we (the Vice President of the Global Supply Chain and the Vice President of the Component Manufacturing, red.) we’re just yelling at each other, because they wanted everything to be on VMI and I said that is crazy” (Vice President Component Manufacturing).

This shows that the managers in the different departments disagreed as how the systems should be used. This can be a result of the fact that the approach towards strategies and goals are different in the various departments as well as the work methods. As the Vice President of Component Manufacturing also pointed out in a quote above there were also the fact that there were differences in the underlying assumptions related to the understanding and prioritising of strategic decisions. The Vice President of the Global Supply Chain was more focused on running the operation whereas the Vice President of Component Manufacturing seemed to also have a more long term strategic focus. These differences can stem from both formal education and prior work places and also result in the fact that there was a lack of respect for each other’s work (interview with the Vice President of Component Manufacturing). This was often a problem and was regularly discussed intensely as the supply chain department and the manufacturing department had very different views of how the production should be planned. The manufacturing department seemed to be very attentive toward not relying on the systems if the systems showed an unusual high demand. This sense making in relation to the data of the system can be seen as a result of the fact that the production unit worked with the actual production and not just numbers meaning that they had an idea about what seemed to be realistic and what seemed to be unnaturally high levels. Whereas the Global Supply Chain was very focused on reaching the goals set for each month even though they did not seem to be realistic, which could be related to the fact that it was their department that produced the data, and therefore it could be difficult to distance themselves from the output of the systems. The formal
structure of the organisation (divided into functions) as well as the geographical placement of the units also seemed to make some form of obstacles between the departments.

“It is a colleague at my level who has the responsibility for the supply chain. I mean the forecasts and signals are his responsibility. My responsibility is the production. There we argue a lot. But my area of expertise is not to find out where the products are in the world. He has to do that – and I do not have the tools to see it” (Vice President Component Manufacturing).

This indicates that the departments looked at themselves as independent and divided units that had their own strategies and goals. Furthermore, it showed that the access to information was not open and transparent and this lack of access could give problems, as the knowledge and information also could become a source of power. The separate geographical location of the departments can result in communication and cooperation challenges due to different work methods and organisational structures as well as different approaches to strategies and different assumptions. This physical distance between the departments also showed itself in relation to the communication and information sharing between the product development and the Danish production site resulting in rework and long product development cycles. The two departments lacked understanding for each other’s work procedures and the relationship was somewhat strained. The production department also had issues with the sales department;

“What does inventory cost. I think that lies far from them in their (salesmen, red.) daily functions. For example a salesman thinks it is a big thing when he has got an order of 10 products, but then we have to make a minimum order quantity of 5000. Then it is not economically feasible. These things I would like if everybody understood, because that cost a lot every year” (Vice President Component Manufacturing).

The production department did believe that systems and directions could be challenged if they did not prove to be sensible and was in that way more in accordance with the processual organisational paradigm, whereas the Global Supply Chain department had a tendency to make the systems and use the data because they believed the systems could increase the efficiency. In other departments the approach towards the future was to determine a best solution and then follow the strategy that was laid out.

“We are very good at discussing things in this company. Sometimes you have to say we have this direction, we have made this strategy, and then we have to
execute it. We cannot rethink it every six months stop to discuss or calculate whether it was right” (Corporate Purchasing Manager Operations).

This communication can be seen as a result of the fact that an organisation is a combination of many systems and subcultures that are interconnected and this connectivity creates a lot of communication and knowledge sharing. From the perspective of the rationalist organisational paradigm this interaction can be seen as a waste of time and resources, but from the processual organisational paradigm it can be viewed as an opportunity to create excess capacity and to create new ideas so that the system can reorganise itself in accordance with the changing demands from the environment (Rasmussen 2011a).

Changes in management can also result in shifting directions due to the fact that the manager has been placed for a more superior strategic reason. In GN Resound there were continuously changes in both management and employees and this meant that even though some of the former employees had been stationed the current employees might not have been.

“There is a tendency to radically shifting direction after each organisational change meaning that the results of the former decisions never show (neither the positive)” Vice President Component Manufacturing.

This change in organisational structure as well as in management can also affect the culture in the departments and the company as a whole. The changes that happen quite often can both result in new approaches and values and bring change to how business is conducted.

“I have a new manager now who is stationed in China, which is a huge change, because Global Supply Chain has always been very Danish. He has also been in manufacturing for a long time, which is a big change in the way of thinking” (Global Planning Manager (from 2010)).

The above quote shows that the manager’s approach and cultural beliefs were important as to how he or she conducts business. As the Global Planning Manager (from 2010) pointed out her new manager had been in manufacturing for a long time and this influenced the way of thinking meaning that it involved the principles of manufacturing as opposed to the former manager. This was also seen in the interview with the Vice President of Component Manufacturing who also mentioned that the approach to how business was conducted changed with this new manager.

“We (the new manager and the Vice President of Component Manufacturing) had a new meeting last Tuesday. Completely different than with the former (Vice
President of Global Supply Chain) he did not want everything on the VMI – he said that would be foolish” (Vice President Component Manufacturing).

The new manager was also stationed in China at the production site, which could also bring more attention to the production part of the supply chain. However, the changes can also result in people feeling uncertain about what is going to happen as well as whether they have their job and function in the company.

7.4 Knowledge Sharing

As it can be seen above there seemed to exist different approaches to knowledge sharing in GN Resound. Some of the employees found that it was important and some found that it was more a waste of time. The author also found throughout the project that a lot of knowledge was stored in different employees but not shared. Knowledge sharing did take place through the project and through the use of the CSA and example is the SWOT inventory workshop used in the PhD project. This workshop originates within the rationalist organisational paradigm and spoke well to the participants as they could see the effect of it. However, the use of the workshop and the methods were more processual and somewhat unfamiliar to them and they opened up for ideas as to how the scenarios could be used such as a platform for developing the strategy on a continuous basis. This seemed primarily to be the thought of the Vice President, who as mentioned in chapter 5 also found it interesting to look further into the narrative aspects as these could have an impact on the scenarios. This lead to a workshop being carried out as described in chapter 5. During this workshop the group of people involved both gained intended and unintended results of the process. As the idea behind the workshop was to determine possible opportunities and threats for the three scenarios this was the obvious result. These can be seen in chapter 5. Beside this result the participants also experienced the process of such a workshop and had a chance to discuss issues that were not debated during the daily routines such as how the culture in China, such as Chinese New Year, affected the supply chain in terms of delays. In relation to this the culture of the different sales companies were also discussed as this was relevant to the different scenarios and how GN Resound would be connected to their customers. Furthermore, they tried out a method that they found to be creative and different from how they usually work.

Through the process of both the workshop, but also the whole PhD project the participants were able to transform some of their tacit knowledge to explicit knowledge and to combine some of their explicit knowledge for example in relation to the sales companies. The number of sales companies as well as which sales companies should be used were important for some of the numerical models and the Global Planning Manager had to define the relevant sales companies in order for them to be used in the model. This came
about from the visual presentations of the models as the sales companies had to be located in order to make the products go through the supply chain. The Global Planning Manager did know how many sales companies were active and which sales companies to put into the model, but the knowledge of the sales companies did not become explicit until he saw the first draft of the numerical models. The Global Planning Manager’s knowledge of the sales companies was different from that found in the systems. In the systems more sales companies existed, but the Global Planning Manager explained that the system’s data was not correct and this also resulted in some irregularities with the data as the search for data in the sales companies systems showed that the data was not updated. When asked about this the Global Planning Manager explained that this was actually a problem, because they did not have an indication in GN Resound as to how much inventory the sales companies had. He did have this knowledge to begin with, but it became explicit as he was confronted with the needed data for the CSA. It became clear that no one possessed knowledge about the inventory at the sales companies even though the systems should make it possible to have a transparent view of the total level of inventory in GN Resound. This was according to the Global Planning Manager (from 2010) not dealt with until in 2010 where she started to get an overview as the sales companies were closing down.

“I am beginning to get an overview of the inventories at the sales companies – there is a lot. We have just closed a sales company and we had to empty it and I received a lot of things that were just lying around and could not be used” (Global Planning Manager).

This shows that the knowledge related to the inventory in the sales companies was not explicit as the Global Planning Manager did not know what was in the inventories, but he did however know that there was a lack of knowledge regarding the area.

As mentioned in chapter 5 the workshop was a part of the scenario planning process and the scenarios as well as the numerical simulations were also introduced and showed at the beginning of the workshop resulting in a clarification of scenario 2 as the Vice President and Logistic Manager pointed out that scenario 2 should look a bit different than it did, which the Global Planning Manager had been unaware of – this first became obvious at the workshop. The Vice President had neither observed at the previous meeting. This clarification was very important as the Vice President and Logistic Manager pointed out from the visual images that direct shipments were not possible in other areas than from the European distribution centre. This point was very important as it affected both the transport costs as well as the inventory costs of the scenario and showed that the visual images of the scenarios were important to discuss with more people. This indicates that their internal knowledge sharing was limited in certain areas.
At the workshop the participants used their individual knowledge to put light on the issues that could affect the scenarios. This knowledge that was combined from explicit knowledge from each participant was combined in posters so that overlapping statements could be grouped. This was for example the contingency related to having either one global distribution centre or three. This had not been discussed before with the Global Planning Manager and it was the result of the participation of the logistics Manager and the Global Customer Service Manager as they pointed to the fact that having three distribution centres would mean that they would have a higher contingency if one stopped operating. This is a very valid argument for pursuing a strategy with three distribution centres as the dependency of one distribution centre is delimited.

Another point made at the workshop that was developed through the combination was how the different managers experienced the effects of having the production and a distribution centre placed in China. These impacts were customs in China that represented a problem, and the different culture, which led to a discussion of what would be the cultural effect of having three distribution centres dealing directly with end-customers as opposed to having sales companies in many different cultures. Afterwards the author made causal maps of the statements in order to combine them in a graphical layout that could be shown to the participants. This structured the complex information from the different statements that were generated at the workshop and it showed how the statements would influence the three scenarios and can be seen in chapter 5. Furthermore, it created a platform for the participants to share the knowledge gained at the workshop with the rest of the department and organisation and could be used to further develop new knowledge as well as to be aware of issues in the surroundings. If the department is looked at before and after the CSA process it can be seen that knowledge development did take place for example in the form that the workshop led to the participants getting other view points of certain topics that they actually dealt with on a daily basis. An example of this is that the global Customer Service Manager could give her view point that the different sales companies in the current situation dealt with the customers and in the new scenarios the Global Supply Chain department would have to deal with the customers and this could create a lot of issues as the different countries had different cultures. A very specific issue that could arise would be the Chinese distribution centre in scenario 1 that would have to deal with the Japanese customers; this would be very difficult and had to be further discussed, because in her experience this was not possible. This gave a new view point to the other participants and other areas can also be seen in the causal maps in chapter 5. Furthermore, the CSA highlighted and brought attention to the fact that information related to for example the inventory and suppliers of the sales companies was insufficient and this became obvious to more persons in the department. This is the basis of the CSA as it advocates a continuous use of the method to iteratively develop the strategy on an ongoing basis that
helps the organisation adjust to developments in the environment. It seemed that some of the participants
gained new knowledge such as how scenario 2 should be constructed, what issues were important to focus
on in the different scenarios through the use of the CSA, but did not necessarily store the knowledge for
future use. Even though the Global Planning Manager did hire a person that could be responsible for
updating and maintaining the strategies made by the CSA it seems that the department only went through
the learning loop one time, as when contacted after a while the author was informed that they were still
pursuing scenario 1, but they were not using the CSA method.

7.5 Strategy Development

At the start of the project the first meeting was held in order to be introduced to the company as well as to
introduce the CSA method as described in chapter 5. The President of the Global Supply Chain and the
Global Planning Manager did use the term scenarios themselves at the meeting, but they used it in a
different way than it is used in the CSA method. They used it to describe different possible solutions to how
the distribution situation could look, but before the PhD project they did not intend to pursue the different
scenarios in a future minded way. They used the term more to identify that there were several possible
solutions to the issues related to the current situation. The intention of the CSA method by the author was
to use the methods as a basis for discussing different future possibilities based on more parameters than
costs and to be able to use the parameters creatively to see how different input can affect the scenarios.
The Global Planning Manager was more interested in the quantitative side and found it important to
incorporate as many numbers as possible in order to predict the future precisely. So the author and the
Global Planning Manager did agree that scenarios were pictures of possible futures, but the Global Planning
Manager found that these should be used mostly to forecast the future based on an extrapolation. The
President and Vice President of the Global Supply Chain were more interested in using the method to
discuss other parameters than costs. This shows that within the same department different approaches to
strategy existed, but the Vice President was however still mostly focused on using the method to confirm
the choice of scenario. The Global Planning Manager did not change his apprehension of how the CSA could
be used during the project as he continued to be focused on incorporating as many numbers as possible to
get as exact pictures of the future as attainable.

The Global Planning Manager and the Vice President of the Global Supply Chain showed different
approaches towards the process of developing a strategy. Where the Global Planning Manager had an
approach that focused on getting to a result the fastest way possible, the Vice President of the Global
Supply Chain showed more interest in trying out different possibilities before choosing, however it did not
seem that the Vice President impacted this on the department. The Vice President seemed to be placed
somewhere in between the rationalistic and the processual organisational paradigms leaning towards the processual organisational paradigm in relation to being curios as to examining different possibilities of the future. He was also very interested in the more qualitative aspects as long as they made it possible to compare the different scenarios. He showed more rationalistic signs in relation to the fact that he wanted to be able to choose the 'best' solution based on the method. The Global Planning Manager seemed to be more rooted in the rationalist organisational paradigm as he preferred the fastest way to the ‘best’ result. He did not show as much interest in the opportunity to examine different possible future paths, but assumed that the scenario that seemed the most sensible would also be the one that proved to be the most cost efficient according to the CSA method, and then he would have documentation for it by the use of that method.

The above gives reason to wonder how come GN Resound was interested in participating in the PhD project as they seemed to on a conscious level primarily locate themselves within the rationalist paradigm, and the PhD project uses methods from both the rationalist paradigm, but also from the processual paradigm. It seemed that the department knew that problems existed in relation to their logistics, the knowledge sharing, the lack of coordination between the IT systems and departments, but they did not seem to do anything about it during the time the author spent in the department. It seemed that they were aware that a problem existed, but they did not posses any tools to solve the problem other than adding new systems, which made the situation more complex rather than improving the desired transparency. New systems can be useful if they are coordinated and connected to the previous existing systems.

"I would say that if we had an MRP system so that we globally could talk together, that would help" (Vice President Component Manufacturing).

The question is whether the right comprehension of the problem existed, and whether an analysis of the problem had been carried out. It seemed that they focused on the problems with collecting data and the time spent on finding data rather than focusing the problem that the systems were not coordinated. The systems seemed to be sub optimised, which resulted in the fact that they were not aware of areas outside of their responsibility. They might have assumed that if they focused on their own systems then someone else would make sure that the systems and data were coordinated at higher level, which did not happen.

A the first meeting with GN Resound both the President of the Global Supply Chain and the Global Planning Manager were present indicating that the management of the department took ownership of the project. The President of the Global Supply Chain was very interested in the methods and was part of the creative process of describing the current situation in GN Resound leading to the new possible scenarios. He
mentioned that they were looking into one of the scenarios, but he also appeared to be very interested in
the other possible scenarios for the distribution. This shows that the President of the Global Supply Chain
exhibits traits of the processual organisational paradigm. It can indicate that GN Resound is not completely
located in the rationalist organisational paradigm, but somewhere in between the rationalist and
processual organisational paradigm. The CSA and the PhD project highlighted the fact that the systems
were not connected and not always up to date and made them realise how unproductive the situation
actually was. This for example happened when data was sought for the numerical models together with the
Supply Chain Analyst. This data that was related to the sales companies was very difficult to get and the
data that did come out of the system was inaccurate as the Supply Chain Analyst could see the data did not
seem correct. Furthermore, the transport cost also showed that there were inconsistencies in the
systems as the Project Manager pointed out that the weight in the systems was not correct for the
products. This was confirmed by the Logistics Manager who was able to find the data related to the weight
of the products, but mentioned that the weight of packaging for transport had to be taken into
consideration. This could also be part of the fact that the systems did not seem to have a person
responsible for their functionality and usability meaning that someone could be accountable for the quality
of data in the system even though this responsibility was appointed to the line organisation, but not to a
specific person.

This indicates that a superior manager with an idea of what happened in the different department did not
seem to exist resulting in a lack of visibility between the different departments. This could be one of the
reasons for GN Resound to be interested in the PhD project as they found it interesting to have several
solutions visualised. They did open up for looking into three scenarios, but was primarily interested in the
one they anticipated to be the most optimal. This way of thinking is also in accordance with the rationalist
paradigm as it favours the evaluation of a series of alternative strategies in order to choose the most
effective to be implemented. This meant that if the CSA could support the one they already found to be the
most effective it would strengthen their argumentation for pursuing that road. It was often also
commented that they were pleased when the results indicated that scenario 1 had the lowest costs. The
result was based on the parameters that they were interested in measuring. Another reason for
participating in the project could be that they were interested in getting a different view of how their
supply chain could be developed as well as a tool for adjusting to unforeseen changes in the environment.
Also the Vice President and the President of the Global Supply Chain seemed to be interested in examining
different paths of the future before making a decision regarding the future supply chain. The Vice President
also found it useful that different aspects could influence the choice of path to be followed. They must also
have been aware of the fact that systems were not functioning as one unit as they were interested in
eliminating the sales companies in order to be more efficient. The department was aware of the fact that changes happened in the organisation as well as the surroundings, and one of the reasons for changing the supply chain in 2007 was the fact that Phonak was looking into buying GN Resound. This meant that GN Resound had to adjust more to the way that Phonak planned their supply chain in order not to be obsolete.

7.6 Obstacles to Transformation

Many organisations try to transform themselves into a more processual mindset due to the rising complexity and diversity of the surroundings (Rasmussen 2011a). The image of GN Resound was an organisation that was affected by the cancelled sale to Phonak, which resulted in the fact that part of the management had left and the whole intention to be part of another organisation had to be revised. GN Resound had been in a somewhat stand by situation where they had reduced the development of new products due to the expectation that they were going to be on the same technological platform as Phonak. In such a process the company can lose customers and the employees will experience insecurity due to the fact that they do not know whether they will be taken over by another company or whether they can keep their job. This can take up a lot of place and remove the focus of the daily business. This combined with the fact that there were as mentioned several changes in the management and new systems were introduced without removing the old or integrating the new systems with the old systems meant that there seemed to be some sort of chaos dominating the daily routines.

The department did seem to go through several learning loops during the process, but the method did not become rooted in the organisation. For such a method to be rooted in an organisation such as GN Resound there must be a clear prioritisation from the top management. It is also necessary that the relevant competences are present in the company as there need to be a specified person that is responsible for the method and who has the competences to both make the narrative as well as the numerical simulations. Furthermore, this person needs to have the time allocated to do this so that it does not become an additional task that is not prioritised. It is also important that the responsible person is process oriented and interested in using the method to examine different possible paths. It appears that it can be difficult to use a method such as the CSA if it is not followed up by the management and several attempts have to be carried out. Furthermore, it is very important that the CSA process is used and supported by a certain management level and that it is implemented in several departments. Otherwise the knowledge and method become very personal and vulnerable to replacements of persons and competences. It is also necessary that the access to the systems is easy and structured. If too much time has to be used on finding the data and updating the data it can make the use of the models too complicated. To have such a method embedded in the organisation it is necessary that it is incorporated not only at the management level, but
throughout the organisation. It is necessary to change the attitudes and behaviour in the organisation in order to change the organisational culture so that it can incorporate such a method. Both responsibility and resources have to be allocated to the task and it can also be necessary that the responsible persons are measured through reports and goals until the process is incorporated. The Vice President of the Global Supply Chain did support the project and method and he did encourage the employees to use it, but it was stated in a way that it was up to them whether they would proceed with the method and process. This brings attention to the leadership of the Vice President of the Global Supply Chain. Leadership seen from an either rationalistic or processual organisational perspective has to be adapted to the situation in the company. Often the form of leadership rooted in the rationalistic organisational paradigm suits situations where the same product is produced again and again and the environment is stable and predictable. The form of leadership rooted in the more processual organisational paradigm can be more suited for situations where the product is customised and changes over time and where the environment is unstable and unpredictable. The situation in GN Resound at the time of the project can be described as somewhat unstable due to the fact that they were in the middle of a situation where the company was about to be sold. Furthermore, the life cycle of the products of GN Resound is short as it is approximately during the first three months after an introduction of a product that they make money on it. Furthermore, the technology development related to the production is quite fast. This means that the form of leadership appropriate at that time could be characterised as a more processual form. The company also found itself in a situation where new strategies had to be made and that also calls for that form of leadership.

“It will be quite different because the former Vice President of the Global Supply Chain (during the PhD project) was very focused on running the operation of the department, the following (after the PhD project) was a strategic manager and now (fall 2010) the manager is again focused on the operation” (Global Planning Manager (from 2010)).

Based on the above quote it appears that the Vice President functioning at the time of the project was more focused on running the daily operations than on making new strategies and incorporating them. There can be several reasons for the fact that it was difficult to embed the CSA method in the organisation at this point in time. The situation was not optimal for this as the focus was on the daily operation due to the fact that there seemed to be a form of chaos where new issues arose and had to be dealt with on a daily basis. This could also be seen from the fact that they did not follow the formal structure that was rooted in the rationalistic organisational paradigm in their daily work and this made the daily procedures and work structures ineffective. The employees saw themselves to be in a functioning bureaucracy, but
they were not as the daily routines were characterised by chaos both because of the external situation, but also because they make and incorporate new systems on top of the old systems without removing the old systems or considering what the problems were with the old systems. Organisations with strong cultures have moderately uniform values across various work groups where organisations with weak cultures can experience a range of subcultures, which operate independently, which makes it more difficult to build collective practices and processes (Debowski 2006). This could be seen in the fact that most employees attempted to sub optimise their own area rather than look at their own function related to the effectiveness of the whole organisation. This indicates that a change in the organisational culture is necessary in order to reduce this sub optimisation and instead focus on collaboration that optimises the entire network. The CSA has the potential to make the strategy process as well as the network itself more transparent.

Some of the obstacles that appeared to be present in GN Resound were for example the communication and cooperation across boundaries and hierarchical structures. There seemed to be a tendency to a form of silos between the departments both based on their subcultures and on their functions as well as location. This meant that it was difficult and time consuming to obtain knowledge across the organisation. This could be due to the fact that knowledge sharing was not directly encouraged, and therefore viewed as unproductive. When asked about their knowledge sharing systems it was not possible to get answers as to how they shared their knowledge in the company other than in the existing systems. As these systems primarily contained data regarding the products and so on and furthermore often was not updated it appeared that knowledge related to processes and difficulties was not stored in a way that could be shared. The effect of a lack of knowledge storing and sharing can be endless phone calls, e-mails, meetings, and confusion regarding responsibilities. All of these have also been observed in GN Resound and mentioned in the above.

The lack of knowledge sharing can also be grounded in knowledge exposure where the employees might fear exposure due to lack of confidence to the intentions of others; this can also be seen in the quote below.

“There have been some internal fights that sometimes have been more about the person than the belief and that is never healthy” (R&D Manager).

Another example could be the Global Planning Manager who did not actually correct scenario 2 even though it was wrong perhaps due to the fact that he actually did not know how it should look. Instead of sharing this with the author he let it proceed until the Vice President of the Supply Chain saw it and
corrected it. The above quote could also indicate that there existed a form of powerlessness in the department as they did not function as a bureaucracy, but more like a jungle. This made the employees focus more on performing according to short term goals rather than share knowledge. This is also based in their unsecure employment and quick changes in management as this also seems to become an obstacle for the corporation and correlation between departments. GN Resound was at the follow up in 2010 incorporating a system called a Control Tower as described earlier. This system was meant to draw data from the previous systems so that the collection of data would become easier and supposedly more correct – this is however still dependent on the fact whether the data is updated and the responsibility for the data quality was allocated to a specific person. This system was however only a system for the Global Operations division. The Financial department was at the same time making a system that they could use and the Sales and Marketing department had their own system. This means that three superior systems existed, but so far there was no intention of making them interlinked. This shows that the knowledge gained from the PhD project was not been embedded in the organisation as it takes time as well as an energetic and dynamic leader to create changes. The fact that the managers were changed constantly created a combination of ignorance and powerlessness and this is not suitable for learning or continuous improvement of horizontal or vertical collaboration.

Based on the above a collaborative environment seems to be the basis for a functioning knowledge-based organisation. The question is how to transform an organisation such as GN Resound in this direction. The attempts to implement new systems designed to ease the work processes and enhance the collaboration and communication seem to have failed. The task of modifying a bureaucratic culture can be a difficult one. Collaborative relations in a bureaucracy tend to be personal and linked to the hierarchy, rather than cutting across it, which also seemed to be the case in GN Resound as the loyalty of the Global Planning Manager for instance was towards the Vice President of the Global Supply Chain and as mentioned he did not find it interesting to pursue scenario 4 even though the Vice President of Component Manufacturing had actually shown interest for this scenario. This means that subordinates develop a loyalty to their managers, who bring their employees with them as they are promoted. This was also seen in GN Resound when the managers of the global Supply Chain were laid off a large part of their subordinates (though still at management level) were also laid off and new managers came. This can however mean that the trust and loyalty can become an issue in GN Resound as there have been many shifts in management indicating that it is better to sub optimise your own function than to actually create a collaborative environment based on knowledge sharing. The employees also appeared to feel solidarity with their own department and this structure of the informal organisation reinforced the barriers between functions and divisions. This was also seen in a workshop for better collaboration held at the Danish Manufacturing site prior to the CSA
project where employees from another department at the headquarter were invited to attend, but none of them showed up. This form of organisation where people informally know where to get the knowledge are sensible towards shifts as they can leave the people feeling confused and powerless which can also be seen from the above.

7.7 Conclusions

The CSA method did show different inconsistencies as to for example how the different departments seemed to sub optimise their own function as the systems showed they did not link together the right way. The whole process of data collection proved that the systems were not up to date and the process of collecting the data also showed that this data was not returned by some units. This indicates that the collaboration between departments did not function as each department seemed to focus on their own function, perhaps in order to survive the chaos, instead of looking at the entire network. This sub optimisation also resulted in a less transparent decision making process as the different units did not agree and collaborate making it difficult to understand certain decisions. The interaction between the two methods did result in enhanced communication between different functions for example at the workshop where different persons attended and did share their respective knowledge and used a new approach for sharing this knowledge.

The CSA project in GN Resound also made the author wiser as to how the method should be used and what issues will arise when using and trying to implement such a method. The CSA project in GN Resound was the first try out of implementing the CSA and many lessons can be learned from this. Experiences related to how the CSA should be carried out have been made and these experiences formed the background of initiating the second part of the case that will be dealt with more in the following chapter.
Chapter 8. Outsourcing, Offshoring, and Backsourcing
After the project with scenario 1, 2, and 3 was finished with GN Resound the researchers found it interesting to look further into scenario 4 (chapter 5). This scenario seemed interesting based on the fact that many companies outsource their production to countries where the salary is lower than in the Western countries. However, articles in newspaper and scientific journals are starting to appear indicating that several companies are beginning to back source their production due to problems with quality and delivery time resulting in more expensive total costs. Based on this the author arranged an interview with the Vice President of Component Manufacturing in GN Resound as it was his comments that in 2008 had been the reason for developing scenario 4. Based on this interview it was found that there was a potential to use the CSA in relation to GN Resound’s outsourcing strategy. It was arranged with the Vice President that a project could be made and master student Signe Arnklit was interested in working together with the author to develop the case regarding scenario 4. This case was planned in cooperation between the author and Signe Arnklit and was based on the author’s previous work with GN Resound and the methods. The collection of new data was gathered based on the already existing data. Some of the data was collected in cooperation whereas some of it was collected by Signe Arnklit and afterwards discussed by both researchers. In this way both researchers could use each other’s data to further develop the case. The chapter is structured so that first some new information regarding GN Resound is described as well as the focus of the new project. Following this a model of the process will be made and enhanced throughout the chapter in order to show how the process developed and to end up in a suggestion as to how a more general process structure could look. Following this the scenarios and the numerical simulation will be described. Finally the results will be listed and the interaction discussed.

8.1 Scenario 4
In 2001 GN Resound relocated the assembly of hearing aids to Xiamen in China in order to reduce the salary costs. This offshoring strategy is in line with the general tendency that has been observed in Europe and the US over the last couple of years. Since 2003 GN Resound has outsourced activities that are deemed not to be core competencies and this is an ongoing process. GN Resound has in this period outsourced design and production of die casting tools as well as production of plastic parts. These suppliers are located in China:

- Polygon, which is the supplier that the purchasing department is focusing on, is located 1500 km from GN Resounds factory in Xiamen.
- XPT is located less than 100 km from the factory in Xiamen.
At GN Resound’s headquarters the hearing aids are designed using in 3D on a computer and it is also at the headquarters that the tool shop is located. There are 15 employees in the tool shop producing die casting tools. The tools are divided into five categories from plus 2 to minus 2, plus 2 being the most complex. The simplest tools are made at suppliers in China; these suppliers are Polygon, XPT, and Audix. Polygon is expected to deliver new tools in the categories plus 1 and 0, XPT is expected to deliver tools in the categories minus 1 and minus 2, and the corporation with Audix has proved to unsatisfactory leading to GN Resound terminating the cooperation. The Chinese suppliers are very price focused and this often leads to the suppliers setting the price in order to win the order, but this way the set price do not always reflect the reality.

Besides the Chinese suppliers there are also some Scandinavian suppliers that delivers plus 1 tools. They could also deliver plus 2 tools, but this is too pricy. It is estimated that the Chinese suppliers will not have developed their competences within the next couple of years to be able to deliver plus 2 tools. Both employees in the tool shop and the vice president of component manufacturing expects that the amount of complex tools will increase over the next years.

The scenario cross in chapter 5 showed four scenarios, but as mentioned only three of the scenarios were examined in cooperation with GN Resound (2008). The fourth scenario was not found interesting at the given time (2008) as it separated the production into a production site in Denmark and GN Resound’s factory in Xiamen, China. At the time (2008) the stake holders in GN Resound predicted that within a time frame of five years the production in Denmark would be moved to China resulting in no production site in Denmark. However, in 2010 GN Resound still had a production site in Præstø and the Vice President of Component Manufacturing as well as other employees at the production site had the opinion that their share of the production would increase due to problems related to quality and delivery time at the third party suppliers in China. He found that especially the hidden costs related to offshoring such as travel expenses, communication where conference calls are made on mobile phones were not taken into account when GN Resound made their offshoring strategy. This indicates that there are a lot of costs related to outsourcing and offshoring that are not discovered until after the processes have been relocated. (Madsen, Riis et al. 2008).
The figure shows how different levels of experienced task uncertainty and complexity make up four different work situations, which require different competencies, means, and institutional support. They also rely on different representations of knowledge (Madsen, Riis et al. 2008, Cheng, Madsen et al. 2010). These four different situations indicate that depending on the task it can be difficult to relocate the process and make a knowledge transfer. This is also what GN Resound has experienced in relation to their production processes as some of them were backsourced to the Danish production site due to the fact that the products have become so complex that the suppliers do not have enough knowledge to make them. Additionally, the suppliers have not been able to operate some of the die casting tools due to their increasing complexity. Based on these issues the researchers contacted the Vice President of Component Manufacturing in order to discuss the possibility of using the CSA on the above issues. The project was discussed and the following focus was considered:

- Examination of the costs related to GN Resound’s outsourcing strategy
- Which factors and trends affect GN Resound’s outsourcing strategy
- How can the fast technological development affect GN Resound’s outsourcing strategy
- How can the CSA make GN Resound’s outsourcing strategy more transparent and dynamic

The Vice President of Component Manufacturing found the CSA interesting to use in relation to GN Resound’s outsourcing strategy. Before the meeting the researchers had thought about possible variables that could be interesting to discuss in relation to GN Resound and to discuss possible variables is also a way to explain and discuss the use of the CSA. The variables were:

<table>
<thead>
<tr>
<th>Salary costs</th>
<th>Coordination (project management)</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery on time</td>
<td>Other costs</td>
<td>Quality of components and parts</td>
</tr>
<tr>
<td>Increased complexity</td>
<td>Time to market</td>
<td>Communication</td>
</tr>
<tr>
<td>Risks</td>
<td>Knowledge sharing</td>
<td></td>
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</tbody>
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*Table 8.1: Possible variables*
The above variables were based on literature studies and the current trends and found interesting by the researchers as they are relevant for an outsourcing process and for the technological development. Based on these observations as well as the discussion with the Vice President of Component Manufacturing a new scenario cross based on scenario 4 was developed.

The scenario cross was again used in order to help structure the scenarios and to ensure that they are all different. Based on the dialogue with the Vice President of Component Manufacturing it was decided to question the chosen outsourcing and offshoring strategy in GN Resound and this also became the basis for the first axis in the new scenario cross.

- The degree of production that has been either outsourced or insourced

The vice president of component manufacturing seriously questions whether GN Resound is actually cutting costs when they outsource the tools and parts they do at the given time (summer 2010). Furthermore, there has been an increased focus on backsourcing or insourcing in the literature and it is being examined in diverse countries and industries. In GN Resound it was also found by the researchers and several employees that it could be interesting to examine as some persons in the company had a tendency to think that once a strategy had been chosen you sometimes just had to follow that line without questioning. This indicates that there exist a disagreement in GN Resound in relation to the outsourcing strategy. This disagreement makes it interesting to use ‘the degree of production that has been either outsourced or insourced’ as an axis. The outsourcing strategy in GN Resound is by some seen as more an economic strategy than a technical strategy.

The second axis was a choice between two possibilities; either the geographical location of GN Resound or the technological development. After discussions with the Vice President of Component Manufacturing it was decided that it could be interesting to examine whether the spread geographical locations have an effect on the production and development. It was also found interesting to examine how the technological development would affect the outsourcing strategy. The original reason for offshoring in 2001 was made based on the differences in salary levels for manual work between Europe and Asia. The salary level in Asia has increased since 2001 and GN Resound is therefore considering whether they should move the factory to another country where the salary level is lower. However, the vice president of component manufacturing do not think that this is viable in the long run and would like GN Resound to consider a more long term stable and competitive solution. He is of the opinion that there could be a great potential in making the assembly process automated as this would reduce GN Resounds dependency on salaries.
Furthermore, he is of the opinion that this could be done in connection with gathering the whole corporation in one place. The second axis of the scenario cross is:

- The degree of automation

There were also considerations as to whether the second axis should be related to costs. However, this was found to be unsuitable as GN Resound the degree of automation was deemed interesting by both the researchers and the managers in GN Resound as this is a trend that can have a major impact on the way GN Resound produces hearing aids.

After the definition of the two axes of the scenario cross the work of gathering data in order to define the new scenarios began as can be seen in the figure below.

![Figure 8.2: The process stage 1.](image)

This figure shows the process of developing scenario 4 into four scenarios. This figure will be expanded throughout the chapter in order to show how the process developed. The development from scenario 4 into four new scenarios is a process of interaction between the researchers and the managers in GN Resound. This interaction is a very important part of the process of developing new scenarios as the knowledge sharing between the researchers and managers happens here. This part is also where a lot of data generation takes place as the researchers have to collect knowledge in order to understand the company and the situation. The data gathering took place through interviews as well as stays in the company both at the production site, but also at the head quarters. This gave a profound understanding of the company and the structure as well as of how the scenarios should be developed. The development of the four scenarios was made through interaction with the managers. The four scenarios are all different and all based on the discussions with the Vice President, the trends of the hearing aid industry, and possible changes in the environment and supplier situation. The scenario cross with the two axis and the four scenarios can be seen in the below figure.
Figure 8.3: The new scenario cross

This figure shows how the four new scenarios look. These scenarios will be further examined in the following.

8.1.1 Scenario A

In scenario A the assembly of the hearing aids is made manually as is the case in 2011. This scenario is the one that comes closest to the set-up in GN Resound in 2011. It quickly became clear that several sub scenarios were needed for scenario A. This is based on the fact that the outsourcing strategy in GN Resound has a focus on constantly outsourcing a larger part of the production to suppliers in China.
There are also several uncertainty factors related to scenario A such as the possibilities of changes in the Chinese market and society. The risk of political disturbance, changes on the regional plan, and increases in the salary level are all factors that GN Resound has to take into account.

8.1.2 Scenario B
In scenario B GN Resound forms a strategic partnership with another company. The strategic partner handles all production of plastic tools, plastic parts, and hybrids. The level of automation is high in scenario B in relation to the assembly of hearing aids. The strategic partner has the competences to assemble the hearing aids through an automated process at a competitive price. The partner most likely also has automated production of plastic parts and tools.
Figure 8.5: Scenario B

GN Resound would most likely choose between two strategic partners. One that produces hybrids and one that produces plastic parts. This is a way to reduce the strategic risk. GN Resound has in 2010 collected prices from SVI which is an electronic supplier in Thailand. At the given time the price at the supplier was the same as the one the Præstø location could deliver.

This scenario is evaluated to be further out in the future as a fully automated assembly process is not evaluated to be realistic within the next 3-4 years.

“In relation to scenario 4 it could be interesting to see if Præstø could be a fully automated hearing aid producer. I just do not think this company is ready for that”

(Global Planning Manager (from 2010)).

Even when the technology is mature it is not sure that the hearing aid business will invest in this due to the fact that the hearing aid business is characterised by small volumes, high complexity, small parts that have to be assembled precisely, and relatively short product life cycle. This means that return of the investment will be difficult to achieve. The scenario is nonetheless relevant as there is a large potential in having an automated assembly process. It would according to the Project Manager in R&D require a different way of thinking and a different process. If a platform approach was introduced automation would be more relevant.
Due to the fact that an automated assembly process is evaluated to be 7-10 years away this scenario is not investigated further. It can however be of great consequence for GN Resound as it could be in line with GN Resounds current strategy of reducing all activities that are too costly. With an automated process the salary level would decrease in relation to the total costs of a product and the location of the assembly process would be of minor importance.

### 8.1.3 Scenario C

This scenario also has a high level of automation. The focus of the strategy as moved to GN Resound producing more of the plastic tools, plastic parts, and hybrids internally. The automated assembly process means that the assembly of the hearing aids is more independent of the salary level, meaning that the assembly can take place in Denmark. All activities in the company are gathered at one location which can create synergies.

![Figure 8.6: Scenario C](image)

The gathering of activities can result in reduced costs on location and maintenance of properties. Furthermore, GN Resound can achieve economies of scale. The scenario will also result in a reduction in travel expenses to their own factory in China such as in scenario A and B. GN Resounds direct travel expenses each year are app. DKK 23 millions. In addition to this there are all the resources that are lost in the daily work due to the travelling. All costs related to the cooperation with suppliers will be eliminated as well as costs of communication.
This scenario is as scenario B not investigated further as the technology is not mature. Furthermore, GN Resound set up in relation to development and design of hearing aids also hinders this. GN Resound should in theory use a platform approach, which means that they in the long run could optimise the development and production, but this is by consultants and project managers at GN Resound deemed not to be possible. However, the scenario is highly relevant due to the synergetic effects of having all activities gathered in one place.

8.1.4 Scenario D

This scenario is characterised by a low degree of automation. The hearing aids are assembled manually a GN Resounds own factory in an East European country such as Czech Republic. The head quarter and the research and development department are located in Copenhagen and the production site in Præstø. The production site is expanded and the capacity is enhanced. The capacity at the toolshop at the head quarters can also be enhanced. All activities are in-house.

Figure 8.7: Scenario D

The coordination and control of suppliers are eliminated and the employees can focus on their core tasks. The travel expenses are drastically reduced. Visits to the factory in Eastern Europe can be made in one day in comparison to visits to the factory in Xiamen, which typically takes 5-7 days. This means a reduction in costs related to travel and stay.

Scenario D is very realistic, but is not located within GN Resounds current outsourcing strategy (2010/2011). The resources that GN Resound have used in order to qualify their current suppliers as well as
the costs of re-establishing the offshoring part in a new country have to be taken into consideration. The costs of re-establishment must be considered to be the same as if GN Resound moves their factory in Xiamen to another country in Asia.

Based on the process of developing the four scenarios it became clear through the cooperation with the Vice President of Component Manufacturing that he seriously questions the current outsourcing strategy in GN Resound and therefore wished for three sub scenarios in scenario A in order to test different possibilities.

![Figure 8.8: The process stage 2](image)

This is also shown in the above figure as it shows how scenario A was developed into three part scenarios through interaction with the managers.

### 8.1.5 Scenario A2

The three sub scenarios under A differentiate from each other in the level of how much production is outsourced to third party suppliers:

- **Scenario A1**: The third party suppliers produce all plastic tools, all plastic parts, and all hybrids.
- **Scenario A2**: The suppliers produce approximately 65% and GN Resound produces the remaining 35%.
- **Scenario A3**: GN Resound produces 65% plastic tools, plastic parts, and all hybrids and the Chinese third party suppliers produce the remaining 35%. The suppliers produce the most simple tools and parts.

It quickly became evident as the development of the scenarios took place and through discussions with the Vice President that scenario A2 was interesting to pursue as it resembles the situation that GN Resound was in at the time (2010/2011). Furthermore, the Vice President of Component Manufacturing found it interesting to identify the total costs related to GN Resounds current outsourcing strategy for plastic tools.
in order to compare the current situation with new possible situations. In this scenario the head quarters and the research and development department are located on the same address. There is also production outside the major city as well as a larger factory in China where the hearing aids are assembled. GN Resound cooperates with two or three carefully selected Chinese suppliers and some suppliers from Northern Europe that are specialised in making plastic tools. In relation to electronic components the company cooperates with a large manufacturer in Thailand called SVI. The set up can be seen in the figure below.

Figure 8.9: Scenario A2.

Scenario A2 poses a challenge in developing all tools in due time and in a proper quality so that the tools can be used in the planned production of plastic parts. It is also a demanding task to get the production of plastic parts at the Chinese supplier to run timely. Moving a tool from GN Resound in Denmark to a supplier in China is a difficult task in reality. The scenario is chosen as the reference scenario as it is close to the current situation in GN Resound (2010/2011). Due to this scenario A2 became the basis for the first numerical simulation. The other scenarios can also be pursued and be analysed as A2 will be in the following, but the focus is on A2 due to the fact that it is close to the current situation, and therefore the Vice President would like to be able to compare the then current situation with new possible scenarios.
Figure 8.10: The process stage 3

The figure shows how the process has developed. The starting point was scenario 4 which through interaction between the researchers and the managers at GN Resound was developed further into scenario A, which was again developed into three scenarios of which A2 resembles the current situation the most, and therefore A2 was chosen as the reference scenario and can now be simulated upon.

8.2 The Numerical Simulation

In order to question the current outsourcing strategy it is interesting to identify the total costs are interesting to identify s the vice president has the impression that too many resources are being used to control and support the suppliers. The tool shop in Copenhagen is often criticised because they continue to hire people as the suppliers are not good enough at tool design (Project Manager in R&D SÆT REF MAN).

In combination with the increasing prices in China the setup is questioned and the total costs relevant to identify in order to look at the hidden costs for a product. There are different costs to consider when determining the total costs for example the hidden costs.

Some of the costs can be found in GN Resounds budgets for the suppliers. Other costs such as costs of travel and stay for the trips related to visits to the suppliers in order to ensure that the quality is in accordance with the agreed standard can also be found in the budgets, but are not directly tied to the use of suppliers. The time used by consultants and employees at the suppliers should also be calculated in the costs. The output of the model should be the total costs for GN Resound in relation to producing a die casting tool that can be approved and used in the plastic part production.

Based on several interviews both at the production site as well as the head quarters a list of primary costs was made in interaction with the managers. This list was also inspired by information found in internal documents, strategies for the tools and articles (Song, Platts et al. 2007, Kumar, Zampogna et al. 2011). It
was important to discuss and make the list together with the managers as did would improve the different forms of simulation and make them more realistic. The costs are:

- Tool production
- Approval of tools
- Production of plastic parts
- Approval of plastic parts
- Reparations
- Materials
- Shipment
- Travel
- Investments in machines
- Maintenance of machines
- Qualification of suppliers (beginning)
- Qualification of suppliers and training (continuously)
- Cooperation of improvement and innovation
- Adaptation of procedures

After the list was made in interaction with the managers the list was also discussed and approved by several stakeholders – two consultants from the R&D department and production site, the vice president of component manufacturing, and the vice president of purchase. The stakeholders added the following points:

- Coordination between GN Resound and suppliers
- Communication

These points are also very important and show how crucial it is to discuss and develop the content of the scenarios further in interaction with the stakeholders. This also shows how the development of the numerical model (input to the numerical model) can be a basis to develop the content of the scenarios further. GN Resound is terminating the task to the Audix supplier in China, and therefore they are not part of the narrative simulation nor the numerical simulation.

### 8.2.1 Input variables

The program ProModel is used to make the numerical simulations and the different input variables and data related to the input variables will be described in the following. The first variable to the numerical
model is the costs that can be found directly in the budgets for the suppliers and consist of the number of tools GN Resound has planned to produce in 2011 as well as the related costs per tool. The table below shows how many tools are planned for and the responsible supplier.

<table>
<thead>
<tr>
<th>2011</th>
<th>Expected division of tools (amount)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Category</td>
</tr>
<tr>
<td></td>
<td>Plus 2</td>
</tr>
<tr>
<td></td>
<td>Plus 1</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Minus 1</td>
</tr>
<tr>
<td></td>
<td>Minus 2</td>
</tr>
</tbody>
</table>

Table 8.2 Expected tools in 2011(GN Resound)

The related prices for a tool can be seen in the table below. The price is related to the complexity of the tool and the supplier. The prices have been given by the manager of the tool shop.

<table>
<thead>
<tr>
<th>2011</th>
<th>Toolshop</th>
<th>Scandinavian supp.</th>
<th>Polygon</th>
<th>XPT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Category</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plus 2</td>
<td>414.000</td>
<td>550.000</td>
<td>(252.000*)</td>
</tr>
<tr>
<td></td>
<td>Plus 1</td>
<td>272.000</td>
<td>350.000</td>
<td>138.000</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>207.000</td>
<td>-(B)</td>
<td>120.000</td>
</tr>
<tr>
<td></td>
<td>Minus 1</td>
<td>138.000</td>
<td>-(B)</td>
<td>90.000</td>
</tr>
<tr>
<td></td>
<td>Minus 2</td>
<td>92.000</td>
<td>-(B)</td>
<td>45.000</td>
</tr>
</tbody>
</table>

(A) Polygon can give an offer on category plus 2 tools, but cannot tools that can be approved. This is also true for XPT in relation to complex tools according to the manager in the toolshop.
(B) GN is not interested in having the Scandinavian suppliers delivering 0, minus 1, and minus 2 tools as it is found by the manager in the toolshop that the Scandinavian suppliers cannot compete with the Chinese suppliers.

Table 8.3: Tool prices in 2011(GN Resound)

In the numerical model the data is pulled from an excel sheet. This means that results of the model are dependent of this sheet and if changes are made in the sheet the results will also change. In the numerical model the prices of the tools are collected in one variable for each supplier. The variables contain the following information:

- “b toolshop1” - the cost of having the tool made at the GN Resound tool shop.
- “b toolshop supplier EU” – the cost of having the tool made at the Scandinavian supplier.
• “b Polygon” – the cost of having the tool made at Polygon.
• “b XPT” - the cost of having the tool made at XPT.

The names of the variable were made by the researchers and the b in front of the name means that these are the costs that can be found directly in the budgets. The four variables are gathered and can be read in the variable “D Direct”. D in front of the name means that it is an output variable.

To be able to find the total costs the hidden costs and the costs of resources have to be added.

The hidden costs are related to four different types of employees that travel to ensure that the tools made by the suppliers can be approved. The four groups are:

1. Employees in R&D that work with design of plastic parts and must approve the tools
2. Employees in Production that work with ramp up and must approve the tools
3. Employees in Purchasing who select and cooperate with the suppliers
4. Employees in Purchasing in Xiamen who have the most contact with the Chinese suppliers

The costs all relate to air travel expenses, other transport, hotel, and other living expenses such as food. Furthermore, the costs contains the price of the time not spend on regular work. A trip to China always last at least a working week and a project manager in R&D has calculated that it costs app. DKK 550 per hour as this is standard for the hourly wage this type of consultants costs internally at GN Resound. The vice president of component manufacturing has validated this price. The table below shows the costs of travel.

<table>
<thead>
<tr>
<th>Costs for Danish specialist per trip to a Chinese supplier in DKK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane ticket – ordinary</td>
</tr>
<tr>
<td>Stay</td>
</tr>
<tr>
<td>Resources (40 hours * DKK 550)</td>
</tr>
<tr>
<td>Plane ticket – immediate problem</td>
</tr>
</tbody>
</table>

Table 8.4: Cost of travels to China(GN Resound)

These costs can also be read in the numerical model:

• “C3P DK travelsupport Polygon” – for travels to the supplier Polygon.
• “C3X DK travelsupport XPT” – for travels to the supplier XPT.
The names of these variables were also made by the researchers and the C in front means that this is hidden costs. The resources used for project management are divided on to the four types of employees mentioned above. The Danish consultants work on making the specifications very precise and detailed. A lot of time is used on coordination and communication in order to minimise the misunderstandings between GN Resound and the suppliers. The costs of the resources that the Danish consultants use to coordinate with the two suppliers can be seen in the following two variables:

- “C2P Polygon support” contains the costs related to the supplier Polygon.
- “C2X XPT support” contains the costs related to the supplier XPT.

The Chinese employees in Xiamen work together with the Chinese suppliers and are all engineers, SQEes Super Quality Engineers. The costs of these employees are based on an estimate from Danish employees at management level. The variables represent costs of salary and travel expenses in relation to cooperate with the suppliers:

- “C1P support Polygon SQE GN” – for the costs of working with Polygon.
- “C1X support XPT SQE GN” – for the costs of working with XPT.

Below a table shows the sum up of all the input variables described above.

<table>
<thead>
<tr>
<th>Input Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>• B toolshop1</td>
</tr>
<tr>
<td>• B tooldesign supplier EU</td>
</tr>
<tr>
<td>• B Polygon</td>
</tr>
<tr>
<td>• B XPT</td>
</tr>
<tr>
<td>• C3P DK travelsupport Polygon</td>
</tr>
<tr>
<td>• C3X DK travelsupport XPT</td>
</tr>
<tr>
<td>• C1P support Polygon SQE GN</td>
</tr>
<tr>
<td>• C1X support XPT SQE GN</td>
</tr>
<tr>
<td>• C2P Polygon support</td>
</tr>
<tr>
<td>• C2X XPT support</td>
</tr>
</tbody>
</table>

*Table 8.5: The input variables.*

The table shows the input variables that were developed for the model. As mentioned the names of the input variables are made up by the researchers, but are based on the name of the different suppliers as
well on the fact that they represent costs and hidden costs. Where B represents that the cost can be found directly in the budget for the supplier whereas C more relates to a hidden cost.

8.2.2 Output Variables
The output variables of the numerical model are based on different types of costs and are meant to show the hidden costs and the total costs. The different costs can be seen in the variables below:

- “D1P total cost” - the total hidden costs related to Polygon.
- “D1X total cost” – the total hidden costs related to XPT.
- “E GN Plasticrelated” – the total cost of producing die casting tools.

The variable “E GN Plasticrelated” can be compared to GN Resounds budget for producing die casting tools. The difference is the extra costs GN Resound has by using Chinese suppliers instead of Scandinavian suppliers.

<table>
<thead>
<tr>
<th>Total Costs*</th>
</tr>
</thead>
<tbody>
<tr>
<td>- D Direct</td>
</tr>
<tr>
<td>- D1P Total cost (Polygon)</td>
</tr>
<tr>
<td>- D1X Total cost (XPT)</td>
</tr>
<tr>
<td>- EGN Plasticrelated</td>
</tr>
</tbody>
</table>

*In relation to the production of die casting tools

Table 8.6: The output variables
The table above shows the different output variables. The names of the output variables are as mentioned made by the researchers and the D in front represents that it is an output variable.

8.2.3 The Simulation Model
Based on the above information and data the numerical model was build. The figure below shows how the model looks in the modelling program ProModel, which was the same program that was used for the other scenarios in chapter 5. The model is build in a way so that it is possible to follow the number of produced tools and in the same way be able to follow the different types of costs related to the production of each tool.
Figure 8.11: The simulation model

The simulation model shows Danish site as well as the Chinese site. Below there are numbers showing how many tools have been made and also follow the different related costs. These numbers are shown as a function of time. The model shows the costs of producing the 122 tools that GN Resound makes in a year. The different results can also be seen in the output file below.
Figure 8.12: The output file

In the above figure the output file from the simulation can be seen. This file is generated after the simulation has run and shows the different key figures. The variable "D Direct" shows that the costs of producing the 122 tools a year are MDKK 23.19. The other relevant costs can also be read from the figure above. These are "B Polygon" which is the cost of the tools that Polygon has produced, this costs is MDKK 6.44. The figure above shows the costs at a given time whereas the development of the cost can be seen on the next figure. Here it can be seen that the cost of the tools Polygon has produced is the most expensive.
The red line shows the cost of having XPT producing the tools which are MDKK 2.35. The third most expensive cost is represented by the dark blue line, which are the costs of project management for Polygon. This can be read under “C2P Polygon Support" at MDKK 2.41. This indicates that the prices at Polygon are app. 57% higher than the price the Purchasing Department uses to decide which supplier to order the tools from. For XPT that delivers more simple tools the cost is 21% higher in 2011.

The total hidden costs of using Chinese suppliers in 2011 can be found by adding the results from "D1X total cost" and “D1P total cost”. This amount adds up to MDKK 4.15. If this amount is added to the “D Direct” the number that is found in the variable “E GN Plasticrelated” comes out. This shows the total costs of producing die casting tools and is MDKK 27.34. The simulation also shows the added costs of using the Chinese suppliers that give the indication of how much it really costs to use them compared to the prices that the Purchasing Department base their decision on.

During November and December 2010 GN Resound again made a case study where they examined the potential and consequences in regards to outsource the hybrids. This case study showed that it at the time would not be profitable for GN Resound to pursue an outsourcing of the hybrids. This case study together with the above simulations made it more interesting to continue with the process of further developing scenario A2.
The above shows how based on the first interaction between the narrative and numerical simulation four new scenarios rooted in scenario A2 can be developed through interaction between the researchers and the managers in GN Resound. Therefore, the following is based on a further development on scenario A2 under the assumptions that changes will happen.

8.3 Further Development of the Narratives and the Numerical Model

The numerical model showed that there is a relevant discussion in questioning whether the current set up is economically viable. There appears to be some trends that are important to consider in relation to the hearing aid industry.

- A continuing outsourcing of die casting tools and the production of plastic parts
- A larger part of complex die casting tools
- A significant difference between the price development in China and Europe

These trends have been developed through interaction with the Vice President of component manufacturing and other managers. The first trend is related to GN Resounds outsourcing strategy which has been the focus of the company for the last years. The superior goal has been to outsource as much as possible. Activities that are not viewed as core competencies have to be outsourced. This is done to free as much capital as possible in order to invest in the core competencies, which in GN Resound is viewed to be developing hearing aids.
GN Resound consider to outsource more than just the die casting tools and the plastic production, they also continually consider outsourcing the hybrid if this is economically viable. But as mentioned above the latest case study of outsourcing the hybrid showed that it was not profitable at the given time.

The second trend can be seen in relation to the design of the die casting tools which is becoming more and more complex and critical.

This point of view is shared by many in the company both in the R&D Department and in the Production Department as most managers and employees expect the complexity to increase over the next couple of years.

The third trend is an expectation that the price development in China is expected to happen faster that the price development in Europe. This is seen as a major challenge.

A research among more than 7000 companies in China showed that they expect an increase in salaries in 2011 of app. 9% (China Daily 2012). A Danish company T-Rex making effect pedals has experienced an increase of 30% over the last two years resulting in the company backsourcing their production to Denmark (http://www.e-pages.dk/budstikken/1324/8). GN Resound has also experienced an increase of 10% during the last couple of years in their factory in Xiamen and are expecting to rise further.

The Suisse Bank Credit Suisse has developed an analysis of China and its development toward 2015. It has to suggestions that are both based on lower growth than China is expected to have. Credit Suisse expects an annual increase of 19% in China until 2015. The more conservative expectation is set at 14%.

8.3.1 The Development Until 2015

Based on interactions with the Vice President, the initial simulations, and the above trends four new scenarios have been developed and deemed interesting to simulate numerically by the Vice President of Component Manufacturing. The scenarios can be seen in the figure below.
Figure 8.15: The development from 2011 to 2015.

All of the scenarios on the figure have taken the price development into consideration. This means that the price developments used for these scenarios are 14% for the Chinese suppliers and 3% for GN Resound in Denmark and the Scandinavian suppliers.

The above shows how the reference scenario A2 has been developed into four further specified scenarios. This process can also be seen in the model below.
8.3.1.1 Scenario A2a

This scenario is a further development of the reference scenario the only difference is the price development as described in the trends above. In this scenario there are to be produced app. 122 new tools in 2015 and the complexity of these tools is the same as in the reference scenario. The division of tools between the three types of suppliers is the same. This means that the amount of travel to China and the amount of project management must be the same as in 2011. The result of the simulation is that GN Resound in 2015 can expect a total cost of producing tools at MDKK 35.43 (in 2011 it was MDKK 27.34). This is an increase of app. 30% which is due to the price development in China.

8.3.1.2 Scenario A2b

This scenario is according to consultants and employees in GN Resound the most likely scenario in 2015. Based on this scenario the expected costs of producing the tools will be MDKK 39.34 meaning an increase of 44% from 2011. In this scenario the hidden costs stands for 33% of the costs to Polygon and 10% for XPT. The result is based on the division between GN Resounds tool shop, the Scandinavian suppliers, and the two Chinese suppliers is the same as in the reference scenario. This means that all the suppliers will produce the same amount of tools as in 2011, but Polygon will have to produce more complex tools (category plus 1). Another assumption is that the Danish consultants have to visit the Chinese suppliers the
same amount of time as in 2011. This is a realistic assumption as the complexity of the tools in this scenario has increased. Persons in GN Resound are also questioning whether the Chinese suppliers have the ability to be able to qualify themselves so that they can produce plus 1 tools without aid and support from GN Resound. If all the hidden costs are disregarded in this scenario the costs of producing the 122 tools in 2015 amounts to MDKK 32.72 which is an increase of 41% from 2011.

As this is deemed the most likely scenario in 2015 it is also relevant to look into consequences and risks other than the economic. One of the most important issues is the quality of the products. Several employees question whether Polygon will be able to produce the desired quality as GN Resound before has been forced to backsource several of their plus 1 tools as Polygon cannot deliver the desired quality. This also effects the delivery time which is another critical issue. If GN Resound has to backsource it also causes delays in the delivery time, which can be critical in the hearing aid industry as products have an app. life cycle of 3 months.

<table>
<thead>
<tr>
<th>Number of tools in category:</th>
<th>2010</th>
<th>2011</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plus 1</td>
<td>5</td>
<td>25</td>
<td>48</td>
</tr>
<tr>
<td>0, minus 1, minus 2</td>
<td>14</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Amount with quality issues:</td>
<td>4</td>
<td>9?</td>
<td>9?</td>
</tr>
<tr>
<td>Amount with delays:</td>
<td>13</td>
<td>29?</td>
<td>29?</td>
</tr>
</tbody>
</table>

Table 8.7: Illustration of what Polygon has produced and shall produce

In 2010 four of the new tools were delayed which is the same as 18% and 13 tools (not new) were delayed meaning that app. 60% of all the tools were delayed. Most (11) were less than seven days delayed. If this is assumed to be the level this will mean that 9 of the tools in 2011 will not live up to the agreed quality and 29 tools will be delayed. Delays can have a direct effect on the performance of the company. Especially as the products have a very short life cycle on the market.

8.3.1.3 Scenario A2c

This scenario is based on the idea that all tools despite of complexity are outsourced to 2-3 Chinese suppliers. The cost increases accordingly to the conservative price development at 14%. The price set for the plus 2 tools is fictive as no one interviewed at GN Resound found it likely that the Chinese suppliers would be able to produce approvable plus 2 tools. In the numerical simulation the result is that the costs will be MDKK 39.83. This is the most expensive of the simulations. Hidden costs and project management amounts to MDKK 11.87 and the costs amount to MDKK 27.96.
This scenario is highly relevant as it is close to the current outsourcing strategy in GN Resound.

8.3.1.4 Scenario A2d

If the complexity of the tools do not increase over the next couple of years this scenario can be highly relevant. This scenario will then mean a reduction in the costs for GN Resound. The result of the simulation is that the total costs are MDKK 35.52 whereof MDKK 9.13 are used for hidden costs and project management.

In the above numerical simulations were carried out for the four new scenarios in order to determine what changes in the current situation may result in. Based on these new numerical simulations scenario A2b and scenario A2c were deemed most realistic by the Vice President of Component Manufacturing, and therefore they became the basis of the further development.

Figure 8.17: The process stage 6

The figure above shows how the process looks at this stage where scenario 4 will be developed into scenario A2b(1) and A2b(2).
8.3.2 Further Development

The models can be even further developed based on the new simulations. Scenario A2b is the basis of developing the scenarios further as scenario A2c is focusing on total outsourcing to Chinese suppliers and the costs of this has been found in the above simulation. The new alternatives shows the total costs if a larger part of the new tools were produced at the tool shop in GN Resound or by the Scandinavian suppliers and can be seen in the figure below.

![Diagram showing new alternatives for GN Resound](image)

**Figure 8.18: New Alternatives for GN Resound**

The figure above shows how scenario A2b can be further developed into scenario A2b(1) and A2b(2) in order to compare a total outsourcing as in figure A2c to a larger degree of backsourcing. The figure shows that the two new scenarios differ in how much GN Resound will produce inhouse. The above scenarios are also based on the same price development as mentioned earlier, 14% for China and 3% for Scandinavian suppliers and GN Resound.
8.3.2.1 Scenario A2b(1)
In this scenario the Scandinavian suppliers produce all plus 1 tools. Plus 2 tools are produced by GN Resound. The minus 1 and minus 2 tools are produced by 1-3 Chinese suppliers. The division of tools is unchanged, meaning that there are no category 0 tools, in order to be able to compare the different scenarios. The result of the numerical simulation for scenario A2b(1) is that the total cost will be MDKK 38.37, which is app. MDKK 1 less than in the reference scenario A2b. In the numerical model XPT is producing all minus 1 and minus 2 tools, which is based on the many challenges GN Resound has had with Polygon. It is also based on the fact that XPT is based 100 km from GN Resounds factory in Xiamen whereas Polygon is based 1500 km from the factory. The shorter distance makes it easier to build a close relationship with the supplier and possible through the use of less resources. Furthermore, the budget is expected to be more predictable as the Scandinavian economies are predictable than the development in China.

8.3.2.2 Scenario A2b(2)
In this scenario all complex tools (plus 1 and plus 2 are produced in house. The numerical simulation shows that this will cost MDKK 35.15. However, the Vice President of Component Manufacturing questions whether all hidden costs to employees has been calculated. The calculation has been documented by a superior employee. Even though the costs could be closer to the Scandinavian suppliers (at MDKK 38.37) they do not exceed the MDKK 39.34 that a continuous production of plus 1 tools Polygon will cost.

If GN Resound should produce 95 new tools in house they would have to increase their capacity and increase their number of employees. The cost of more employees is used in the calculation for this scenario. The tool shop would have to be enlarged, but there is space for this at the head quarters due to the consolidation of the global distribution centers (see chapter 5). XPT is still used to produce the more simple tools in this scenario both because of the fact that GN Resound has a factory and distribution centre in Xiamen, but also since the prices of producing the tools in house at GN Resound is somewhat questioned.

With this scenario GN Resound also decreases the risks that are related of losing a critical important supplier as well as having a supplier in a politically more unstable country. Furthermore, GN Resound reduces the risk of suppliers revealing patents and other important information. Another gain is that the R&D department is located close to the actual production of tools meaning that important knowledge sharing is made easier and faster as the two departments are actually located within walking distance from each other.
After this the process was stopped. The process can of course continue and could also be iterative in itself so that there was an arrow pointing to scenario 4 in order to get new ideas in relation to this and possible to the original scenarios 1, 2, and 3.

8.4 The Results

The numerical simulations have shown results for the total costs GN Resounds outsourcing strategy in relation to several different scenarios. The different scenarios can be compared directly and the costs found are related to costs and hidden costs including travel expenses, project management, and used resources. The results of the numerical simulations can be seen in the figure below.

Figure 8.19: The results of the numerical simulations

The figure is a way to show how much it will cost GN Resound to follow a given strategy based on the same input variables. It shows the new scenarios with the results in order to compare them directly. The most
expensive strategy to follow is Scenario A2c which is the scenario that focuses on an outsourcing strategy where 100% of the activities are outsourced to Chinese suppliers. The least expensive strategy to follow is Scenario A2b(2) where all the complex tools (plus 1 and plus 2) are produced inhouse and the tools produced in China are produced close to the GN Resound location in China. The difference between the two is 11% in 2015 using the conservative suggestion for price development from Credit Suisse. As mentioned scenario A2b(2) is somewhat unsure in relation to the cost of producing tools inhouse, but the figure above also shows that given the development of more complex tools A2b(2) will still be less expensive than A2c and A2b if the price of producing the tools inhouse is closer to the price of using the Scandinavian suppliers. This means that if the complexity of the tools increases, which most managers in GN Resound believe it will, then it will be less expensive to pursue a strategy where the tools are produced inhouse or close the GN Resound location in Denmark. These scenarios can be used in the strategic discussion in order to better determine what factors should be considered when a certain outsourcing strategy is chosen and this figure above was shown to the top management in GN Resound who found it very interesting and usable. This indicates that the CSA method helped GN Resound in developing a more transparent strategy process. The method helped in creating new scenarios and to test them relatively quick.

The figure above is different from figure 8.18 ‘New Alternatives for GN Resound’ as this figure shows how scenario A2b can be developed further, and the above figure shows the results of the different scenarios.

**8.5 The Dimension of Interaction**

The above case shows an example of how the CSA can be used at a more specific level in order to analyse different possibilities related to outsourcing strategies. The process above also showed that there are two important dimensions of interaction.

- The interaction between the numerical and narrative simulation
- The interaction between the researchers and the managers in GN Resound.

This can be seen in the figure below that shows a model of how the process can look.
The figure shows the two forms of interaction, which are important as they support the process and as *clarification, creativity, and communication* takes place through these interactions. The dotted arrows in the above indicates that in advance it is not possible to see in which direction the next step will go, it can be that four new scenarios based on scenario 1 are developed, but that is dependent on the specific situation and the managers involved. The idea with the CSA is that it can continue in an ongoing process.

The figure shows that the process started with a reference scenario in order to clarify the situation and to clarify what kind of costs were relevant to consider in order to find the total cost of GN Resounds outsourcing strategy. This is a good starting point as it will also help the researchers and the managers clarify which kind of data is needed in order to develop the numerical model. Based on the reference scenario and the interaction between the researchers and the managers the first numerical simulation was made. The interaction between the two methods challenged some point of views as scenarios that appeared to be attractive was found to be more expensive when explored in depth. Before this project was made it was the idea in the headquarters that outsourcing was the way ahead for GN Resound as money could be saved, while the Production site in Denmark was of another opinion. This knowledge was not shared or debated, but the CSA method proved to be an effective tool to put focus on the hidden costs as well as on the different possibilities of how the production of tools should be carried out. In this case the CSA method proved to be useful for both clarifying the situation as well as clarifying the total costs related to the outsourcing strategy.

The first interaction between the narrative and numerical simulation formed a creative basis for the development of new scenarios. Initially the plan was to pursue scenario A, B, C, and D, but the numerical simulation of the reference scenario formed new ideas as to what could be interesting to examine based on the input and output variables and the results. As the numerical model showed that some narratives were
unattractive or unrealistic to pursue the numerical model became the creative basis of further developing
the narratives. This was the case with scenario A2 which became the reference scenario and showed that it
was this scenario that was actually interesting to develop further. The interaction between the two
methods was used to explore new and innovative (such as total costs was for GN Resound) ideas through a
combined effort, and it also helped see different viewpoints as it took several scenarios into consideration.
As the models were showed to several persons in the company and used by them as well, the interaction
was also a way to incorporate knowledge sharing in GN Resound or at least in the involved departments.
This further development of scenario 4 can also give new input and ideas to the other three original
scenarios related to the distribution (chapter 5). The placement of distribution centers can also be affected
by GN Resounds outsourcing strategy and this can give new input to the scenarios described in chapter 5.
This indicates that the interaction between the two methods can be creative in the way that both the
scenarios and the numerical simulations can be constantly developed. An example of how this method
opens up for the possibility to get new ideas based on the scenarios can be seen below. A Project Manager
in R&D came up with an idea based on the work above. He came up with a scenario that included parts of
all the scenarios. The scenario can be seen below.

![Figure 8.21: Scenario with more local suppliers](image)

This scenario suggests that GN Resound chooses more local suppliers to all their facilities. Meaning that GN
Resound in Denmark uses Scandinavian and Eastern European suppliers to produce new tools and the R&D
department in Xiamen uses Chinese suppliers located close to the factory – primarily XPT. The idea would
be that the consultants could meet and adjust design, construction, and machine settings. This gathering of
consultants could be an advantage for all. There has not been dedicated resources to consultants in the
Project Managers department can visit the suppliers and help with the set up of tools. If a consultant was to go to a supplier in China each time a new tool was to be set up it would cost MDKK 1.25 (based in scenario A4). In comparison it would cost MDKK 0.54 if the supplier was placed in Scandinavia or Eastern Europe. This development of a new scenario also puts focus on the strength of the iterative interaction between the two methods which can result in a creative process that sparks new ideas.

The interaction between the narrative and numerical simulation at times takes place in the researchers head and is not always visible as for example when choosing how to build the model and what to call the variables. Therefore, the interaction between the researchers and the managers is very important in order to communicate to the persons that are not involved in the simulation what it shows. This is essential so that the managers experience the creative input both the narrative and numerical models can give, but also for the managers develop ownership for the process. Furthermore, the CSA method is a good way to communicate to people that have been outside the process as the method is both visual and constantly developing, this was also the case in the above as the results were sent directly to the top management who took it into their considerations. The CSA method supports a form of knowledge culture as the method encourages people to work together. The above is a case of how the team from DTU collects the knowledge and makes the models, but the process has involved several persons from GN Resound working in different areas and with different opinions. The CSA method can be a tool to make the different stakeholders share their knowledge in a more constructive way and communicate across borders.

The idea of the CSA method is that the process can continue in an iterative process proving that the method can successfully be used to assist the strategy process. It is also possible that if the scenarios and simulations are used with a broader user group in the company and perhaps outside the company new ideas to the term total costs can be found. The models above are case sensitive to GN Resound, but could be used in broader sense as to what kind of hidden costs production companies have in relation to outsourcing. The top management found the results and the method very usable as the method is a smart tool to make different scenarios and relatively quick test several consequences of each scenario before carrying them out in reality. This way it makes it supports the strategy making process and makes it possible to learn without having to face the real costs.

The work with the scenarios and the numerical simulations was ended at this point. GN Resound can integrate the model and update it with the relevant data from the suppliers. Furthermore, the model can be developed to include other relevant parameters such as the level of quality and the ability to deliver on time. This would make the model even more usable for aiding in the strategy and decision making process.
8.6 Follow-up

A year after the project was ended at GN Resound an interview was held with the Vice President of Component Manufacturing in order to follow up on the project and evaluate it. The interview showed that work based on the CSA was still used in GN Resound. The project had been around to many different persons and some had looked into it carefully and changed their opinion of what the outsourcing strategy should be, some had looked into it and not changed their mind, and some had not looked into it at all. The situation in the company was more or less still the same as in the reference scenario, but there was a tendency in the company towards the fact that they should not outsource everything without giving thought to the total costs. The total costs concept had been accepted by many in the company and as the complicatedness of the tool continues to increase more thought was given to how to go about it as the Chinese suppliers still fail to meet the quality demands. The project had also opened up for the fact that a cross functional panel had been created. Before the project the different departments found it difficult to work together and to other departments viewpoints, but the cross functional panel was a step in the right direction.
PART V. Discussion & Conclusion

In part five the findings of the project are discussed. Three specific issues related to the main parts of the thesis are discussed as well as the research questions are discussed in relation to verification, validation, and accreditation. Based on the discussion a conclusion of the main objective is made as well as reflections on future perspectives.
Chapter 9. Discussion
This chapter consists of a discussion of the thesis and is divided into three parts: Discussion of the main parts, discussion of research questions and results, and contribution to research.

9.1 Discussion of the Main Parts
The thesis has three main parts which are methodology, literature and theoretical work, and empirical work. A main issue related to each part will be discussed in the following.

9.1.1 Mixed method design
As described in chapter 2 the thesis is grounded in the mixed methods research as the idea is to combine narrative and numerical simulation in order to develop a strong method in relation to strategy development. The approach to how the methods should be carried out was also mentioned in chapter 2 as the idea of the CSA was that both the narrative and the numerical simulation should have equal status in the project and should be performed sequentially to begin with and then be carried out more and more concurrently. The two cases however developed differently. In the distribution part of the case the three scenarios were more or less decided upon by GN Resound beforehand and it was only scenario 4 that was completely new. There was also a large amount of data that had to go into the models. This meant that the focus was on the numerical part and the process became somewhat more time consuming due to the time it took to process the quantitative data as there was only one researcher carrying out the project. The emphasis was put on the numerical part, but a large amount of time was also spent in the beginning of the project in describing the three scenarios narratively even though the scenarios were thought of by the company. The beginning of the process was carried out sequentially as the three narratives were first described and then numerically simulated. After the first numerical simulation the more concurrent process started as there were some changes to the narratives based on the numerical simulation as well as changes to the numerical simulations based on the narratives. However, this process was not dominant in the distribution part of the case as the sequential part of the project took up most of the time and as it was the first time the CSA project was carried out.

In the outsourcing part of the case there was a concrete purpose at the beginning of the project, but there were no scenarios. The scenarios were developed along the way through iterations between the researchers and the managers at GN Resound. This means that there was a focus on both methods had to begin with in this part of the project. The methods were also in this case used more sequential in the beginning as the reference scenario was developed as a basis for the first numerical simulation which gave input to new narratives and so forth. The outsourcing part of the case reached the part of the process where the two methods are used more concurrently. The narrative simulation had took up more time in
the end of the project where the two methods were carried out in a more concurrent manner. This was due to the fact that first a reference scenario was developed and a numerical simulation based on this was developed. Then the narratives representing the future were developed and based on these the input to the numerical simulation was changed in order to show future consequences. Based on this new narratives were again developed. This means that there is slightly more focus on the narrative simulation towards the end of the project as several new narratives were developed, but the numerical simulation was changed in input parameters.

From the above it can be seen that the process in the outsourcing part of the case is closest to the intention of the CSA as described in chapter 2. This indicates that therefore the outsourcing part of the case must be the most successful part as the methods comes to overlap more and more. But it can be discussed whether the CSA is more successful the more the methods overlap or if the CSA method is more successful when the two methods have equal status in all the project. The cases both developed differently and the way the CSA is carried out is also dependent on the context. In the first case it was a specific wish from the management of GN Resound that they wanted to have a certain amount of data in the model. This means that the project could not have been made if the researcher had not agreed to incorporate this data. The fact that the scenarios were given at the start of the project naturally reduces some of the emphasis that are placed on the narrative simulation as the development of the scenarios are more limited than in the second part of the case where only a purpose existed. It is difficult to determine whether one approach is better than the other as it is very dependent on the context. It is the author’s conviction that the distribution part of the case would have developed differently if more focus had been put on the interaction of the two methods to begin with and the large amount of data had been added at the end instead. This would have made it possible to have more iteration between the two methods and it could have resulted in better models that could have been developed further to support the strategy development. The distribution part of the case placed more emphasis on the narrative part at the end as scenario 4 was developed by the researcher and this became the starting point of the outsourcing part of the case. This shows that the process has shifted between putting emphasis on the narrative and the numerical simulation as well as shifted between being carried out sequentially or concurrently. It has been a unique opportunity to follow the project over such a long period of time being able to get several iterations with the CSA. As described in the follow up chapter the work with the CSA has been used by the company and it was indicated by the vice President of Component Manufacturing that the work had resulted in several initiatives. Furthermore, the manager could see further use and further development of the process as the work done for example in the outsourcing part of the case could be tested in the different departments and then developed further as well as incorporated more in the company.
9.1.2 The CSA as A Strategic Tool

The work with the CSA was conducted in GN Resound to support their strategic decisions in relation to distribution and outsourcing. Narrative simulation makes it possible to explore paradoxes and opposing interests through alternative imaginations of future situations. Numerical modelling of selected parts of the scenarios can supplement the narrative analysis by doing sensitivity analysis to examine the reaction of certain output variables to a certain change of input values. As narrative simulation has an important function with regard to involve stakeholders in the scientific and designing activities narrative simulation can be relevant in addressing many strategic issues in companies such as corporate social strategies, product development, market development, environmental strategies, purchasing strategies etc. Narrative simulation facilitates an exploration about possible, functional linkages, and numerical simulation can add further knowledge about, how much these relationships influence each other. The model developer(s) and model user(s) must interact to focus on interdependent relationships and the functioning between different sub-systems. The expert knowledge that the model user(s) posses can be applied to the narrative and numerical simulations and through interaction with the model developer(s) it can be integrated into new scenarios and numerical models. The CSA can show stakeholders the likely effects of their preferences and viewpoints in a given scenario and it can be used at many different levels in a network as well as across networks.

The CSA also influenced how the different employees in the company worked together as the process shed light on aspects such as total costs. This meant that the project helped the different departments to actually see the case from another viewpoint. This was also seen in both part of the cases as in both cases the departments communicated and used the results, but in neither cases were the narrative and numerical models developed afterwards. However, the CSA did have impact on the company. Scenario 1 was chosen and followed by the department in the distribution part of the case. The department was laid off little more than a year after the case was carried out, but it is still a modified version of scenario 1 that GN Resound is pursuing. In the production part of the case they also learned about themselves. A cross functional panel had been incorporated that made it easier for the different departments to work together and a focus of total costs had been incorporated in the company. This indicates that the CSA worked well as a strategic tool that can also put enhance the transparency in relation to certain areas.

The CSA was used in two different ways in relation to strategy. In the distribution part of the case the CSA was used in order to support the intended strategy that the management had chosen in a more rational analysis. In the distribution part of the case the CSA was used more as part of an emergent strategy as the project was initiated due to the fact that the top management had made an outsourcing strategy that was
questioned by the Danish production site in their attempt to adjust to this strategy as well as the external changing circumstances. This means that the CSA was both used in a top down approach as well as in a bottom up approach. It can be argued that both cases were successful as the company got the results that they could use. But as described earlier the first part of the project did not go through as many iterations as the second part of the project. This was partly due to the fact that the scenarios had been more or less decided upon and that the CSA was intended to carry out a more rational analysis of the three narratives. This indicates that the CSA can be used for both. It is however the intention of the author that the CSA should be used in order to adapt and learn through interactions between strategy development and implementation in order to constantly adjust and revise strategy in light of experiences. As strategy often in practice combines a centrally made design with a more decentralised adaptation the CSA supports this.

9.1.3 The Researchers Different Roles

The empirical work in this thesis is based on observations, interviews, informal interactions, and archival research. The author carried out a case study in the company throughout a long period of time. The interaction process between the researcher and the participants have been ongoing since spring 2008 and as late as in March 2012 the last interview was held. As mentioned above the approach has been based on a mixed method approach and this means that during the process the author has possessed several different roles. The author has both carried out a case study where the researcher’s role was to observe the case as a researcher. These observations were resource intensive as the author was present in the company for a long period of time. The research also falls into the category of action research due to the as the researcher initiated scenario 4 and as a workshop was held. The last role was that of modeller where the researcher based on the information given made models that the managers in GN Resound had to consider and decide upon. This indicates that mixed methods research of this kind requires that the researcher(s) posses different skills in order to use both approaches and combine them as well as understand and analyse different forms of data.

Based on the project it appears that the CSA is a good tool that supports a broader framework for decisions in relation to strategy development and implementation. It emphasises the way the model developer and model users interact as it changes the traditional comprehension of both the users and the developer. The developer obtains a role more as a facilitator for the process as the model users have to be part of making the solutions to a higher degree. The tool can be used as a practical tool to develop and support strategies in companies in relation to outsourcing, distribution, production, risk management etc. The CSA can also be used as a tool for the researcher to get a deeper understanding of the company in relation to for example the internal systems, the structure, the culture, whether there are contradicting mental models in a
department, the communication etc. And thirdly it is also a tool that allows the researcher as well as the managers to look further into the future in relation to strategy development and implementation. The process showed that an important aspect of the CSA is the interaction both between the narrative and numerical simulation and the interaction between the researcher and the model users. These two forms of interaction are different than a typical approach to modelling that is normally based on a model developer making observations of a given case or company for a period of time and then the model developer extracts from the company in order to make the model. The model is then presented to the company in order for them to comment on it. The CSA advocates an approach that seeks to involve the model user as much as possible in the development of the model. The project has shown examples where the users were directly involved in how the model was developed before the model was finished both through meetings and dialogue, but also through workshops. This opens up for the fact that the users can comment on the model throughout the process and also for the possibilities that the users can relate to themselves in a different way than they normally do. The process could be opened up even more for the possibility that the model users could have an even more active part in the model development itself so that the users learn more about the numerical models as well as get the possibility of using the models and developing the models after the model developer is no longer part of the project. This can however be more challenging in reality as it would require a specific person to be responsible for the model in a given company. It requires that the person has the necessary competencies in relation to modelling and this means that either a person with the competencies should be hired or an existing employee should be educated. The idea is relevant towards the assumptions of the CSA that it should be a tool that involves the model users in the process and requires them to be a large part of making the solution. Furthermore, it sustains the fact that the CSA is an ongoing iterative process if an employee could continue the work carried out in the beginning. However, in reality it can be challenging to incorporate as the employees in a company often are busy with the everyday tasks and often such a model could be pushed back in order to get more urgent matters done, but it is doable as GN Resound at the end of the distribution part of the project did hire a person to be responsible for the developed tool as one of his tasks. However, as mentioned the department was shortly after laid off. It is also a task that has to be grounded at top management in order to get the support for it. This kind of involvement can also mean that the users can influence the model developer too much so that the model becomes too much a representation of the wishes of the users and not of the reality. In order to overcome this it is necessary for the model developer to take the wishes of the model users into account, but at the same time be able to maintain her own points of view. This was also an issue in the first part of the case as the company insisted that they only wanted to examine scenario 1, 2, and 3. The author accepted this, but insisted that scenario 4 was also a part of her work even though the department was not
interested in it. So the author did not follow the company in the fact that scenario 4 was not interesting. As things developed it turned out that scenario 4 was interesting also to GN Resound and their outsourcing strategy which is very relevant for their supply chain and their costs. This indicates that it is very necessary for the model developer to be able to both listen to the company, but also to be able to withdraw from the context in order to reduce some of the influence by the model users.

The approach gave the author a profound knowledge of the systems, culture, and work relations in a company, but it also meant that the author became a part of the reality in the company making it more difficult to observe it objectively. As mentioned the traditional approach to numerical modelling is that the researcher gathers information related to the modelling and then the researcher extracts herself in order to make a model that is then presented for the stakeholders. The author in this case was very involved with the company while making the model in the first part of the case including during the time when the model was made. This is also shows how case studies are normally conducted so it indicates that due to the nature of the mixed method research the researcher found herself located in between the two paradigms postpositivism and constructivism. This approach made it possible to get a deep knowledge of the company and at the same time develop a model for the strategy in the company, but also understand the company at a deeper level. The two methods complemented each other as the narrative and numerical simulation needed different input in order to be made. It can be challenging for one researcher to carry out both the narrative and numerical simulation as the researcher both has to be very involved in the case, but also has to withdraw from the case at a given time to make the model. A way to go about this is that the researcher to begin with gets a deep understanding of the given company or case in order to make the first narrative and then withdraws from the case when the first numerical simulation is made. Following this the researcher can again get involved in the case when presenting the first draft of the model to the users so that the users become involved in the following model development. This is very important as the CSA method focuses on the fact that the users are involved in the development of the model and that the model is based on information given by the users. There are also benefits from being only one researcher carrying out the whole process. This is due to the fact that in this situation one person gets all the knowledge and carries out both the narrative and numerical simulation avoiding the possibility of dividing the two approaches between two persons with strong abilities in one area. If the narrative and numerical simulation is divided between two persons then it makes it more difficult to use the two methods concurrently. Furthermore, in the situation where one researcher carries out the process it also gives an opportunity to develop knowledge within both areas at the same time. This means that if two or more researchers are involved in the process it is imperative that they do not separate the narrative and numerical simulation between them.
9.2 Research Questions Seen From a Company Perspective

The thesis set out to answer the main objective:

Can the combination of narrative and numerical simulation methods support and improve strategy development and implementation of effective production- and distribution networks?

The question was motivated by the fact that narrative and numerical approaches to strategy development are often separated and often strategies are made at the strategic level, but have impact on the operational level. Therefore, it was found interesting to examine whether a combination of a narrative and numerical simulation could support a more robust strategy development as well as improve the implementation of such a strategy. The main objective was divided into three research questions that will be discussed in the following based on the verification, validation, and accreditation model from chapter 5.

9.2.1 Research Question 1

How can narrative and numerical simulation be applied to enhance the interaction process between the model developer and the model user?

This research question is closely related to verification as it is concerned with the question whether the model is made right, if it fulfils the specifications, and whether it reflects the reality. This can be assessed by answering different questions.

Does the CSA result in an interaction between the numerical model and the narrative model?

As it was seen in the case the CSA does indeed result in an interaction between the numerical model and the narrative model. The program code in the numerical model is based on the narrative simulation, which means that the numerical model implements the narrative model and then again the narrative model continues to implement the numerical model. The narrative model was the starting point for the whole simulation process and the interaction between the two forms of simulation helps in assuring that the program code of the executable model correctly implements the conceptual model. Based on the continuous interaction between the two forms of simulation, but also the interaction between the author and the participants in the project, both the conceptual and the executable model are constantly tested in order to assure that the conceptual model is correct. In this way also the executable model is reflecting the conceptual model. It was also shown that the narrative simulation was a good method to create a reference scenario and in this way have more aspects in the narrative model in the first run of the narrative process. The executable model is not made in one instant, but is made over several interactions with the conceptual model and during several interactions between the author and the participants in the company.
This means that the executable model is a result of an iterative process that attempts from the beginning of the process to verify the requirements according to the conceptual model. This is an important aspect of the CSA as the numerical simulation is tested and updated accordingly as the narrative simulation develops. This also opens up for a learning process as the participants are confronted with unsure elements in the conceptual model from the beginning of the project.

*Does the CSA satisfy the intended use?*

Whether the CSA satisfied the intended use seen from the company perspective can be seen in relation to both the first and the second part of the case. The conceptual models were based on the wishes of GN Resound and on the requirements analysis and in that respect they satisfy the intended uses of the model. In the first part of the case the intended use was to test different scenarios for the future distribution based on specific variables. As mentioned above the conceptual models were developed through interaction with several persons in the department in order to take their ideas and opinions into account so that the conceptual models became as correct as possible. In both cases the cost aspect was very important as this was the driving factor behind the company’s wish for using the CSA model. This made it crucial to incorporate the cost perspective to the degree that the department wished as this was the basis for making the project. In doing so the researcher made sure that the model satisfied the intended use as the parameters chosen by the company were examined, however as mentioned before it is also important that the researcher can withdraw from the case and decide whether there are more parameters there are necessary to examine or other options. It is important to keep the purpose in mind as this purpose is guiding for the project. In the first part of the case the overall purpose was to examine three distribution strategies in order to determine their related costs. This purpose was pursued, but it can be discussed whether more parameters should have been included. It can be questioned whether the author followed the wishes of the department too much by focusing on their parameters and variables. This means that the outcome can have been influenced by the fact that they favoured scenario 1 and therefore possibly looked into parameters that would give this result. It also resulted in a process that was influenced to a large extent by the numerical modelling as the large amount of data made the numerical part the most time demanding. A focus on the interaction between the narrative and numerical simulation could have resulted in several iterations between the two methods. Furthermore, a process where the model could have interacted to begin with and then the large amount of data could have been added later could also have resulted in more iteration. The CSA method can also be discussed in relation to this as the fact that it is one person carrying both narrative and numerical simulation as well as data gathering also means that it was a time demanding process. The narratives on the strategic level were given in advance in this part of the
game, which limited the creative possibilities. If the author had insisted on focusing as much on the narrative aspects the model might have developed on another basis. The Vice President of the Global Supply Chain and the Global Planning Manager were not interested in 2008 in exploring whether the production and outsourcing strategy could be relevant. This project was however presented to the Vice President of Component Manufacturing in 2010 who found it very interesting to pursue. In that sense the researcher did follow the wishes of the Vice President of the Global Supply Chain, but also pursued other aspects that were deemed interesting by others in GN Resound. This shows that scenarios that at one point are found uninteresting can later on be interesting. This was due to both time and the fact that it was another contact person who worked with some of the problems that arose due to the outsourcing and offshoring of production. It also shows that the method can be used to show internal disagreements in a company as GN Resound during this time has gone from the idea that everything should be outsourced to the idea that when a clear advantage is present then it is a good idea to outsource.

In the second part of the case the CSA also satisfied the intended use as the method was use to show the hidden cost of the given outsourcing strategy. In this part of the case the CSA was developed on a basis that it was going to challenge the current outsourcing strategy. The models were developed based on this strategy, but with information from the operational level.

*Does the CSA produce results when it is needed and in the required formats?*

The executable model produces the results that were asked for by the company and it produces them in the required format. Furthermore, the executable model gives the result in an output version that is easy to show and explain to others as it can be generated as a graphic illustration. Much consideration and carefulness is however crucial as to the quality of the data in relation to the CSA. The results of the CSA are not more correct than the data put into the model. Furthermore, the limits of the executable model also must be considered in relation to the conceptual model and the simuland meaning the constraints of the models must be taken into account. The intent of the CSA is not to forecast the future, but to open up for new discussions about the possible futures as well as make the model user(s) able to navigate in possible futures. The CSA is a functional tool if used properly as it makes it possible to make several scenarios of the future and test the consequences relatively quick in the numerical model.

### 9.2.2 Research Question 2

*How can narrative and numerical simulation be used to explore possible futures for multinational production and distribution networks in accordance with the trends within a certain branch or sector?*
Validation is concerned with the question whether the model is a right representation of the simuland and this can be determined by answering several questions.

Is the CSA a correct representation of the simuland and does it produce valid data?

The conceptual models were developed dynamically in interaction with the participants in GN Resound and this also meant that the process opened up for learning about where contradictions in the scenarios existed as well as what was possible to put into the conceptual model and what had to be taken into consideration. This means that the conceptual models are different future representations of parts of the simuland and as such they are not correct representations of the current simuland, but they are correct representations of how the stakeholders see the future simuland. This can bring an element of uncertainty as it is not possible to be able to completely foresee whether the scenarios will develop exactly as they are described at that given time. This is however also the dynamic part of the CSA as the intention is that the models can develop over time reflecting the actual development as well as making it possible to test new outcomes. The intention is also that changes are taken into consideration as they occur so that the model is always up to date. This is also what makes the models flexible as the CSA is an approach that can relatively quickly describe different scenarios and test these scenarios in order to give management an idea of what the consequences are of each scenario.

Under what range of inputs are the CSA’s results credible and useful?

The input has to be considered in order to reflect whether the results of the models are credible and useful. Given the fact that a large amount of products and spare parts are simulated in the executable models it would seem that the results can be categorised as credible. However, the data in the model is based on existing data and then it has been analysed in order to get an average and a standard deviation of the data. GN Resound’s products, and therefore also the spare parts, have a short life cycle span, and it can be argued that the shift in products will be so great that the actual products put into the model do not resemble the products in the simuland. This was discussed with the Global Planning Manager who found that an average and a standard deviation would be representative as the throughput would be representative of the future as well. This was also due to the fact that GN Resound does not experience seasonal fluctuation. In the second part of the case the data was also found and discussed with the employees in GN Resound in order to determine how the data would look in the future. Not all data related to the simuland are taken into account. The numerical simulations show results that are related to the future so there will be a degree of uncertainty as the data put into the models in these cases are data that are expected to be true, but cannot
be tested until they have actually happened. The data is based on the interaction between the author and the employees in the simuland and therefore the processes and data are reflections of the simuland.

The model made represented the simuland to the degree that it was possible according to the data accessible. The models were constantly tested with different persons in the department in order to ensure that they were as close to the proposed simuland as possible. The part of recreating simuland is a little bit more difficult in the CSA as the simuland is more a narrative of future possibilities. This means that the models are not intended to recreate the current situation as accurately as possible, but to create a possibility to test possible outcomes of future situations. This means that the simuland in a way is represented by the narrative.

9.2.3 Research Question 3

*How can narrative and numerical simulation clarify the strategy and decision making process in multinational companies and make it more transparent?*

Accreditation is concerned with the question whether the model is the right one for the job. This can be discussed through several questions.

*Are the capabilities of the CSA and requirements of the planned application consistent?*

The capabilities of the models were consistent with the planned application and this was checked continuously during the interactions with the managers so that the elements of the models were agreed upon. The models were continuously discussed through the interaction with the different persons in the department, but it was also at the official end of the first part of the CSA project in GN Resound the conceptual and executable models were presented for the Vice President of the Global Supply Chain and the Global Planning Manager at a meeting. Here the models were presented and explained as well as the results and the Vice President confirmed their use as well as urged the Global Planning Manager to use the CSA method onward, but however as described earlier without appointing resources or making it part of their performance measuring. In the second part of the case the models were also discussed concurrently and at the end they were brought to the top management in order to show them how the total costs of different outsourcing strategies looked. This was taken into the considerations regarding outsourcing by the top management.

The CSA can help in the strategy process as decisions often must be made in the short term in response to long-term goals or proposed changes. Through back casting, scenario analysis and numerical simulation can link long-term transition related to each scenario to the shorter time horizon of current decision makers by
making strategy formation plans including goals, various milestones, needed resources and how to obtain them as well as types of opposing interest, inertia and barriers to be taken into consideration. It is also important that the interactions in the CSA correspond with the given business plan of the company. It is important that it does not take too much time from the managers as people in companies are often busy. The interactions should be adjusted so that they fit the given company in order to help improve the strategy process and make it more transparent to the degree that it makes sense.

Transparency is enhanced through the fact that the models are build in cooperation with others. The “what if” scenarios are decided upon and based on these to begin with the first drafts of the numerical models are made. This interaction with others means that there is a transparency as to what is made. Furthermore, the numerical models can be opened to show what lies behind also based on the narrative part as this is the basis for the numerical model to begin with. This interaction improves the transparency as it is possible to follow how the models develop and what goes on in the mind of the researcher as the model explicitly explains this. The visual part of both the narrative simulation, but also the numerical simulation using ProModel means that the process can also be followed in a way that for example more basic modelling such as in Excel does not allow for. This visual part is important in order for others to quickly get an idea of what lies behind the models. This all makes the process more transparent, but total transparency is not the ideal. It is important to choose what should be transparent. Not all calculations are interesting as there is a risk that if everything has to be included then the transparency can result in the fact that it becomes less transparent as it becomes confusing.

9.3 Contribution to Research

This thesis’ contribution to research is amongst other a methodological development within the mixed methods research as it was tested whether narrative and numerical simulation could be combined in a way that would make it possible to use the two methods concurrently. The project contributed as to the barriers of using the CSA and in which context the CSA can work in. The researcher found that it is important to get an idea of how the model should develop as well as to play with the development of the model before adding a lot of data into the model. This is important in relation to the fact that the CSA is located in the field between the rationalistic and processual organisational paradigm. In order to use the creativity found in this field it is important to first make a prototype of the model in order to use it to develop new scenarios and models. Data needed in the model can be added at a later stage. It is however still necessary as a researcher to be aware of the validity and quality of the data as well as the process of retrieving the data. Ideally the researcher should in the CSA be responsible for guiding and aiding the stakeholders in creating the scenarios, but it should be the stakeholders that generate the ideas for the
scenarios as they possess the knowledge and as this makes them take ownership of the process. Furthermore, the researcher should be responsible for creating the numerical model through interaction with the stakeholders. It is however a good idea that the stakeholders or someone in the company is responsible for providing and analysing the data that has to go into the model as the knowledge of the data, its location, and its usability is best found in the company. The idea of the CSA is also that the researcher acts more as a facilitator that helps the stakeholders and managers in the company to see their situation in a different way as well as taking a look into the future. The researcher resources are best used on this, but in reality it is likely that the researcher has to do some data analysis as the researcher has to decide what kind of data is needed, but it should not be the primary task. This means that it is important for the researcher to make demands. In the same sense it is also important that the researcher is critical towards whether the indicators/parameters are valid input and output parameters. There is a risk of quantifying something that cannot or should not be quantified in the excitement to get as much as possible into the model. This is why the CSA also operates in the field between the two organisational paradigms so that the two forms of simulation covers a broader perspective than if the researcher was just using one form of simulation.

This project also gave a deep understanding of how it is to work in the field between the rational organisational paradigm and the processual organisational paradigm. The two methods are rooted in two different organisational paradigms and the CSA is located in both approaches. The use of the CSA has led to the understanding that it is not a question of using either one or the other of the organisational paradigms, but more a question of using both of them. It was seen in the case that the rational and the processual organisational paradigms can at times hinder each other as the many systems that did not talk to each other and that were not transparent made it difficult to turn into a processual path as the systems did not contribute with what was the intention. However, this also made people act more in a processual manner as they had to find and take what they needed where they could.

The CSA supports the idea that strategy is a combination of central design and decentralised adaptation. In both cases the model was developed at an operational level, but had effects on the tactical and strategic level as the distribution strategy and the outsourcing strategy were examined and determined. The method shows how the three levels are interconnected as it operates across these three levels. This is also the force of the method as it can be used on several levels in a network and also across a network taken the trends of the branch and network into consideration. It is possible to move around in several layers as the method works on the operational, the tactical, and the strategic level – it has shown how these levels are interconnected.
Chapter 10. Conclusion

This chapter presents the conclusion of the project’s main objective as well as the implications of the research and practical implications. Furthermore, it will discuss the future perspectives.

The need for strategy making seems ever more important in the current turbulent business environment. A need to be able to not only plan for the future, but also be able to act on changes before they happen is a dynamic approach to strategy making. Both narrative and numerical simulation are two independent and known methods that each has their own strengths. This made it interesting to examine how an approach that involved both perspectives could create a tool that can help make strategies more robust and dynamic. An extensive empirical work in combination with a literature study made it possible to develop several scenarios as well as numerical models for different situations in order to examine whether the CSA is a method that can be used to improve strategy making. This was carried out in order to answer the main objective of the thesis:

Can the combination of narrative and numerical simulation methods support and improve strategy development and implementation of effective production- and distribution networks?

The CSA was tested over two times in one company making it possible to compare the process. During this project it was found that the CSA is a way to support and improve strategy development and implementation as it makes it possible for decision makers to systematically test several different outputs of possible solutions in order to prepare for future consequences. The CSA is a way to evaluate risks and address possible unforeseen problems in a more methodical way than either guessing or forecasting. It can be viewed as an interactive method, which can both be used within the rationalistic and processual organisational paradigm.

It was found that the two dimensions of interaction support the strategy development as the interactions makes it possible to analyse different aspects in relation to strategy within the framework of both narrative and numerical simulation. The interactions also support the implementation of strategy as the CSA method involves several persons, both employees and managers, in the process. It was found that beginning with a reference scenario that can be numerically simulated upon was a way to make the CSA method creative and to improve the strategy development as new scenarios were found. This makes it possible for the computer model to force a precision and clarification of the narrative in order to support the development of new possible scenarios and strategies. This reference scenario showed the current situation and when simulated upon it opened up for new ideas as to how the scenarios could be developed. This improved the strategy making process as other scenarios were investigated than the ones originally thought of.
It was also found that the CSA method appeared to work on several levels as it was developed at the operational level, but used to support and improve the strategy development at the either tactical or strategic level. This shows that the method supports strategy implementation as the data needed are found at the operational level through interactions with employees at the operational level. This can support the development and implementation of a new strategy as the persons that will be affected by the strategy have been a part of the process. This indicates that the CSA is placed in the boarder line between the processual and rationalistic organisational paradigm. It is in this boarder line that the CSA can be used in a way that increases learning in relation to the strategy development.

The CSA was tested two times in one company. It gave input as to whether the CSA can actually support and improve strategy development and implementation. The focus of the CSA is on the interaction between the two simulation methods as well as the interaction between the model developer and model user during the process of the CSA. The more creative part of the CSA is that it provides a feel for the scope of possibilities within a narrative. It can help determine how responsive an outcome is to changes in parameters and conditions and this was a part that could have been more enhanced in the first part of the project. Both projects focused on cost calculation, but the second part of the project was more open towards exploring new scenarios and using the CSA to learn.

In the first part of the project the large amount of data that had to go into the model also limited the iterations as the data finding and handling was very time consuming. This was not only due to the fact that it was a large amount of data, but also to the fact that the data was difficult to find and not always consistent. In this part of the project a less complex model in the sense of numbers of products and parts could have been developed to begin with in order to use it for testing the already developed scenarios and then later the large data set could have been added. This could have helped in keeping the focus on using the CSA as both a tool for critical analysis and creativity throughout the process. This could also spark a backcasting of the process and give valuable insight into for example how constraining the long term goals are, what actions are needed to obtain these goals, who are responsible for obtaining them. This kind of explorative exercise can be caused by even the simplest models and perhaps even more by a simpler model representing issues that are relevant for making strategic decisions rather than calculating the future. Exploring the boundaries of models can give this valuable insight to both the narrative and numerical part of the method.

The project at GN Resound has been carried out for a period of almost 4 years starting in the spring 2008, and much has been learned in this process. If it had been started today I would most likely have gone about it differently. To begin with the project was initiated at a meeting with GN Resound where two contact
persons described the then current situation as well as the desired future. Given my knowledge today I would suggest that a reference scenario is made and then simulated upon in order to let the numerical simulation become a creative tool for developing new scenarios. I would also suggest that the reference scenario should have a limited amount of data in the model and rather let the model be more complex with various calculations. Based on this it would then be possible to have more data input in the later models once the skeleton of the models were clear. In this way it would both be possible to let the interaction be more creative as well as have the vast data input.

The use of the method in the first part of the case definitely opened up for the use of the method in the second part of the case. And the two parts of the case together have given input to how the method can be used in a way that both enhances the creativity, clarification, and communication. The clarification and the communication were both easier seen in both cases, but the second part of the case opened more up for how the numerical part of the CSA could be used in a creative manner.

It also has to be mentioned that in the first part of the case the department in question was in a state of change where the organisation and the structure were unstructured. This was seen through how difficult it was to retrieve data and how inaccurate most of the data was. It could also be seen from the fact that the whole department was laid off in 2009. The interview held with the successor also showed that it was almost impossible to find the data and the structure. This also had an influence on the fact that the department in the first part of the case found it more difficult to see the learning process of the CSA. They constantly had to fix problems with delivery times as well as quality issues and that left little time to use or completely appreciate the CSA. This connects them to the second case as we in this case learned that the outsourcing strategy in GN Resound actually was responsible for failed delivery times and quality issues. The department in question here seemed somewhat more structured and therefore more open towards using a new tool.

It seems very important that the organisation is open towards incorporating and using new methods to support the strategy development. This means that the enacted values have to reflect that several aspects in relation to strategy are valued and measured, for example that it is possible to challenge an existing outsourcing strategy to see if a more suitable alternative exists. It also means that if the CSA method is to be incorporated in the daily processes it is important that the manager does not let it be up to the employees whether they want to use it or not. It appears that the manager has to be an anchor person for the method as the method also operates on several levels, but has influence on the strategic level. The method can also be time demanding so it is important that the employees are given time to work with it and are rewarded if they do use it.
The intention of the CSA method is not only to test possible future situations once, but to create a method where the model structure can be reused either by the same persons or other teams. A way to do this is to encode key decisions in the models that can be altered and changed in order to adapt to changing conditions. This however means that the models should adapt to changing conditions and should incorporate important decision factors. It is also very important that the models are subjected to outside comments from either other persons in the department, other departments, or perhaps stakeholders outside the organisation such as for example in the second part of the case the suppliers in China and in Northern Europe. This should be done continuously in order to make sure that the scenarios and the numerical models are up to date and it can also spark new creativity as to how the narrative and numerical simulations could look.

An important issue of the CSA is that its intention is not to produce a predictive model, but a model that allows for exploring possibilities that are consistent with the narrative part. In order not to constrain the creativity and use the CSA method as intended it is important that both the narrative and the numerical parts are both taken into consideration. If not there is a risk of ending up with a model that is so close to the normal use of either narrative simulation or numerical simulation, and this is not the intention. This means that there is an emphasis on both creativity and critical analysis throughout the process as these two are interlinked. This was fulfilled more in the production part of the case perhaps due to the fact that only a purpose was given beforehand and not the possible scenarios.

The CSA method also advocates an approach where the modeller interacts to a large degree with the model users in order to get the model users as involved as possible in the development of the solution as well as in the implementation. This is a benefit of the approach as it seeks to gather and use knowledge that is located in the users in order to make a tool that is not based on quick fixes, but seeks to have a long term perspective.

The use of both narrative and numerical simulation opened up for many development possibilities as the narrative helped structure the numerical simulation in order to find a relevant and clear process and flow to simulate upon. Furthermore, the numerical simulation gave important feedback to the narrative simulation as it highlighted the areas that had not been thought through and areas that needed to be improved such as for example in the production part of the case where new scenarios were thought of based on the first numerical simulation. The force of the scenario building was that when describing scenarios of the future distribution strategy it stimulated the process of seeing different possibilities through these scenarios that could be simulated upon. These scenarios gave ideas that could further develop the narratives and this is where the strength of combining the two methods can be found. The
interaction between the two methods inspired each other and assisted in developing a more profound simulation of the future. The communication was improved as the CSA made it important for the model user(s) to participate in developing the scenarios. Furthermore, in the outsourcing part of the case the numerical simulation showed that some of the initial scenarios were not deemed interesting to pursue. The CSA can also be used to communicate the result as it was seen in both parts of the cases, but especially in the outsourcing part where the result was taken to the top level of the organisation. This made it possible to show that the total cost of outsourcing was different than what had been assumed by the management.

The advantage of using the two methods in combination in this case was that the combination can be used to clarify unclear issues and parts so that everybody has a possibility to see the scenarios from the same perspective, and furthermore the interaction can be used to expose contradictions in existing mental models regarding the strategy that are not otherwise exposed. Furthermore, it gave the stakeholders an idea as to what the possible outcomes of the scenarios are as the narratives were illustrated as well as improved and understood by the simulation. Part of the idea of combining the two methods is that the models and the process should be replicable and transferable and in constant development. Therefore, it should be possible for the company to use the model to continuous strategy development.

The CSA has been used on two cases in the same company for two different areas. It appears that the method is flexible and can be used for several purposes. The CSA method in itself is generic, but it is necessary to adjust it to a given company and case as it might not be that another company has the same data or setup as the ones made for GN Resound. The second part of the case could perhaps be used for other companies in a situation that reflects GN Resounds as some of the data, such as the salary level etc can be generic. The first part of the case could also be used if the data input in the model is changed.
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Appendices

Appendix 1 – List of information needed from sales companies

Appendix 2 – Ideas from the workshop

Appendix 3 – Causal maps of scenario 2 and 3

Appendix 4 – Inventory level scenario 2 and 3

Appendix 5 – Transport costs scenario 2 and 3

Appendix 6 – Resources costs scenario 2 and 3

Appendix 7 – Total costs of sourcing

Appendix 8 – The interaction between narratives and numbers

Appendix 9 – The sustainable utilization of human resources in global product development

Appendix 10 – Combining narrative and numerical simulation: A supply chain case