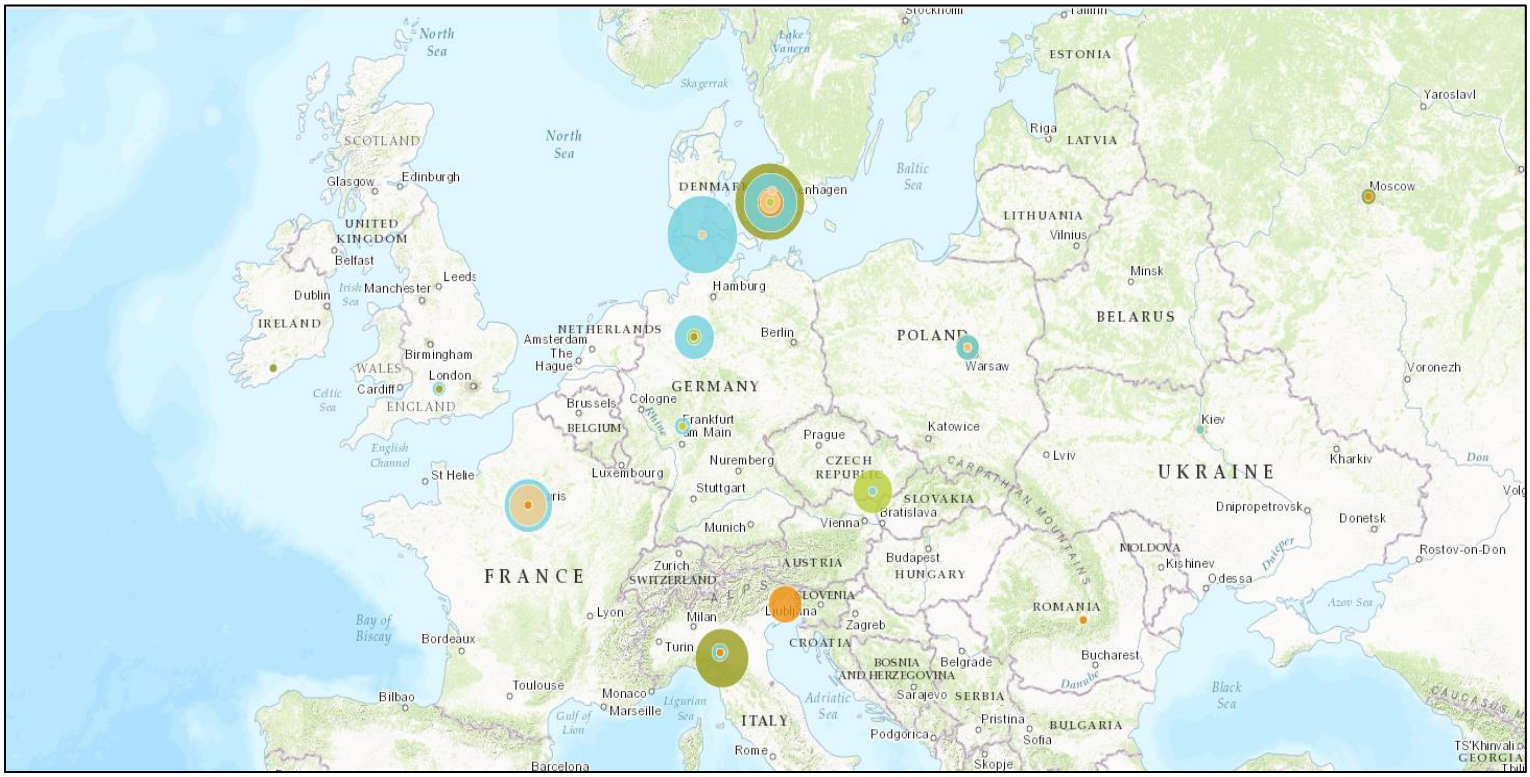

Supply Chain GeoVisualization

Visualizing Geospatial Logistics Data for Supply Chain Management
at the Danish Bioscience Company Chr. Hansen

Copenhagen Business School
MSc EBA Supply Chain Management
Supervisor: Vahid Sohrabpour
Master's Thesis

Søren Stærkind: 26.07.92
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Abstract

Purpose: In this paper, we present a definition of Supply Chain GeoVisualization, and outline the effects that visualization of geospatial freight logistics data can have on the supply chain of the Danish bioscience company, Chr. Hansen.

Design/Methodology/approach: A systematic literature review exposes an academic knowledge gap, which is explored through a pragmatic systems theory methodology, and a collaborative research approach. The dataset – which includes company documents containing a large logistics report, expert interviews, and empirical observations – undergoes a coding process via Grounded Theory method.

Findings: The use of visualization of geospatial data is found to have promising potential in a supply chain efficiency context. This is primarily found to be because the use of data is profoundly enhanced when managers visualize data points on a geographic map. Specifically, savings on logistics costs were unearthed through the visualization of freight modes, and a suggested switch from Air to Sea Freight.

Research Limitations/implications: This investigation considers only a single case company; future research should test the extent of potential effects of visualisation of geospatial logistics data across organisational boundaries, encompassing entire supply chains and/or industries. This study is the first of its kind to bridge the gap between visualization of geospatial data, the analytical usage of maps, and supply chain management. The disciplines of information management, decision-making and geography are explored in the paper, though only to the extent that they answer the research question.

Practical Implications
The authors demonstrate that geospatial data-visualisation holds good promise for managers and practitioners, and that cost saving opportunities can emerge from a cleverly constructed visual map.

Social Implications: Supply chain transparency and reducing commercial CO2 emissions are contemporary issues facing society. The authors expect that an increased use of geo-spatial visualisation by supply chain management academics and practitioners will bring society a step closer to addressing these concerns; future studies should explore this.

Originality/value
This paper is the first of its kind to connect the use and value of geo-visualisation of Supply Chain Management activities on a global scale – in a collaborative case-study research approach.

Keywords: Supply chain management, Supply Chain Optimisation, SAP Lumira, Data Visualisation, freight logistics, Collaborative Research, Pragmatism, Grounded Theory, GeoVisualization

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Last, but certainly not least we would like to thank our significant others, Victoria & Sabine. Your patience, encouragement and overwhelming kindness and support has guided us through this journey. With love and appreciation, thank you Victoria & Sabine.

Abbreviations

Terms	
Abbreviation	**Explanation**
BI	Business Intelligence
CH	Chr. Hansen
CMR	Collaborative Management Research
COL	Cost of Logistics
FC&E	Food Cultures & Enzymes (division)
HHN	Human Health & Nutrition (division)
IC	Inter-Company shipments
KPI	Key Performance Indicator
NCD	Natural Colour Division
OB	Outbound shipments
SC	Supply Chain
SCM	Supply Chain Management
3PL	Third-Party Logistics

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1 Introduction

This chapter initially presents the background and motivation of our thesis, as well as the choice of methodology and research approach. Next, it introduces the case company, and outlines the role of practitioners in the thesis process. Thereafter, the means of exploration are presented, along with the roles that we take on as researchers within our chosen paradigm. Last, in preparation for the development of the problem formulation, the terminology of the thesis is introduced, and the boundaries of the thesis research are delimitated.

1.1 Background

Wieland recently noted (Wieland, 2016) that there is a 'pervasive paradox in academia'. And unfortunately, research conducted at business schools often offers little or no actual value to practitioners (Carmen Nobel, 2016). In her September article, Nobel assembles the examples and opinions of highly regarded Harvard Business School educators and explores reasons and solutions to this paradox. One key take-away from this publication is that the 'disconnect between practitioners and academics', adds to the perception that contemporary business research is not 'useful' to those who need it.

Our thesis asserts that an academic field like Supply Chain Management (SCM), which is dominated by the positivistic paradigm and quantitative survey research (Gammelgaard, 2004), is limited in application (Näslund, 2002). The argument is also explored within the context of research methodology: several authors have claimed that if researchers within an academic discipline only conduct research that is the same as everyone else's, then the usefulness of that research will be questionable (Näslund, 2002; Näslund, Kale, & Paulraj, 2010). We interpret these different perspectives as a call by SCM academics and practitioners to conduct research that is useful and closer to organizations. Our thesis is an attempt to answer that call. Following suggestions by Shani & Coghlan (2014) and Gammelgaard (2004) re: increasing the relevance of SCM and logistics research, we suggest that there is an important role for pragmatic, collaborative research done using the systems approach.

1.2 Presenting the Case Company

This thesis was created in collaboration with the case company Chr. Hansen (CH). CH is a global

bioscience company, leading industry in the production of natural solutions for nutritional, pharmaceutical and agricultural industries. Among other things, CH specialises in making the bacteria cultures that go into the world's supply of yogurt, and in the natural colours that are used in beverage and confectionary products. The company has been able to grow its revenue by around 10% annually in the last years and projections indicate this rate of growth will continue in future; CH has reported revenue of €949 million in 15/16. Since it was founded in 1874, the company has expanded to 30 countries, directly employing 2.800 people across their divisions and business units. Headquartered in Hørsholm, Denmark, CH has production facilities in France, Germany, US and China, providing innovative natural solutions to customers in more than 140 countries. The primary locus of Supply Chain (SC) control is in Avedøre, and was the primary location for our on-site visits.

Recently several authors have explored issues associated with global SCs (Suarez-Barraza, Miguel-Davila, & Vasquez-Garcia, 2015) and the need for the effective and transparent management of them (New, 2010). Global business activity inevitably leads to complex global logistics and SCs. This complexity is associated with challenges that need to be addressed. In the interest of finding such a solution, a collaborative process was initiated in Autumn 2016 between CH and ourselves. Together we decided that assisting in the visualization of CH's global outbound (OB) and inter-company (IC) shipments was a task of great importance, as it could lead to better understanding and optimization of their complex global SC. Specifically, we embarked on this collaborative process with the dual intent of visualizing CH's Global SC, and expanding our practical and theoretical knowledge of SCM. The opportunity for logistics optimization was a key focus of the GeoVisualization case work conducted in this thesis.

1.2.1 Clarification of role

As 'scholar-practitioners' (Tenkasi & Hay, 2012) we have been in close collaboration with CH. CH provided us with an on-site workspace, access to meetings and interviews, software licences, and their Cost of Logistics (COL) report. We have not been remunerated for our collaborative work with CH, though the organization invested many hours of their employees' time, printing, lunch, coffee, in addition to providing us with relevant company documents.

1.2.2 Introduction to Lumira

After helping to refine our research purpose, CH provided a licence for the software package *SAP Business Objects Lumira*. This is the software that we used in the thesis for analysing the COL report and visualizing the IC and OB shipments of CH. Visual outputs from these analyses were used multiple times to complement the written word. Before our collaboration with the firm, the program had been used for selected one-off projects by two different members of the Business Intelligence (BI) and IT department. Over the last 6 months, and in the specific context of the CH's Global Logistics department, we have effectively become super-users of Lumira.

With some minor exceptions, CHs entire enterprise is connected to SAP, the BI module and the central SAP data warehouse. SAP is CH's Enterprise Resource Planning (ERP) system, and is used for most things in the organization, within and across departments, sites, and countries. SAP data warehouse collects and aggregates all customer orders and shipment data, from which the COL report is exported. The logistics department then adds geospatial data to this dataset, thus enabling later GeoVisualization in Lumira.

SC GeoVisualization is an exciting tool for an organization that is mostly connected. It makes the visual analysis more complete, and leads to greater potential for the sharing of holistic and actionable knowledge across different departments and sites.

1.3 Introducing GeoVisualization

This thesis includes an ambitious and structured literature review. Its first goal is to identify an academic gap worth exploring. Its second goal is to lay out the theoretical building blocks which then support development of sufficiently detailed, reflexive, practical, and holistic answers to the problem formulation of this thesis. The literature review will go about that goal in four main ways: **First**, the academic gap will be defined. **Second**, the nature of SCM will be delineated, and the goals and complexity of effective SCM will be introduced. **Third**, the methods and theoretical contributions of Data Visualization and Cartography will be described and synthesized. **Fourth**, a summary and evaluation of the academic literature will be presented, and the importance of GeoVisualization for the purposes of SCM will be discussed. Understanding all four areas of the literature review is important to contextualizing the casework, the discussion and the practical implications found in this thesis.

1.4 Definitions

The literature review chapter includes definitions of terms used throughout the thesis. In the interest of providing a clean reading experience these definitions are presented here in the Introduction, as well. The **holistic definition of Supply Chain Management** is put forward by Gammelgaard.

> *"Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics activities. Importantly it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies*" (2010, p. 120).

The definition of **GeoVisualization**, is put forward by MacEachren and Kraak.

> *"GeoVisualization integrates approaches from visualization in scientific computing, cartography, image analysis, information visualisation, exploratory data analysis and geographic information systems to provide theory, methods and tools for visual exploration, analysis, synthesis and presentation of geospatial data".* (2001 in Hernandez, 2005, p. 210).

We have chosen to synthesize the above definitions. Our definition of Supply Chain GeoVisualization follows here, and is used throughout our thesis

> *Supply Chain GeoVisualization is the theory, methods and tools for the interactive, visual exploration, analysis, synthesis and presentation of geospatial SC data, to aid in the holistic and purposeful management of the complex and multi-actor activities of SCM.*

1.5 Purpose

The thesis will explore the extent to which SC GeoVisualization proves effective in the different realms of SC insight, understanding, communication, optimization, and Management. These are different SC effects that can be or are affected by SC GeoVisualization, and we explore these effects through the application of the tool Lumira upon the logistics data of CH. This discussion leads to the following problem formulation:

How can the SC GeoVisualization of logistics data lead to SC insights and understanding, and to what extent can that greater understanding lead to SC optimization and cost savings?

1.5.1 Focus Points

The research purpose has been identified collaboratively with CH, and it contributes in three pragmatic ways to both Academia and SC Practice.

1) The thesis includes a structured literature review which identifies an academic gap of SC GeoVisualization, and provides background on the building blocks of SC Complexity, sound mapping practices from Cartography, and Data Visualization for better Decision Making.

2) The core of this thesis is a pragmatic, in-depth case study, using the Collaborative Research approach, and firmly grounded in the holistic Systems Theory school of SCM research. Academic contributions include a detailed and structured argument for the choice of Collaborative Research. Specifically, the research process chapter and the associated meta communication found within the thesis document add to the procedural validity of this collaborative research project.

3) During the course of this project we developed and maintained fruitful and professional relationships with SC practitioners at CH. Practical contributions resulting from that collaboration include: specific case-based explorations of the cost saving opportunities present in a switch between Air and Sea freight, plus a conceptual model for SC GeoVisualization.

1.5.2 Delimitation

This thesis uses the holistic definition of SCM put forward by Gammelgaard (2004), but we do not intend

to cover every facet of the discipline. As should be clear, this thesis has nothing to do with sourcing practices, and very little to do with supplier negotiations, though they both exist within the broad scope of the definition presented above. The holistic nature of SCM is explored only to the extent that it contributes to the 'greater understanding' of the problem formulation.

The delimitation of this thesis has three additional areas worth mention: borders of the literature review, 'truth' of the research approach, and unexplored cost savings. The literature review of this thesis touches upon three main fields: SCM; cartography, and data visualization. We believe that we argue convincingly for our decision to include two disciplines outside of the one we are most familiar with – SCM – but we recognize that we've only superficially dealt with, for example, the field of cartography. Different research projects, based in different disciplines, could have answered our area of research from different angles.

As well, some of the literature used in the review draws a link between data visualization and better decision making. Better decision making has been linked to better SC performance, yet there are few sources that draw a direct link between data visualization, better decisions, and greater SC performance. We have therefore chosen to shorten that link, and suggest that SC GeoVisualization contributes directly to SC oversight and greater performance. We recognize that a more ethnographic research project could have focused more on the environment in which decisions are made, and could have resulted in different and valuable findings.

This thesis attempts to address the problem formulation in a collaborative and pragmatic fashion. The findings presented in this thesis are what we and the SC practitioners we collaborate with deem to be useful. Different research paradigms lead to different conclusions, and we do not assume that ours are the most important. We do however believe that they are useful to us, to academia, and to the organizations that we collaborate with.

As part of our collaborative research, we explored the cost savings opportunities that were deemed most useful, both by ourselves and by the SC practitioners that we worked most closely with. Specific examples of the benefits of SC GeoVisualization are explored in the text to come. We also believe that there are multiple cost savings and opportunities for SC optimization that have not yet been discovered. We view these 'yet to be discovered' opportunities as proof of the great potential for SC GeoVisualization.

1.6 Outlining Chapter

The opening chapter, **methodology**, outlines the paradigm, methodology and research approach employed in this thesis. This chapter feeds into the **research process** chapter, which in turn provides a detailed walk-through of the steps taken in the literature search and review, as well as the data collection steps carried out in the thesis research process. Next, the **literature review** chapter identifies an academic gap, and integrates cross-disciplinary academic literature to build the theoretical building blocks for this thesis. Thereafter, the first part of the **analysis** chapter describes the knowledge that emerged from data gathering and analysis, and culminates with the creation a model for SC GeoVisualization. The specific **case work** is the second part of the analysis, and it applies two specific SC optimization cases to this model. Next, the **discussion** chapter outlines and discusses specific findings from the analysis chapter and compares them to the body of literature which is detailed in the literature review. Lastly, the **conclusion** chapter summarizes the results and findings and provides a cohesive answer to the problem statement.

2 Methodology

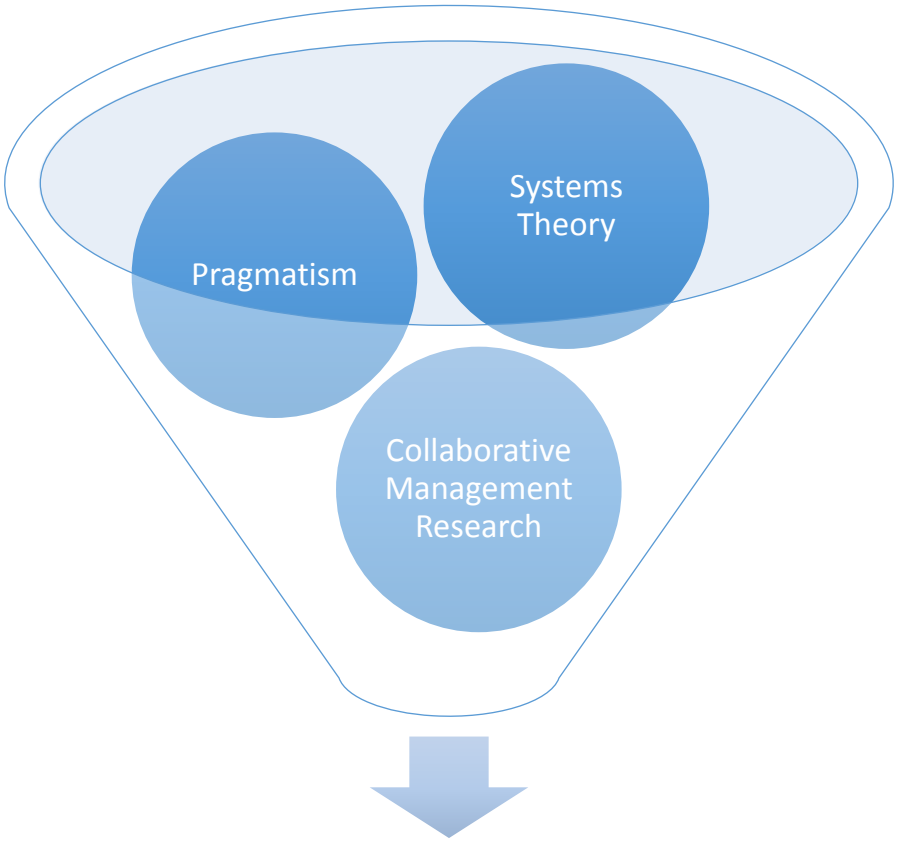


Figure 1: Synthesis of paradigm, methodology, and approach to research. Source: Own Creation

This thesis should be relevant for Logistics and Supply Chain Managers, as well as for the students and researchers making up the academic sphere of the discipline. It is said that logistics involves messy and 'wicked problems' (Ekwall, 2012; Näslund, 2002). The practice of logistics is therefore "based on holistic and systemic thinking and uses multi-disciplinary and cross-functional approaches" (Näslund, 2002). This suggests that the foundation for understanding is found in interrelationships within systems,

and the interpretation thereof. Considering such a perspective, our research approach tackles the often unstructured, or yet to be discovered managerial issues and organisational problems that exist in the real world. Solving those problems risks making a mess, and it is therefore important to strive for academic rigor and have a cleanly delineated methodology chapter.

The methodology of this thesis employs the systems approach. Our paradigm is pragmatism, and our approach to research is Collaborative Management Research (Canterino, Shani, Coghlan, & Brunelli, 2016). This synthesis of paradigm, methodology, and research approach is visualized in Figure 1 above, and serves as the three-part structure of this chapter. This chapter initially addresses the dominant methodology of SCM, and makes the argument that current academia could be more relevant to business. Hereafter, it discusses the 'usefulness' of the Pragmatic Paradigm. Lastly, the chapter argues to how the research approach of Collaborative Management Research is both academically rigorous and practical: being useful to the SC practitioners at CH, and beyond.

2.1 Paradox of Business Research

Recently, it has been noted (Wieland, 2016) that there is a 'pervasive paradox in academia', as research conducted at business schools often offers little or no actual value to practitioners (Carmen Nobel, 2016). In her September 2016 article, Nobel assembles the examples and opinions of highly regarded Harvard Business School educators and explores a myriad of reasons to explain and solve this paradox. One key take away is the 'disconnect between practitioners and academics', and notes there is a perception that contemporary business research is not 'useful' to those who need it. Nobel's article mirrors Mckinnon's (2013) suggestion that researchers' focus on getting published in the 'top' journals is detrimental to the relevance of their research field:

> Among other things, it can skew the choice of research methodology [towards positivism], lengthen publication lead times, cause academics to be disloyal to the specialist journals in their field, favour theory over practical relevance and unfairly discriminate against relatively young disciplines such as logistics (Mckinnon, 2013, p. 6) [comment added]

When the academic sphere places a higher priority on a journal's ranking than on practical use, it risks relevance in the real world: "the business world – and the rest of the world, for that matter – is losing out

on some serious brainpower and analytical reason" (Carmen Nobel, 2016). We interpreted the Carmen Nobel article as a call by industry to come closer to their problems and research something useful. And although we argue for a departure from the dominant positivistic paradigm, we do not condemn the role of quantitative and measurable data in SCM research entirely. Neither do the professionals in Nobel's article (2016). Indeed, a central focus of this thesis is analysing and visualizing a large quantitative dataset, thereby transforming it into something meaningful and useful.

Building on research by Monieson (1981), Näslund (2002; Näslund, Kale, & Paulraj, 2010) addresses the argument in terms of research methodology, claiming that if researchers within an academic discipline only conduct the same kind of research as everyone else, then the usefulness of the research will be questionable. In this section, we assert that an academic field like SCM, which is dominated by the positivistic paradigm (Gammelgaard, 2004), is limited in its application by business practitioners (Näslund, 2002).

Three initial conclusions can be drawn from this, and we argue that they justify our choice of methodology, paradigm, and research approach. First, because traditional journals publish academic 'knowledge additive' articles, with research that is rarely 'applied' (Mckinnon, 2013), SCM academics are not solving all the problems that practitioners need solved. Gammelgaard (2004) reckons that current research is 'useful, but just not useful enough' (p. 483). Second, this lack of practicality is damaging to the relevance of an academic field that is actually applied, practical, and 'easily lends itself to identifying research questions that are of relevance to business managers' (Näslund et al., 2010). Third, the first factor could explain the difficulty we had finding relevant articles for both our research approach (collaborative management research), and theoretical discussion (data visualization in a SCM setting). Ultimately, we believe that this thesis provides a new and important perspective, and that it justifies a new and pragmatic way of conducting research, which is useful for academics, practitioners, and students. To increase the relevance of SCM and logistics research, we suggest that pragmatic, collaborative management research using the systems approach, should play an important role.

2.2 Research Philosophy: Pragmatism

The challenge identified above was the issue of usefulness. The Pragmatic paradigm is a direct response to that issue, and one that we embrace whole heartedly. Pragmatism is not a veneer applied to this paper out of academic laziness. Pragmatism, its theory of truth, and its logic *abduction*, have been, to the best of our ability, threaded throughout the entire document, and has influenced many of the choices outlined in the research process chapter. Pragmatism is also inherent to the systems approach found in SCM research (Gammelgaard, 2004), and since pragmatism emphasizes the usefulness of *specific tools* in *specific situations* (Egholm, 2014), we find it fitting with the collaborative research process of this thesis. We use the specific tool of Lumira to approach the goal of SC optimization within the specific setting of CH's global logistics department. Examples of findings that are useful in the context of CH's supply chain are shown in the 'Case Works' and 'Practical Implications' chapters. These chapters also describe the limitations of GeoVisualization, and the challenges that its implementation presents for a supply chain context.

The truth theory of pragmatism acknowledges things to be true, when the investigations conclude that the results are *useful* and *helpful* in explaining phenomena and events and moving practice and academia forward (Egholm, 2014). Our thesis applies abductive reasoning, also known as *inference to the best explanation* (Egholm, 2014). Abduction involves both the application of inductive reasoning (siphoning from broad to specific) and deductive reasoning (specific hypotheses being proven or disproven through a comprehensive and broad search). Examples of abductive inference are given in the "casework chapter", where conclusions are made based on Lumira's presentation of the SC, on our understanding of the observations made while 'hanging out' on-site, and on our interpretation of SCM literature from our SCM graduate program.

2.3 Research Approach: Collaborative Research

This thesis embraces CH's need for a practical solution to visualizing their geospatial data, and calls for academics to engage in research that is more practical, hands-on, and context-rich, yielding outcomes that may be useful to both industry and SCM academia. Our approach places this project firmly in the realm of pragmatism and addresses the 'paradox' mentioned earlier in this chapter. The solution that this thesis suggests, and works with for its duration, is a focus on a robust, valid, and 'useful' approach to

research. This approach, called Collaborative Research, is a field of Action Research, and it is both fitting and crucial to SCM.

Bryman & Bell offer a definition of Collaborative Research as follows:

> [...] an approach in which the action **researcher and a client collaborate in the diagnosis of a problem** and in the **development of a solution** based on the diagnosis. A common theme among management and business researchers is that action research output results from '**involvement with members of an organization'** over a **matter of 'genuine concern to them'** (2011, p. 413, emphasis added).

Passmore, Woodman, & Simmons offer another:

> […] an effort by two or more parties, at least one of whom is a **member of an organization** or system under study and at least one of whom is an **external researcher**, to **work together** in learning about how the behaviour of managers, management methods, or organizational arrangements affect outcomes in the system or systems under study, using **methods that are scientifically based** and intended to reduce the likelihood of drawing false conclusions from the data collected, with the intent of both **proving performance of the system** and **adding to the broader body of knowledge** in the field of management (2008, p. 20, in Canterino et al., 2016, emphasis added)

The above two definitions complement each other, with the former being simpler and easier understood, and the latter being a more comprehensive and holistic example that also comments on issues of procedural validity. Both definitions involve researchers and practitioners as active parts of the research, and both focus pragmatically on the usefulness of the research and its outcomes. Bryman and Bell's definition refers of course to Action Research, and it would therefore behove us to state clearly that this thesis is <u>not</u> conducting Action Research. We believe, as others have before us, that the action research approach should be viewed as an umbrella term – one that includes Collaborative Research (Canterino et al., 2016). The simplest distinction between the two approaches is that action research literature emphasizes that 'action' implies and involves a change process within the organization – an aspect that is outside the scope of involvement for this thesis. Therefore, we draw upon the action research and case

study literature, only to the extent that it helps us understand our Collaborative Research with CH and our role in it. Action Research is itself a form of case study, and we find ourselves therefore in a similar situation that Näslund et al., (2010) found themselves in, when critically reviewing action research in SCM – needing to reference case study literature. We hope that our readers will forgive us the following simplistic connections between the different forms of research: not all case studies are action research, and not all action research is collaborative research, but all collaborative research is action research, and all action research is case studies. A contains B, which contains C. We will therefore briefly address action research and case study literature where relevant, particularly when we tackle the matter of our academic rigor through procedural validity (Stuart, McCutcheon, Handfield, McLachlin, & Samson, 2002; Yin, 2003).

2.3.1 Naming Conventions

In the interest of simplicity, our approach to research is called Collaborative Research in this thesis. It is worth noting that different authors cited in this chapter refer to the approach as Collaborative Management Research (CMR) (Canterino et al., 2016; Passmore, Stymne, Mohrman, & Adler, 2007; Shani & Coghlan, 2014; Tenkasi & Hay, 2012) thus highlighting the 'management' aspect, or Collaborative Research (Börjesson, 2011) keeping the interaction with business implied. Collaborative management researchers (Canterino et al., 2016) and action researchers (Berg, 2004) locate the approach as a type of Action Research, and avid SCM Action Researcher Näslund (2002; Näslund et al., 2010) refers often to the collaborative nature of Action Research. Other SC and Operations Management academics simply note that research of a collaborative nature, or at least research of collaboration within supply chains, is a good idea (Daugherty, 2011; Fawcett, Magnan, & McCarter, 2008; Parente, Lee, Ishman, & Roth, 2008). It is worth noting, however, that these researchers were not conducting collaborative research or action research. In an exception to this naming convention we borrow a page from Canterino et al., (2016) and identify our two closest contacts at CH as members of our CMR team. Our interaction with them is described in more depth in the research process chapter.

2.3.2 Role of Researchers

A large aspect of conducting Collaborative Research involves rigorously explaining the extent and nature of the collaboration – and the researchers' role in it. We have seen ourselves as partners with the 'study population', making the research considerably more value-laden than other, more traditional endeavours. Respondent 5 has intimated that he sees us as the 'super users' of the software Lumira, and that we're occupying a role like consultants. Likewise, both practitioner members of the CMR team respect the notion of academic relevance in our collaborative relationship, and we define our role therefore as 'scholar-practitioners' (Tenkasi & Hay, 2012). More of the intricacies of our access and direct involvement with the case organization is described in the 'research process' chapter, applied in the 'case work' chapter, and discussed in the 'discussion' and 'implications' chapters. Based on the assumption that our thesis will contribute with some useful and actionable knowledge for CH, our CMR team members gave us exceptional access to richly detailed and sensitive company documents and to qualitative data in the form of on-site workspace and interviews. To their credit, Respondent 5 and 7 seem genuinely interested in the academic output of this thesis as well – a situation that sits well for the collaborative effort of graduate students as a "two-way process whereby the researcher becomes involved in the generation of research outputs […] a process wherein the research is conducted 'with people', rather than 'on people'" (Bryman & Bell, 2011, p. 420).

Since collaborative research aims at a redistribution of power between the researchers and the participants (Berg, 2004), this thesis considers the members of CH as active participants and contributors, rather than passive subjects. Likewise, we were active participants/contributors, rather than passive observers. Ever pragmatic, we came together with the practitioners of our CMR team and collaboratively identified potential problems. Our 'Analysis' and 'Discussion' chapters sought to unearth the underlying causes for these problems and the 'Casework' and 'Implications' chapters explore possible interventions (Berg, 2004). The problem formulation and research questions of this thesis are based upon a mutual understanding of the issue – overview of freight logistics – and the context of the setting – CH's global outbound supply chain.

2.3.3 Procedural Validity

Critiques of case studies, as well as collaborative and action research including qualitative aspects, state that these forms of studies are too subjective, too difficult to replicate, lack transparency, and include problems of generalization (Bryman & Bell, 2011). Our response to this criticism, and our justification for our more subjective, true-because-its-useful, research approach is addressed now. Our research process was a collaborative in-depth case study of an organization and it certainly includes qualitative data. It also includes a richly detailed exploration of a quantitative dataset supplied by CH. The two types of data, and their interplay, complement each other. The delineated research process chapter provides procedural validity of each type of data; our role in the organization, and the actions we've taken. Where quantitative studies rely on measurement, qualitative validity is created by creating transparency in the research process (Bryman & Bell, 2011). Case studies – an ideal method in systems analysis (Gammelgaard, 2004) – are judged valid 'when their research process is detailed' (Yin, 2003) The rigor and quality in our research approach is accomplished through procedural validity and reliability (Stuart et al., 2002).

The classical elements of *external reliability*, *internal reliability*, and *internal validity* are accomplished through the detailed description of our research process chapter. There we describe the actions we have taken, and our reasons for doing so. Simply put, we chose methods that we, and our CMR team, deemed to be both useful and academically relevant. We believe in truthfulness and usability. Since our work has been useful to our own learning and to the logistics activities of CH, we assert that we're delivering a credible, transferable, dependable, and confirmable thesis (Bryman & Bell, 2011). We don't see objective observation as possible, and believe that any attempt to be completely objective would be a disservice to our readers. The ontology of pragmatism is neither positivist nor constructivist: pragmatists consider that social phenomena is interpreted by individuals, and that the meaning of social phenomena is determined from outcomes (Egholm, 2014).

Therefore, the reality that we are presenting/visualizing in this thesis, is dependent upon the context of the phenomena being studied, and is 'true' when useful (Egholm, 2014). We assert that our background, experience, and personal characteristics have shaped our collaboration with the academic experts and practitioners at CH. We also expect that their background, experience, position, and age have affected the way that they interact with us. We have consciously striven to reduce damaging bias through academic rigor and descriptions of our procedural validity (Stuart et al., 2002), but we accept that our

findings are relevant in the context they're presented. Being objective about our attempt to define a truth in this thesis would not have been useful, and has therefore never been the goal of our research.

2.3.4 Sources of Collaborative Research & SCM

While not a new idea, collaborative research, has not been used extensively in the field of SCM. The references compiled in the introduction to this section represent a handful of the very small number of researchers conducting or mentioning collaborative research, some of them in SCM. When Näslund (2010) critically analysed the quality and extent of Action Research within the field of SCM and Logistics, he was disappointed to find only 26 articles out of over 3000 searched. We can corroborate his finding, as our EBSCOhost subject term search for 'Action Research AND Supply Chain Management' gave 24 results within the Business Source Complete database. In addition, our subject searches for 'Collaborative research', 'Collaborative Management research', and both of those plus SCM, gave no relevant results, and in some cases no results at all. Only after changing the search to 'CMR' did we find one relevant result (Canterino et al., 2016) out of 22 database entries returned. Unlike 'Action Research', 'Supply Chain Management' and 'Data Visualization', neither 'Collaborative Research' nor 'Collaborative Management Research' are recognized subject terms in Business Source Complete. Our search in Thomson Reuters Web of Science for 'Collaborative Management Research' returned 10 results, all of which used the research approach. In an instance of serendipity, about half of the results were relatable to the field of SCM. Therefore, in addition to Canterino et al. (2016) which was also found in this search, three of the articles were downloaded for this paper, and are used to support our choice of Collaborative Research for this thesis. Outside of the main databases (EBSCO, Web of Science) which are suggested for student usage by CBS library and experienced CBS Academics, SAGE Publications includes a good selection of academic textbooks on the topic of Collaborative Management Research. Sources from that publisher are also included in this section.

Scant pickings one could say, but relevant pickings nonetheless. The 'paradox of research' section offers one possible reason for the paucity of Collaborative Research in SCM. In addition to providing pragmatically useful findings and hands-on experience to Christian Hansen, this thesis should serve as a convincing argument for the value of more applied, holistic, and collaborative research that contributes to the solving of real industry problems while being close to the problem at hand. In the context of our

collaborative research, we agree with the assertions of Näslund (2002; Näslund et al., 2010) and Meehan et al., (2016): 'useful' (action) research is relevant for, and important to, the future development of the Logistics and SCM discipline.

2.3.5 Linking Research Process

The material of this thesis is introduced here, used throughout, and thoroughly described in the research process chapter. The collaboration between organization and researchers includes a structured literature review, in-depth analysis, collection of qualitative data, and the practical use of a data visualization software in the visualization and analysis of sensitive and richly detailed company documents – the Cost of Logistics report and associated files. To assure academic rigor – hereby responding to criticism of collaborative research specifically, and qualitative and subjective action research and case studies in general – we make a great effort in this thesis to achieve procedural rigor, reliability, and validity (Stuart et al., 2002). This is accomplished, insofar as we believe, through the adequate search for, compilation of, and structured analysis of the material of this thesis.

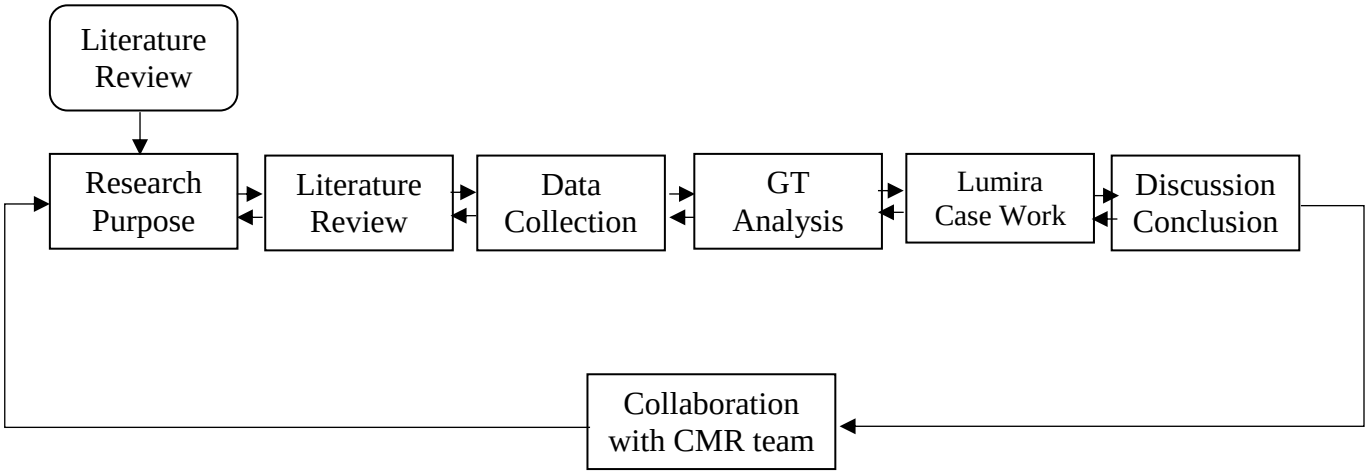
The qualitative data that will be described in the research process chapter to come, was gathered during regular on-site visits and is comprised of observations and findings derived from workshops we led, working interviews, and meetings with the two CH members of our CMR team. This data is analysed via the structured coding of grounded theory, and the collection and analysis is subject to the iterative process inherent to grounded theory. The thesis is complimented by a structured literature review. In addition to refining our research purpose and identifying a gap in contemporary literature, this literature review compliments our analysis, casework, and theoretical discussion of the actors, behaviour, of the SC practitioners of the Global Logistics department of CH.

3 Research Process

This chapter contains a detailed description of the research process for this thesis as called for by the Collaborative Research approach to increase the academic rigor of the research process (Näslund, 2002; Näslund et al., 2010; Passmore et al., 2007; Tenkasi & Hay, 2012).

Model 1 below outlines the major steps that the thesis research process went through. The steps are presented chronologically. As the arrows between them suggests, while they *happened* in that order, their

development was iterative: 1) Research Purpose; 2) Literature Review; 3) Data Collection; 4) Grounded Theory Analysis; 5) Lumira Case Works; 6) Discussion & Conclusion.



Model 1: Research Process. Source: Own Creation

3.1 Research Purpose Development

This section provides an overview of the collaborative research process that has developed over the months of October 2016 to January 2017. The research process began with a rigorous brainstorming of our shared interests and competencies. The resulted in our contacting the bioscience company Chr. Hansen – a choice that was motivated by a positive previous experience of collaborating academically with CH. After e-mail correspondence, all members of the proposed CRM team met in October, and agreed on goals and expectations for the collaboration.

The research purpose, GeoVisualization of logistics data, originated from CH's desire to have an overview of the global company logistics activities on a continuous basis. This would allow the company to avoid the expense and inconvenience of conducting new shipment analyses from scratch every time they needed one. Thus, the research purpose was formulated primarily based on the industry problems of CH. This focus is in line with Börjesson (2011) who states that the purpose of collaborative research is to tackle problems faced by practitioners, and thus produce knowledge that is relevant to both business managers and the research community. Throughout the process, we received valuable and constructive feedback from the CRM team, and from the thesis supervisor. Their comments added to our understanding and contributed to slight modifications of the research purpose and process.

We attempted to keep the stakeholders informed of various activities surrounding the research process, and to give and receive feedback (this was enabled by our weekly visits to CH's site in Avedøre). This is in line with Berg (2004) who argued that informing and empowering people to work collectively is an integral part of conducting collaborative research. Likewise, we held a group workshop during a morning meeting in February 2017, where the logistics department were presented with the current results – as of February – followed by a discussion session where all stakeholders were invited to contribute. The next part of the process was the structured literature search, and analysis of said academic literature. This literature guided the development of the process, and aided in forming relevant questions for the subsequent parts of the research process.

3.2 Literature Search & Review

This section has been inspired by different experts and literature and is divided between three primary sub-sections: 1) the role of experts – the 'who' of inspiration, the choice between ideal structures of a literature review; 2) the 'what' of inspiration; and 3) the actual steps, results, and boundaries of the literature search and review process. Whenever possible and relevant, effort has been made to visualize the results of the different sections as well as the links between them.

The problem formulation guided the process of searching for the sources, selecting which ones to abstract-skim, which ones to download, as well as the category that they were subsequently placed in. Though the research purpose has long been the same, the problem formulation has been slightly modified along the way, based on the availability of both empirical data, and academic sources. This means that we have adjusted our expectations for the outcome of the thesis, based on the realistic expectations for what empirical data, and academic sources would be able to unearth (Rienecker & Jørgensen, 2006). Sources will be quoted to the degree that it aids in emphasizing important points.

3.2.1 The Role of Experts

We developed and maintained professional working relationships with industry (CMR team and CH practitioners), and academic (library and supervisor(s)) experts. The choice of literature review approach was inspired by several academic experts met under the course of studies at Copenhagen Business

School. They contributed to the construction of this thesis, and the effect of their input on the literature review will be discussed here – as well as in later chapters – and presented in Model 2 later in this section.

3.2.1.1 Academic supervisors

Two months into the thesis process our first academic supervisor bowed out due to unforeseen and unavoidable personal issues. Before her departure however, she provided us with a good example of a structured literature review (Shollo & Kautz, 2010). In mid-January 2017, an agreement was made between ourselves and a new academic supervisor, an event that intersected with the literature search phase of the thesis process. The input of our supervisor helped give direction to the literature search, and challenged us to realign our research purpose through the early creation of a thesis abstract. This affected the inclusion/exclusion criteria of articles in the second round of abstract reviewing, as well as the identification of relevant disciplines. Furthermore, the academic supervisor's written and oral feedback on the preliminary analysis of the literature, as well as subsequent sections, inspired a short search for extra articles as well as a re-consideration of articles that were originally excluded – step 6 in Model 2. Our Academic supervisor was very much a part of the collaboration of this thesis, and could be considered an honorary member of our CMR team.

3.2.1.2 Role of CBS Academics

CBS's Operations Management department has a deep pool of SCM experts, and one Associate Professor's blog, SCMresearch.org (Wieland, 2011 – 2017), has inspired this literature search and review process. Specifically, it inspired us to create a scoring method for SCM journal rankings (Appendix: 1), as well as highlight the risk inherent to choosing journals based only on 'merit' (Wieland, 2012; Mckinnon, 2013). The preliminary article pool of this thesis included a fair number of articles from past SCM curriculum. Specifically, in addition to the professors and courses mentioned above, the academic and practical expertise of Professors in charge of the courses *Managing Global Supply Chain Operations*, *Decision Making in Supply Chain Management*, *Business Process Excellence*, and *Supply Chain Strategies*, were judged as significant enough to merit the initial inclusion of seventy articles from their curriculum, in the literature review process. The extent to which these articles were *used* is detailed in later sections and chapters – literature review, discussion and the like.

3.2.1.3 Role of the Library Experts

CBS library is a treasure trove of literature, knowledge, and expert academic researchers; tapping into that has influenced the tools and process of this thesis. We attended a literature search/reference management workshop in January 2017, and were exposed to best practice search techniques and use of the reference management system, Mendeley. At a later stage in the literature search, an appointment was made with a library expert and CBS researcher. This meeting expanded upon the techniques of database searching developed over our past five years of under-graduate and graduate education, as well those presented in the library workshop above. Techniques included the use of '*' and '?' as wildcards, as well as best practice for finding literature reviews and conducting subsequent backwards-looking reference searches and forward-looking citation searches. The meeting with the library expert also benefitted the thesis through the joint finding of several SCM literature reviews. In later correspondence, he also helped us identify the top ranked geography and cartography journals (Appendix: 2) – a scientific field with which we (and our experts) are less familiar with.

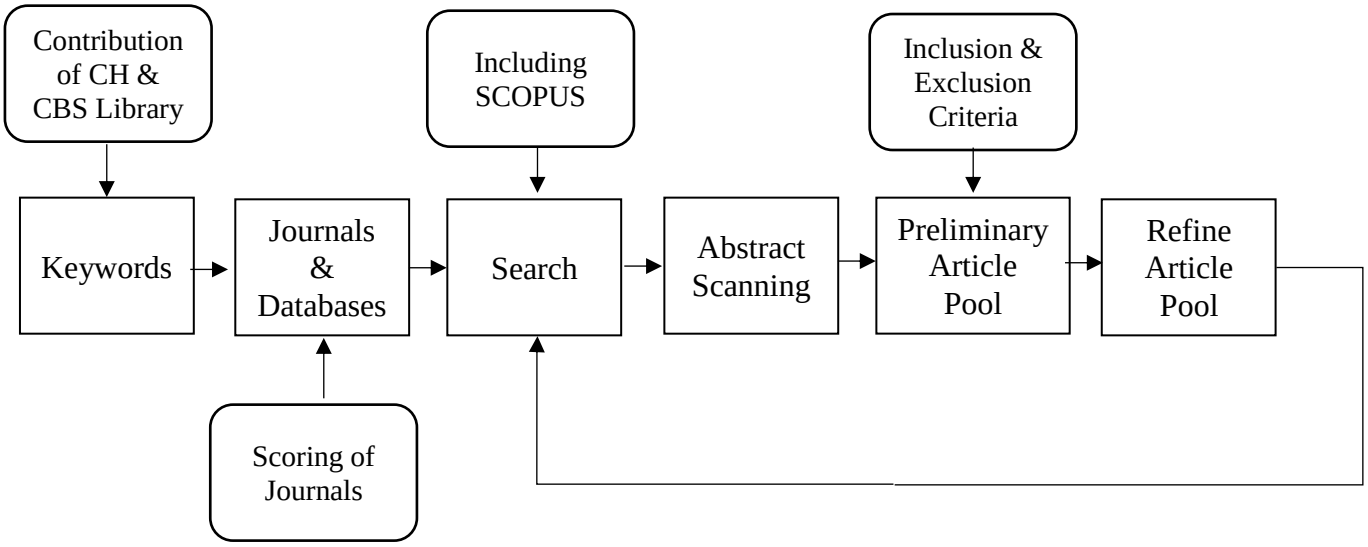
3.2.1.4 Role of CMR Team

In addition to jointly setting the direction, delimitation, and purpose of the thesis, initial meetings with the members of our CMR team helped unearth keywords that were later used in the literature search process. The role of CH was naturally a practical nature, so keywords that were discussed in early meetings were converted to academic search terms, when conducting journal and database searches.

3.2.2 Methods of a Structured Literature Review

An early and important step in any master's thesis is the search of existing literature, and the subsequent analysis of the material found. Accordingly, reviewing the main concept, ideas and research relating to the chosen areas of interest, forms the basis for the writing of the literature review (Bryman & Bell, 2011). In the interest of applying and fulfilling the requirements of academic *rigor,* it is suggested that this literature review be as structured as possible, as well as transparent and detailed in its description of steps taken (Bryman & Bell, 2011). The extent to which this thesis follows the rules of a structured (Shollo & Kautz, 2010) or *systematic* literature review as outlined by Bryman and Bell (2011) is

dependent upon the chosen paradigm of Pragmatism, the iterative research process of Collaborative Research, as well as constraints particular to graduate students. Bryman and Bell (2011) suggest that graduate students are commonly constrained by some of the following elements: the lack of a significant research budget; a strict six-month timeline (CBS timeframe: November 15th, 2016 to May 15th, 2017); and the relatively 'lowly' status of students when it comes to assembling a panel of experts in methodology and theory (Bryman & Bell, 2011). To the best of its ability however, and in the context of these constraints, this thesis was by the structured literature review of Shollo and Kautz (2010). The search for, and use of literature for this thesis was focused, purposeful, and structured (Rienecker & Jørgensen, 2006, p. 236) – but not strictly positivistic/systematic. The development of the search process is visualized in Model 2 below. It shows that its initial structure was inspired by Shollo and Kautz (2010), and was later adjusted through the iterative use of industry and academic experts.



Model 2: Literature Search & Review Process. Source: Own Creation, inspired by Shollo & Kautz (2010).

3.2.3 Steps of the Literature Search and Review

The following section outlines the literature search and review process by explaining the six steps in Model 2. A number of steps were conducted to rank the journals and data bases in the literature search and review, but in light of Mckinnon (2013) article on the dangers of depending too heavily on top ranked journals, we chose to move our extensive and subjective journal ranking to Appendix: 3.

3.2.3.1 Keywords

Keywords were developed out of the problem formulation found in the introduction of this thesis, as well as together with the CMR team. The final keywords chosen, their combinations, and their search streams are as follows: Business Intelligence AND Geospatial, Business Intelligence AND Supply Chain, Supply Chain AND Data Visual*, Business Intelligence AND Vis* AND Logistics OR Supply Chain, Geographic Information Systems AND Supply Chain, Geographic Information Systems AND Business Intelligence, Location Intelligence AND Business Intelligence, Information Management AND Data Visual*, Data AND Visual* AND Logistics, SAP AND Geo*, SAP AND Data Visual*, Data AND Vis* AND Geospatial, Supply Chain AND Vis*, Supply Chain AND Geospatial, Logistics AND Geospatial, Logistics AND Vis*, Logistics AND Vis* AND Map*, Logistics AND Geo* AND Map*, Logistics AND Geo* AND Map* AND Vis*.

During the database searching, a good supplementary process was experienced between the two researchers – as advocated by the teaching of both AR and Pragmatism. This is shown here by search streams that complemented each other, as well in round two and three of the abstract review, where the sorting in Mendeley got deeper and more specific (moving from core or not, to the thematised sub-folders). We regularly inspected the work of each other, and it became clear that the gaps in each of our individual methods were covered by the other. An example of this came clear when one of us searched for Supply Chain and Vis*, and came up with 3000+ results. Upon inspection of the other's method, it was noticed that the other had searched for 'Supply Chain' and 'Data Visual' and gotten a more satisfying 82 results.

3.2.3.2 Journals & Databases

Database searching was conducted in EBSCOhost's Business Source Complete using the keywords and combinations outlined above. No specific timeframe was set on the search, as it was our initial goal to be as inclusive as possible). We recognize of course that we could have complemented our search with the use of Thomson Reuters Web of Science – we did so when compiling our methodology literature – but we do think that the detail of this literature search process is quite sufficient for a master's thesis.

The combined number of the keyword searching led to an initial abstract scanning of 2775 papers. Inspired by the research experts of CBS library, tactics such as using the roots of words, wildcards, and

(subject terms) vs. (all fields), were used to get the most out of the database. For example, 'vis*' was used first to capture visualization but was later discontinued for the use of 'visual*', as moving away from 'vis*' excluded out of scope results that included 'visibility'. Likewise, using 'geo*' (subject terms) and specifying NOT 'geo*' (authors) included 'geography', 'geographic information systems' and 'geospatial', but excluded irrelevant entries by 'George'. Differences between the spelling of American and Commonwealth English were also considered for one keyword: Visualization. Visualization (z) is the only correct spelling in American English, while both Visualization (z) and Visualisation (s) are accepted in the Commonwealth. Visuali?ation was used in EBSCOhost to include results with both spelling variants and therefore not accidently exclude anything relevant. This thesis consistently spells visualization with the Z.

3.2.3.3 Searching & Use of SCOPUS

SCOPUS was used to check the usefulness and reputation of some of the article authors. It was also applied to consider the references (backwards) as well as the citations (forwards) of interesting literature. Furthermore, SCOPUS was used to explore the scientific fields of Cartography and Geography – which we did not have any prior knowledge of. It was helpful in finding the well cited textbook "Cartography: Visualization of Spatial Data" (Kraak, 2003). When searching for other scientific material, we used only the filters of SCM and logistics, and hereby found (Farris, 2010) – which lead to the exploration of (Carvalho, Machado, & Tavares, 2012). Via a shared reference search, the work by Hennig (2016), about digital cartography, was found. The academic work of (Kraak, 2003) is well-cited, but not in the SC field (excepting Farris, 2010). Kraak's published article (built from the conference paper) is in Dutch originally - and is not cited in EBSCOhost or SCOPUS.

3.2.3.4 Abstract Scanning

The endeavours described above resulted in a collected pool of more than 200 articles in a shared 'watch folder' in MS OneDrive, that were automatically transferred into a shared folder in the reference system, Mendeley. The next step in the process involved reading the abstracts, while making sure to correct the citation information along the way.

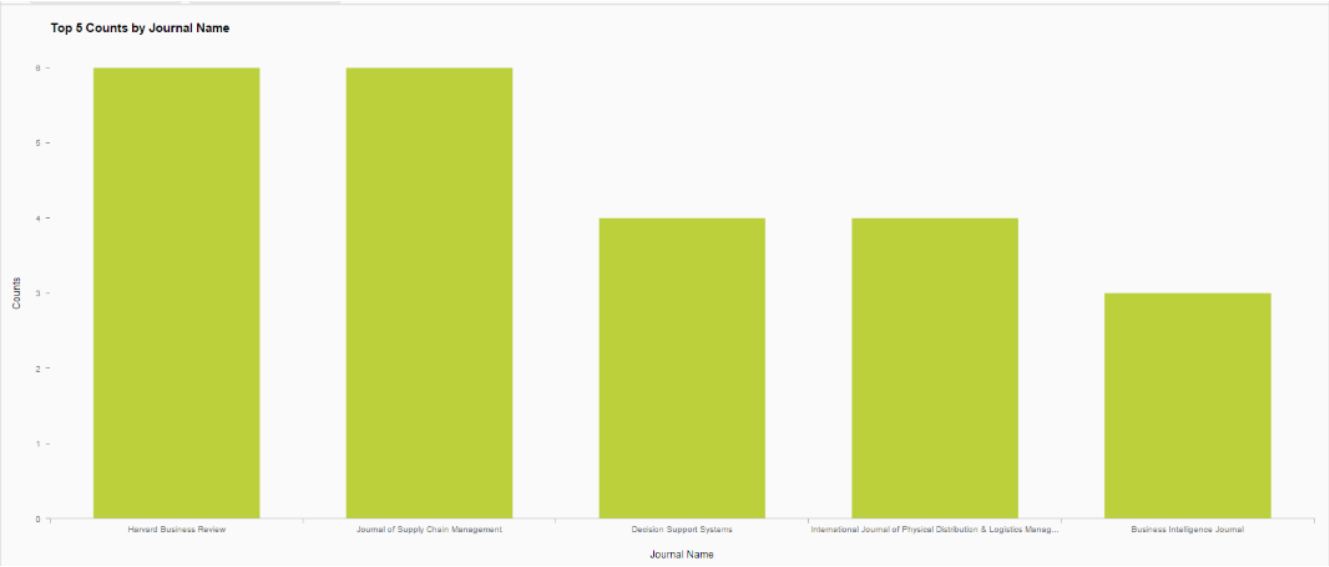


Figure 2: Journals ranked by number of articles. Source: Own Creation

While reading the abstracts in Mendeley, a sort between 'core' articles and supportive articles began. Literature that made it into the final article pool and that was thus read for this thesis includes entries published in: seven of the top ten most cited journals by Operations Management researchers/professionals (Wieland, 2011), three of the top eight Information Sciences journals (Shollo & Kautz, 2010), as well as three of the top five SCM journals and a good assortment of the top ranked operations management journals as found by Näslund et al. (2010). Top cartography/geography journals (by their impact factors) were also included in the search process and articles from good quality journals of that discipline have also been read and analysed.

3.2.3.5 Preliminary Article Pool

The preliminary article pool was composed of 92 articles, and the second refinement narrowed that down to 72 articles. (see Table 1 for the siphoning of literature search and review).

	Search Results	Abstract Scanning	First pool	First refinement	Second Refinement
Top SCM Journals	169	8	217	92	74
Top Cartography Journals	96	10			
Reference Searching	151	5			
Databases	2775	124			
Curriculum	70	70			

Table 1: Process of creation Article Pool. Source: Own Creation

3.2.3.6 Refined Article Pool

The sources of preliminary pool of articles in the 'core' folder where checked against the reputable opinions of SC scholars Shollo and Kautz (2010), Wieland (2011), and Näslund (2010) and the articles from 'top' journals that they reviewed. Round two of the abstract review process dealt with inclusion based on merit. After the articles were considered on their ranking merit, the remaining articles were judged more critically based on their content. Inclusion/exclusion criteria at this point focused on their ability to aid in answer the problem formulation, as well as the subject correspondence, applicability, journal rankings, and inter-relatedness (Rienecker & Jørgensen, 2006). Additional exclusion was based on type of paper, i.e. professional/promotional vs. academic journal papers.

3.2.4 Boundaries of the search

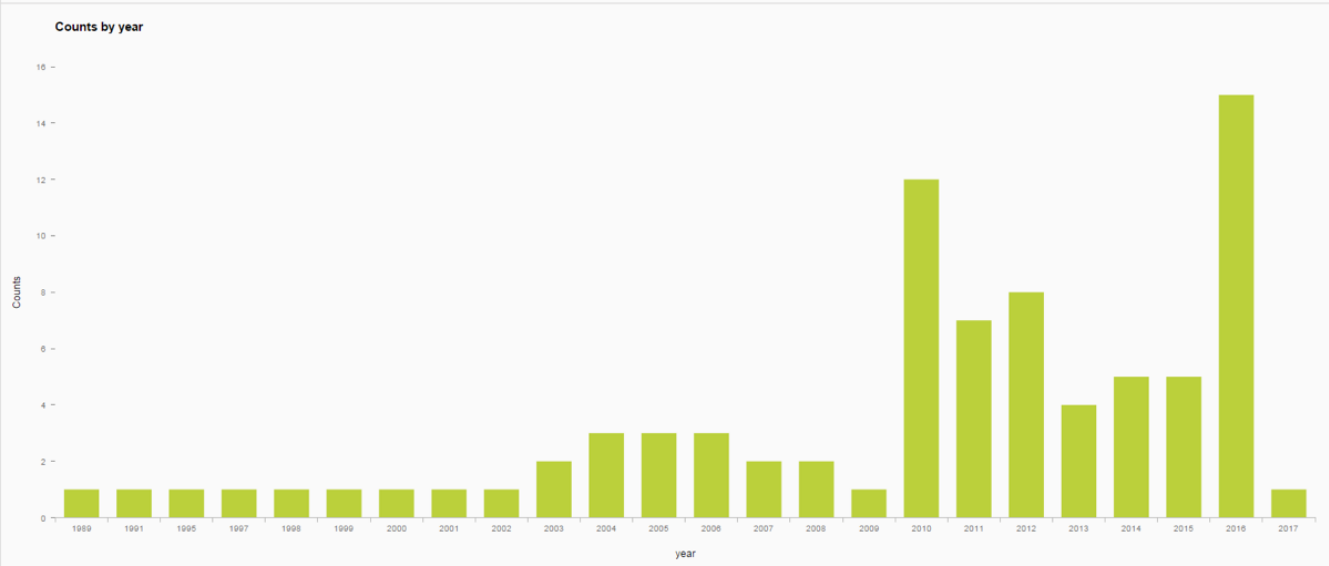


Figure 3: Articles by published year. Source: Own Creation

The literature used in this paper extends back to 1989 (see Figure 3) but there is a greater prominence of articles from year 2000 on. The literature spans across a good number of core and periphery publications in the SCM, IS/DM, and Cartography disciplines. It does so, not just to identify an academic gap – of the lack of GeoVisualization in SCM – but to signify the need for a bridge between the academic discipline of mapping, and that of SCM and Logistics. Figure 4 shows the journals used in this thesis, the thicker, broader rings at the top are the most commonly used (and top ranked), while the smaller point of the cone

are periphery journals. Though the problem formulation was specific, the field of theory to be studied was not. As an example of researchers who experienced a similar difficulty, this chapter is concluded with the 2014 Geographic Information Science article published by Blaschke and Merschdorf. Like SCM, GIS and the science of the technology behind the use of geospatial data is a dynamic and young field. In such an environment, the researchers found it very difficult to define precise boundaries for their discipline, and their article was a testament to the fact that they would rather have called GIScience a multi-disciplinary and multi-paradigmatic field than imposing walls. Blaschke and Merschdorf (2014) build a solid defence of their choice into their article, and we believe that they've also argued well for the choices made. After all – as can be seen in the top journal searching in section 1.8, as well as the motivated argumentation for AR in section 1.2 – if we had limited our search to the top journals of SCM, then we would have been disappointed – just as Näslund et al. were in 2010 upon searching 3000+ articles and finding 26 that used AR –and inhibited by the next to complete lack of geovisualization in the SCM and Logistics field.

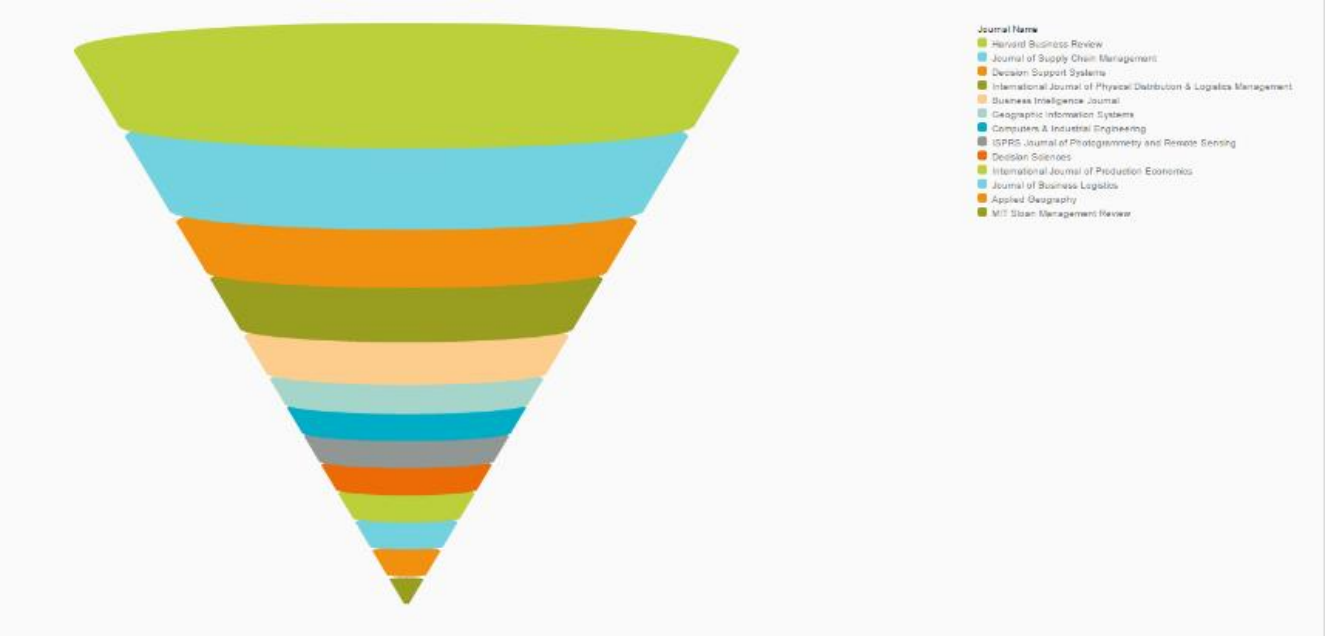


Figure 4: Journals in the article pool. Source: Own Creation

3.3 Data Collection

This section describes the data collection process for this thesis. Our collaborative approach shaped the way we collected data – and with the continuous involvement of the CMR team the data collection

process included: *Company documents, onsite visits,* many informal meetings, eight *working interviews,* and two *workshops.* Each step in the data collection process will be described in the following sections.

3.3.1 Company Documents: COL Report

As mentioned earlier, CH gave us access to their complete Cost of Logistics (COL) report from 2016 – a spreadsheet containing +400.000 rows, and +25 columns. They've also provided us with additional data upon request – cost data, product shelf-life and the like. The textbox to the right outlines the rows of data that holds relevance for this thesis. However, to conduct the necessary analyses on the dataset, we had to create *Data Hierarchies* and *Data groupings.*

3.3.1.1 Creating Data Hierarchies

Creating any type of hierarchy in Lumira involves getting the application to recognize certain aspects of the data input, and relate that to a set of predefined hierarchy categories. The types of hierarchies created in this thesis include: 1) Geographic Hierarchies, to put the "Geo" in GeoVisualization; and 2) Time Hierarchies, to enable temporal filtering and visualizations alongside the GeoVisualization.

Creating the geographic hierarchy involved first appending the information of longitude and latitude to the dataset on customer country/city, and DC country/city. To create the hierarchy, we first selected the columns from which country/city data was gathered (Lumira helps recognize whether the columns are valid candidates for creating certain types of hierarchies). Next, we specified which columns to gather the longitude/latitude data in. The application then set up the hierarchy, allowing us to switch between viewing city, country or region, on the geographic ESRI map. This added to extra data granularity and allowed us to zoom in or out and get more data based on the different

COL Report Data

Plant 0: The site that ships the delivery to the end customer. Can be a production site, or a DC.
Plant -1: The site that shipped the items to plant 0.
Deliv. Date: The date of delivery
Delivery: SAP specific number
Item: Item line number.
Material: SAP material number
Material description: Short string describing the item
Volume: Gross weight in tonnes
Incoterm: Who holds responsibility for what, and who is paying for what
Handling Units: The units that the item is considered in – it is dependent on the type of item
Business Units: Product area: Cultures
Route 0: The mode of transportation – the number indicates lead time days
Place of production: The primary place of production of the type of delivery item
Conversion/unit: Conversion between costs, and prices. Helps determine the handling costs
Order quantity: The quantity of items included in the specific order request
CH Units: Allows value comparison across item groups
Freight OB unit: Unit costs on the weight – from country to country.

hierarchies, in line with ideas prescribed by GIS academia about interactive digital map usage (Hennig, 2016; Kraak, 2003).

Creating the time hierarchy involved converting the data in the delivery date column to a format that Lumira recognizes as a date format, in this case yyyy-mm-dd. This allowed us to view the temporal data of our preference. Specifically, the ability to sort month-by-month came in handy for the second analysis carried out in the "Caseworks" chapter.

3.3.1.2 Creating Data Groupings

Creating groupings in SAP Lumira is a tidy way to better understand and visualize one's dataset. The types of groupings created in this thesis included: 1) Volume grouping, to allow filtering that would drive greater understanding of the data and more specific visualizations – namely the difference between discrete shipments of over/under five tonnes respectively; 2) shelf-life groupings, to provide insights into the requirements of the different products, based on the shelf-life – and thus the realistic opportunity of moving a range of shipments from air freight to sea freight.

The Volume grouping was created by the construction of a "calculated dimension" (equivalent to 'IF' 'functions' in MS Excel). This allows the user to mathematically specify the type of groupings he/she wishes to create. We created the volume grouping by first sorting the Volume column on "> 5" – and then creating a new column of either "True" or "False", based on the data input (this grouping will be referred to as the "+5 filter" going forward).

The shelf-life grouping was created by "Grouping by Selection". To do so, the user names the different groups, and selects the desired ranges. In this thesis, this grouping resulted in the following shelf-life groupings: < 3 months, 6-12 months, 1-2 years, and + 2 years. Having the shelf-life grouping was particularly useful for the analyses carried out in the "Casework" chapter, in combinations with filters such as "Air freight", and when looking at specific months to/from the same DC/customers.

3.3.2 On-site Visits

From January through May 2017, we spent an average of one day a week at CH's site(s), to understand the inter-dependent structures and systems that concerns the logistics supply chain in the organisation. We always spent an entire working day during these visits, including access to a workspace, coffee and

'water-cooler chit-chat', informal catching-up meetings with our CMR team, as well as lunch in the company canteen. This is in line with Näslund (2002), who states that social research, and especially case studies benefits greatly from spending time in the organisation, both 'asking questions' and 'hanging out' – and Börjesson (2011) who state that collaborative researchers should establish a close and long-term relationship with the organisation under study. The onsite visits conducted throughout this thesis process entailed the following means of data collection: *Observations*, and *Informal & formal meetings*. This time on site was prefaced by a handful of meetings in autumn 2016 where we felt out the organization and solidified the contacts that would later become our CMR team.

3.3.2.1 Observations

The weekly visits to CH's site allowed us to make observations, which added to the collaborative nature of the thesis research process, by enhancing and developing our understanding of CH's SC context. We believe that in our collaborative casework with CH, our observations are inseparable from the case work, we recognize that the observations and experiences we had on site influenced the outcomes. We captured the observations in notes written in pen and paper every time we deemed it useful – in line with our pragmatic methodology. However, we did not engage in extensive and structured field notetaking, a method that has generally been linked to ethnographic research (Bryman & Bell, 2011). Since the pragmatic/CMR approach of this thesis process cannot be characterized as merely observing, this thesis will not go into depth with ethnography. The influence of observations was felt in the 'usefulness' of them, the general feel for the organization that we compiled contributed to our understanding of the findings of our casework.

Our observations were mostly *participant observations*, as described by Yin (2003). We assumed an inside role in the context of SC optimization, that continuously developed through our collaborative approach. Specifically, we noted the interplay between the employees in the logistics department, and their colleagues in the other departments at CH. Lastly, we made observations about the VP of Global Logistics, and the way in which he interacted with his employees, as well as with other stakeholders surrounding the project – in a very positive and engaging manner – and particularly promotional about the thesis project.

As earlier mentioned, the CMR approach of this thesis is closely linked to, and inspired by action research; about which Näslund (2002) says: "The core idea of action research is that the researcher does

not remain an observer outside the subject of investigation" (p. 333). We arguably became *insiders* at CH through our collaboration; the formal and informal meetings, as well as the cantina made good settings for us to get to know the SC practitioners of CH. Becoming insiders was valuable to us at the workshop in February, when we presented our preliminary results – which is outlined in the next section.

3.3.2.2 Workshops

As earlier mentioned, we held a group workshop during a morning meeting in February 2017, where we presented the logistics department with the preliminary results, followed by a discussion session where all stakeholders were invited to contribute. At the workshop, we experienced that one employee wanted the tool to be able to visualize the entire supplier/customer network, instead of just the freight footprint. Likewise, we observed comments made about the data granularity of the COL report, and how the data cleanness would need to increase for him to be interested in using the tool.

Looking forward, we will present the research findings to stakeholders during a two-day session on May 23-24 2017. The stakeholders will include the global logistics team and those involved with Distribution Centre planning at CH.

3.3.2.3 Informal & Formal Meetings

During the research process, we had regular meetings with both the CMR team, as well as other stakeholders in CH. The understandings achieved from these meetings allowed us to direct our efforts towards the most value-creating aspects of the research, in accordance with the goals of pragmatism. The on-site visits on CH were not just about gathering information and developing knowledge, but also about collaborating with the practitioners on developing a better solution for SC optimization. Naturally, this meant that we spent a lot of time at CH's site. This is in line with Näslund (2002), who says that logistics researchers should spend time in the organization, since only by being out 'in the real world' can one gather first-hand information to develop knowledge and gain relevance.

The formal meetings were usually planned a week in advance, via email, whereas the informal meetings were often just planned when we met someone in the hallway, or in the canteen. The formal meetings generally served the purpose of long-term planning and structuring the collaborative research process,

while the informal meetings generally concerned more immediate purposes, such as when we wanted to showcase and discuss recent process with Lumira – or when we had urgent data issues.

3.3.3 Expert Interviews

The bulk of the empirical dataset for this thesis consists of the eight semi-structured expert interviews, conducted between February and April 2017.

3.3.3.1 Semi-structured Interviews

The semi-structured interview format allowed for an openness to changes in procedure, wherein the respondents had an opportunity to take part in co-creating the interview, as argued for by Kvale (2007). We structured the interviews by taking notice of the interview settings – by briefing the respondent before the interview, and debriefing afterwards. In the briefing, we laid out the topics that we wanted to discuss, and we asked if the respondent had questions or wonderings before we began. Also, we underlined our intentions with the interviews, and the thesis, and the anonymity that they could expect (Kvale, 2007). In the debriefing, we provided the respondents with an overview of what would be happening next. Lastly, we made sure that all questions they had had was answered, and then thanked them for their time.

3.3.3.2 Empirical Saturation

There was no upper limit on the number of interviews, that CH were ready to provide. The number of recorded and analysed expert interviews landed on eight, instead of eighteen, because we needed a certain understanding of CH's SC setup to prepare the interviews – thus being able to ask meaningful/purposeful questions, and consequently receive useful answers. Therefore, most of the interviews that are cited in the analysis are from March 2017. Each additional interview added increasingly less new content to the analysis, and we found that at the eighths interview a certain level of 'empirical saturation' was achieved (Bryman & Bell, 2011). Naturally, it is speculation what would have happened if we had continued conducting interviews throughout May 2017, and new concepts would surely have occurred. However, after the eighth interview we felt that we had sufficient insights and understanding of the case context – indeed, after the sixth interview we felt that we had experienced theoretical saturation. The interviews, through our Grounded Theory coding, resulted in analysis that was both useful to practitioners, and academically relevant – thus achieving the aims of our pragmatic and collaborative research approach.

3.3.3.3 Table of Respondents

We sought a diverse group of interview respondents, while we naturally also desired to interview practitioners, who were the most likely to need a GeoVisualization tool. Additionally, pre-investigation work with the CMR team identified content worth asking about and respondents worth asking. Table 2 below shows the seven respondents (plus one group interview) interviewed for this thesis. The interviews lasted between 45 and 75 minutes, and the sound files that are included on the physical USB sticks.

#	Gender	Age	Position	Division	Years Exp.	Education
1	M	30	Supply Chain Coordinator	NCD	3	BSc Engineering
2	M	50	Director, Global Logistics	NCD	25	MSc Engineering
3	M	35	Global SC Manager	Enzymes	10	MSc EBA SCM
4	M	40	BI Architect	BI	15	MSc Engineering
5	M	50	VP	Group Logistics	25	MSc Engineer
6	M	45	Director, S&OP	FC&E	20	BSc Communication
7	F	30	Project Manager, PMO	Group Logistics	6	MSc Engineering

Table 2: Table of Respondent. Source: Own Creation

3.4 Grounded Theory

This section contains detailed descriptions of the interview transcription process, and the subsequent data analysis – conducted via Grounded Theory; the practice of deriving theory from data. According to Strauss & Corbin (1994), the data should be systematically gathered and analysed through the research process, via a *constant comparative method* between analysis and data collection – which we find to be in line with our pragmatic abductive reasoning. Similarly, (Bryman & Bell, 2011) argue that the process of GT is an *iterative* and *recursive* process, wherein analysis and data collection proceed in tandem, and continuously refer back to one another. The decision to use Grounded theory for our analysis grew out of our desire to prove our procedural validity (Stuart et al., 2002). Grounded Theory is a transparent and structured way for us present the analysis, and continue to uphold the academic rigor that we claim we're practising. The section contains the following areas: *Transcription, Coding, Pragmatism/Abduction/Grounded Theory,* and *Criticisms of Grounded Theory.*

3.4.1 Transcription

The eight expert interviews were transcribed using MS Word and Windows Media Player, and a hotkey was set up to easily pause and play the audio recording. When the respondents were talking, a number on the left side would indicate the minute of the audio recording at which he/she said it. A parenthesis was added to indicate when we said something, or asked a question. This helped to provide context for the subsequent coding process.

Since most of the expert interviews were conducted in Danish, the transcription involved a continuous translation process, that could, we suppose, have been a source of error between the transcriptions and the spoken word. To tackle this issue, we made sure to go back to the audio recording when doubt arose about the original quotes of the respondents. Additionally, between the two of us, both English and Danish are mother-tongues. The transcription summaries are included in the Appendix: 5, in English, and a USB data stick with all the sound recordings is attached to the physical copies of this thesis.

3.4.2 Coding

A total of four read-throughs of the transcription summaries were made during the *coding* process. Coding is the key process in Grounded Theory, whereby data are broken down into smaller parts and given names (Strauss & Corbin, 1994). The coding process tends be to a constant state of potential revision or fluidity, wherein data chunks are continuously treated as potential indicators of *concepts.* Concepts, one of the outcomes of GT, refer to the labels given to discrete phenomena, also referred to as 'building blocks of theory' (Bryman & Bell, 2011, p. 578).

We began the coding process as soon as possible after the accumulation of our first six interviews, to sharpen our understanding of the data and theoretical sampling (Strauss & Corbin, 1994). The coding process was performed on printed examples of the interview transcription. To best analyse and 'make sense' of the dataset, we conducted first *open coding*, followed by a *focused coding* (Esterberg, 2002).

3.4.2.1 Open Coding

Our initial coding was an open coding – in which we went through the transcriptions bit for bit, searching for patterns and themes – in line with Esterberg (2002): "In open coding, you don't use someone else's

pre-established codes, or even your own. Rather, your goal is to see what is going on in your data" (p. 158). The first two read-throughs were conducted separately, by each of us, on printed pieces of paper. No notes were written during the first read-through. On the second read-through, we wrote notes and suggestions for codes on the printed copies, setting ourselves up for the focused coding. We coded the first six interviews in the same session and it was our experience that *focused coding* began to occur already in the second round of *open coding*. The first half of the interviews coded were mostly pure, whereas the last half's coding was slightly influenced by the coding we had just applied to the first. We believe that this reflects the pragmatic creation of knowledge – that the interviews we conducted were shaped by content and topics discussed with earlier respondents, our developing experience with Lumira and geovisualization, and a growing sense of what was 'useful', to us in our scholar-practitioner role (Tenkasi & Hay, 2012), as well as the practitioners at CH. The rapid development of codes, common across the interview transcripts, that 'made sense', suggests the high level of internal cohesion that existed amongst the respondents and our interaction with them.

3.4.2.2 Focused Coding

On the third read-through, the codes were in the back of our minds when reading, and a sorting took place, where chunks of data were sorted into specific categories (Esterberg, 2002). Hereafter, the categories were collected in a table for each interview, and the duplicates were deleted, so codes which had the same meaning were merged. The following categories emerged from the coding process: *Supply Chain Optimization, order size and frequency, lead time, route choice, supply chain overview, operations vs. strategy, exploration & scenario building, presentation & Presentation levels, internal communication, external communication, value of visualization, limits of visualization (temporal aspects), user-friendliness (user-interaction), tool usage, data quality, market conditions, incoterms,* and *wish list*.

Though all codes were extracted directly from the transcribed expert interviews, it is worth noting the overlap between the research purpose of this thesis, and the codes 'value of visualization' and 'limitations of visualization', this overlap was likely introduced via specific questions asked by us – which fits of course with the 'use' that we were making of the working interviews, the value of visualization was the 'point' of the interviews.

Hereafter, all the text chunks were put in one large document, and each respondent were given their own colour. This allowed us to drag around the text chunks that fitted the different codes, without losing track of who said what. If a data chunk was found to fit in several codes, it was copied into both. Similarly, since all parts of the process were conducted by both of us, in tandem, many data chunks ended up in 3-4 codes. We saw the frequency of which the concepts where found in the coding as indicators of their usefulness (Strauss & Corbin, 1994), and further proof that the different respondents (with different backgrounds and business units) thought about things in similar ways.

3.4.2.3 Theoretical Saturation

A satisfying level of *theoretical saturation of coding* was experienced after we had both been through the fourth read-through, as well as the colour-coding and category creation. Complete theoretical saturation of coding suggests that the researcher has reached a point where there is no further point in reviewing/coding the data set to see how well it fits with the key concepts and categories (Bryman & Bell, 2011). It is possible that new concepts could have emerged had an extra number of read-throughs and re-coding been made. However, it was found that we had sufficiently categorized and analysed the data to achieve useful findings – in line with our pragmatic CMR approach. We noticed this saturation at the point where we conducted our seventh and eighth interviews. Kory added to the practitioners 'wish list' – with the addition of relevant forecasting insight/requests, and mentioning that visualizing different key customer groups could be strategically relevant. His interview added little to the theoretical understanding that had emerged from the first six interviews. One benefit was that, as an American, his interview is easier to pull 'quotable' chunks from, but other than that, we encountered theoretical saturation. Likewise, our final interview with Katharina, a very active member of our CMR team, added little in the way of 'extra' theoretically relevant context. This interview did serve us well however, in that we were able to check up on, and confirm, concepts we'd developed over the course of our months of collaboration with CH. Both of our last two emails allowed us to 'show off' the latest visualizations we'd come up with, which increased the usefulness of our collaboration.

3.4.3 Grounded Theory & Pragmatism

Our data gathering and analysis throughout the thesis process was both active and co-creating. This is in line with Bryant (2009) who states that researchers inevitably are 'actively' gathering the data – especially in pragmatism, wherein reality is 'always in the making' by social actors who 'carve out' data from reality, which is always socially located. Thus, as discussed in the open coding section, the earlier interviews created foundation for the subsequent interviews, both in terms of choice of respondents and the choice of topics. This development of the analysis also meant that although we did attempt to see the transcriptions context-free in the open coding, this was not entirely possible. The interviews themselves were shaped by the developing experience that we had with Lumira, as well as our experience with the CMR team at CH. We did have a preunderstanding of the content of the interviews. Pragmatically, this is not being biased – as objectivity was not our goal, and we were rather developing an understanding of what would be useful (Egholm, 2014). Likewise, as we identified the *concepts* from the coding process, we evaluated their strength based on their perceived usefulness – in line with Pragmatism. The usefulness was determined from the continuous back-and-forth with the CMR team – in line with the Pragmatist/Grounded Theory perspective of knowledge creation as an *on-going activity* (Bryant, 2009). As well, though they ended up being an effort of theoretical saturation, interviews seven and eight were conducted *after* our initial Grounded Theory analysis had been conducted – as a search for evermore useful information.

3.4.3.1 Grounded Theory & Abduction

The back-and-forth method of Grounded Theory is characterized by the pragmatic logic of *inference to the best explanation* (Egholm, 2014), better known as *abductive reasoning.* Per Bryant (2009), the relevance of abduction is not in proving truths, but rather saying something about the world that unfolds new or unknown phenomena. Whether the statements about the world proves to be true must thereafter be examined by *looking at the data* (Strauss & Corbin, 1994). Throughout the thesis process, diving into the relevant data has been the main focus, since 'theories and concepts are best seen as tools' to carve out useful knowledge from the data (Bryant, 2009). Taking the pragmatic position, we consequently argue that the ultimate criterion of good research should be that it makes a difference. We draw abductive inferences from the analysis section, and they are presented in the casework chapter. These inferences

are of course the result of the *constant comparative method* of Grounded Theory (Strauss & Corbin, 1994), wherein we continuously evaluated and compared new information in regards to our preunderstandings.

3.4.4 Criticisms of Grounded Theory

Bulmer (1979 in Bryman & Bell, 2011, p. 583) rightly questions whether it is possible for researchers to suspend their awareness of relevant theories or concepts, even momentarily, as prescribed by the advocates of Grounded Theory. It is generally agreed that what we 'see' is conditioned by many factors, one being what we already know about the social work under study, as well as our theoretical background (Bryman & Bell, 2011). Additional criticisms of Grounded Theory involve the time constraints that researchers often face in terms of note taking or transcription of the interview sound recordings, as well as the fragmentation of the data chunks, which can cause the data to lose vital context (Bryman & Bell, 2011). Ultimately however we do not believe that this criticism invalidates the use of Grounded Theory in this thesis. For us, Grounded Theory was applied as an example of Academic Rigor. It was a demonstration of a procedural validity, and the lack of complete objectivity was never striven for in our search for value-rich useful solutions to practical problems.

3.5 Collaborative Casework Process

Following the Grounded Theory analysis findings, opportunities for the *most useful/impactful* GeoVisualizations arose. The process involved in-depth visualization and exploration in Lumira – and constant referral back to both analysis and literature. This chapter – presented later – entails our suggestions for specific SC optimization. We made abductive inferences to the best explanations, based on our experience with Lumira, and our interpretation/understanding of what would contribute most value to the SC practitioners of CH – based on communication and feedback from the CMR team.

4 Literature Review

The goal of this literature review chapter is to lay out the theoretical building blocks, that will allow the provision of a sufficiently detailed, reflexive, practical, as well as holistic answer to the research

questions and problem formulation of this thesis. The chapter will go about that goal in four main ways: **First**, the existence of the academic gap will be demonstrated by outlining examples of academic work that comes close to the gap, without breaching it. **Second**, the nature of SCM will be delineated, and the goals and complexity of effective SCM will be introduced. Understanding this is important for understanding the implications, that visualization can have towards opportunities for SC optimization, as well as what intended or unintended effects optimization can have on the different areas of the SC. Per Systems Theory, visualizing logistics data has SC effects, especially if the visualization leads to decisions that reach into other parts of the supply chain. **Third**, the methods and theoretical contributions of Data Visualization and Cartography will be described and synthesized. Visualization of geospatial data is the means to an end, namely an optimized supply chain, and we believe that it is not possible to understand the effects of GeoVisualization on SCM, without an explanation of the field of Data Visualization. The field of Cartography is also discussed here. Visualization is inherent to the study and practice of making maps, since Cartography is defined as the visualization of geospatial data. This thesis could not talk about visualizing geospatial logistics data on an interactive world map, without making mention of, and paying tribute to, the field of Cartography. **Fourth**, a synthesis between the academic literature will be presented, along with a conceptual model that depicts how the thesis has been inspired by, and made use of, the fields of Data Visualization, SCM and Cartography.

4.1 Identifying the Academic Gap

As mentioned earlier, we believe we have identified an academic gap, namely interactive GeoVisualization for SC understanding and optimization. Throughout the course of the structured literature search and analysis process, no specific references that matched these specifications were found. It should be clear through the synthesis below that no previous literature was found that comprehensively includes all three scientific fields of SCM, Data Visualization and Cartography. Because academic research should always stand on the shoulders of giants, this section provides examples of authors who have investigated geographic or visual/mapping aspects of SCM.

The research that was found includes Chow, Choy, Lee, & Chan (2007), who conducted a case study on the integration of web-based RFID technology in visualizing logistics operations, Rodrigue (2012), who outlines the distinct geographies of global supply chains, Jing & Cai (2010) investigating the mapping

of logistics capabilities in Asia, Sackett, Al-Gaylani, Tiwari, & Williams (2006) reviewing the need for visualization in manufacturing, Cornel et al. (2016) outlining the uses of composite flow maps for different social and business applications, and Suárez-Vega, Santos-Peñate, & Dorta-González (2012) whom investigated the use of location models and GIS tools for retail site location.

The closest this thesis comes to finding something 'spiritually' similar to its research purpose, was Bell's 1985 article *Visual Interactive Modelling as an Operations Research technique.* In this article an interactive, graphical, routing model was identified (Fisher, 1983, in Bell, 1985). The age of the article should of course be considered. Thirty years ago, it is hard to imagine that either Bell or Fisher had access to an interactive data visualization software – like SAP Lumira, that on a standard laptop computer is powerful enough to visualize the large logistics dataset used for this thesis. The essence of what Bell presented in 1985 is however very in line with some of the key contributions of this thesis. Bell floats the notion that the 'Ease of validation [of the data or problem at hand] is vividly demonstrated [on an interactive map]', especially in logistical routing problems where the decision maker can view and confirm the accuracy of a road network. He compares the value of a tabular representation of geospatial data to the cartographic representation of them, and similar to this thesis, finds maps far superior. In the early 1980s it made good sense for SC academics and practitioners to want to visualize their logistics activities on an interactive map, they felt that treatment of data would lead to better SC decisions and strategy/operational execution. It is with the same logic that this thesis is built, as we believe it makes sense to visualize global SCs cartographically, and that doing so with a powerful interactive software can bring great value to SC practitioners and academics alike.

Despite the extensive effort put into the literature search and review – outlined in the research process chapter – we could not find academic articles that exist in the same space as this thesis is presented. What was found is evidence that the industry is taking advantage of current technology and data visualization techniques, to visualize their supply chains and networks. Specifically, a 2013 Supply Chain Management Review article by Jozo Acksteiner and Claudia Trautmann applies what they call 'Geographic Analytics' to provide a solution quite in line with this thesis:

"Geographic Analytics—the visualization of network information on a map in order to drive supply chain optimization. Flexible, transparent, and **intuitive**, GA has greatly enhanced HP's toolbox for strategic assessments." (Acksteiner & Trautmann, 2013, p. 28, emphasis added)

Acksteiner and Trautmann claim that Geographic Analytics had the added benefit of contributing to strategy, in that the visual presentation of the supply network made it easier for the HP executives to intuitively understand the global reach and complexity of their SC – thus enabling more involvement, better decisions, and the creation of better SC strategy – than traditional analysis techniques (Acksteiner & Trautmann, 2013). The need for Geographic Analytics, or 'SC GeoVisualization' is real, what is missing is a proper academic treatment. This thesis assumes the access to relevant data and technology has been an inhibiting factor till now, and suggests that modern SCM is now at a point where GeoVisualization can have a real impact on SC optimization, network analysis, CO2 emission footprint analysis, and SC risk mapping.

4.2 Nature of Supply Chain Management

This section presents the nature of SCM, as well as the goals and complexity of effective SCM. This thesis recognizes, appreciates and employs the following definition of SCM, offered by Gammelgaard:

"Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics activities. Importantly it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies" (2010, p. 120).

Supply chains are complex; they involve flows of goods, information, and money between different people, departments, organizational entities (Gammelgaard, 2010), as well as SC actors that have different goals, concerns, priorities, and who operate in different settings, cultures, and countries (Croxton, Garcia-Dastugue, Lambert, & Rogers, 2001). Ekwall (2012) contends that the complexity of SCM is enhanced by the fact that SC problems are inherently 'wicked problems' – further emphasizing the need for a pragmatic, Systems Approach to logistics and SCM (Gammelgaard, 2004). Adding to the complexity of SCM, firms are increasingly competing in a global context – which according to Levy contributes to the following SCM hurdles:

"In a global supply chain, managers must plan for longer lead times, expensive air freight, higher inventory levels, poor sales-forecasting accuracy, and significant delays in resolving technical problems" (1997, p. 94).

SC optimization is motivated by the need to address these challenges – and has likely also been a contributing factor to the increasing attention paid to SCM in recent years (Suarez-Barraza, Miguel-Davila, & Vasquez-Garcia, 2015). SC optimization and dealing with SC complexity are topics often written about, from different angles. The complexity of contemporary global SCM calls for holistic understanding of processes across the SC (Croxton, Garcia-Dastugue, Lambert, & Rogers, 2001), as well as a strategy that 'fits' the needs of the downstream customers (Gammelgaard, 2010). Some of the notable strategic contributions involve Fisher's (1997) identification of strategic SC choices, based on product type; low margin commodities vs high margin fashion products. Furthering Fisher's contribution, Christopher, Peck, & Towill (2006) state that a firm's SC strategy should be tailored to match the "order winning criteria" (Hill, 1993 in Christopher et al., 2006, p. 277) of the market, whether it is product quality, price, and/or lead time.

Another response to the challenges of SCM has been that of visualization. This section includes a brief discussion of the approaches to using visualization techniques to better comprehend the SC. In most cases, visualization is not actually an included keyword in the literature, even if the product is visual and the goal is of gaining a better understanding of the SC or business setting. Merriam-Webster defines *visualization* as the following: 1) formation of mental visual images; 2) the act or process of interpreting in visual terms or of putting into visible form.

Here are a handful of the commonly used visual SC and business tools that would fit into the dictionary definition of visualization: SCOR, Business Model Canvas, House of Quality, Business Process Modelling, Risk Mapping, SWOT, and Porter's Value Steam. All these models have different strategic goals and reasons, some are more energy intensive than others in their creation, and they can have differing levels of strategic or operational importance. These examples employ a mix of symbolic, numerical, graphical or tabular formats, but the end goal is the same, by presenting a representation of

the business model, risks, opportunities, or the SC itself, these approaches attempt to elicit a response similar to that found by Smelcer and Carmel:

"GIS users, upon seeing their data on a map for the first time, respond with, 'Oh, now I see!', implying that maps provide users with new insights into their data. This presumably leads to better problem solving." (Smelcer & Carmel, 1997, p. 392)

4.3 Data Visualization & Cartography

Mapping, and the creation of visual models, i.e. employing visualization, *just not calling it that*, seems to be quite common and sought after in the SCM Discipline. Words can accomplish only so much, and even words, compiled in sentences, paragraphs, sections and chapters of a thesis, are simply a *map of the author's mind* (Hammond, 2006). Whether the techniques mentioned above are visualizing concepts, KPIs, or ideas, the point is that through seeing it, and going through the process of creating (the visual model) SC practitioners and Academics can get a better handle over the situation at hand. A foundational belief held by SC mappers is that the development process of a (strategic SC) map, and the disseminating process of it, should lead to a better common understanding of the supply chain (Farris, 2010). Network, value stream, and Strategic Supply chain mapping, approach the topic of this thesis GeoVisualization, but stop short of the *geographic* aspect. Suarez-Barraza et al., (2015) treat SC value stream mapping as an attempt to map, and thus understand, the flows of product, information, and money across a SC. They find that value stream mapping is a valuable, though difficult task. Specifically, despite efforts to implement supply chain programs, the acts of mapping, documenting and obtaining data from the different organizations in supply chains is complex and difficult (Suarez-Barraza et al., 2015).

One involves getting lost in too many details, and another involves providing an ineffective perspective for management use (Farris, 2010, p. 165). Mapping techniques have been developed for a long time, and alongside it, the main issue has always been that of complexity. A good supply chain map is recognized as one that is interpretable, recognizable, and in an easy-to-disseminate format.

The mapping of a supply chain network will often be a complex task – making the task so overwhelming that it dilutes the strategic benefits of the map. The task of mapping can quickly become too complicated to be useful (Farris, 2010, p. 169). This point is taken a step further by Gardner & Cooper (2003): *"[…]*

there is no way to include enough information in a supply chain map to manage the supply chain and still have the map useful for strategic purposes" (p. 41).
Geovisualization as a concept is a key element for developing effective strategic supply chain mapping (Farris, 2010, p. 170).

4.3.1 Geospatial Data & GIS

Global business has a geographic focus, geography is therefore important to business, regardless of one's chosen industry (Handa & Vohra, 2010). Addressing the role of the geographic and spatial elements of global business activities, a variety of authors in the decision sciences discipline found that Geographic Information Systems play an important role in decision making within many organizations. Swink and Speier (1999) found that role to be increasing in magnitude, and Handa & Vohra, (2010) found GIS to be very useful for both analysis and decision-making in a wide variety of situations. Tomlinson (2011) applied GIS to Strategic Management, and recent researchers have explored the relevance of GIS use in decision support (Zhu, 2011) and decision making (Eldrandaly, 2011), embedding GIS into spatial decision support systems (SDSS). One specialized SDSS was developed by SC researchers in the biomass industry, to improve the efficiency and effectiveness of biomass feedstock provision (Lin, Wang, Rodríguez, Hu, & Liu, 2015).

"Spatial decision making problems are multi-facetted challenges. Not only do they often involve numerous technical requirements, but may also contain economic, social, environmental and political dimensions that may have conflicting values" (Eldrandaly, 2011, p. 115)

This is found to be similar to the 'wicked problems of SCM' (Ekwall, 2012), and if the problems are indeed so 'wicked' then the attractiveness of a geovisualization tool to help with decisions should be clear.
Stepping outside the realm of industry specific applications, there is a rising relevance of putting GIS into the hands of individual customers, Online mappings services do just that, and are becoming increasingly popular (M. A. Erskine, Gregg, & Karimi, 2016).

4.3.2 Challenges of GIS implementation

Despite the rush of new, exciting technologies in recent times, like Information and Communication Technologies (ICT), and Big Data (Davenport, Barth, & Bean, 2012; Lancioni, Smith, & Oliva, 2002; Rayport & Sviokla, 1995; Sanders, 2016) GIS implementation and its usage in Decision Support and Making capacities is not universal, nor does it avoid its hurdles. Underlying data quality continues to be a foundational issue and in some cases the data (that would enable a correct and richly detailed map) simply does not exist – Handa and Vohra (2010) note for example that the quality of geospatial data is quite low, sometimes non-existent, and this has a critical hampering effect on mapping practices and usage in the country of India.

4.3.3 Visualization without maps

The recent phenomenon of Big Data, studied by a number of researchers reviewed in this thesis (Davenport et al., 2012; Richey et al., 2016; Sanders, 2016; Schildt, 2017; Zhong, Newman, Huang, & Lan, 2016), underlines and emphasizes the increasing needs for managers to handle large datasets. There are many ways to visually present data, and some of them are more effective than others (Blanco, 2013), the ability to choose and create those more effective ways is a crucial skill for management going forward (Berinato, 2016). The volume, veracity, velocity, and variety of Big Data (Richey et al., 2016) can be more than individuals and organisations can cognitively handle. Two research streams have been identified, that address this issue of data comprehension are those of *Sensemaking* (Baker et al., 2009; Bendoly, 2016) and *Cognitive Fit Theory* (CFT) (Baker et al., 2009; Dennis & Carte, 1998; Park et al., 2016; Petrusel et al., 2016; Vessey, 1991).

Bendoly (2016) critically examines sensemaking and visual data exploration, and suggests that to be valuable to an organisation, data visualization needs to be a continuous process and become a facet of organizational culture. Baker et al. (2009) explains the role that the visual display of data has in enabling individual sensemaking in data exploration tasks, and outlines the ways in which visual representations facilitate sensemaking.

According to CFT (Vessey, 1991), *Cognitive Fit* is achieved when the choice of data visualization matches the type of task at hand, hereby optimizing both decision making accuracy and decision-making speed (Baker et al., 2009). Vessey's seminal 1991 paper compares the decision-making performance

between graphical and tabular representations of data. The basic concept is that graphical and tabular presentations evoke different cognitive responses – perceptual or analytical - and that depending on the task and data at hand – spatial or symbolic – one or the other would be appropriate.

4.3.4 Visualization with maps

The software tool that this thesis has utilized has the methods of Geovisualization (Kraak, 2003) built in, it's certainly relevant therefore to provide a definition. Geovisualization includes the "theory, methods and tools for visual exploration, analysis, synthesis and presentation of geospatial data" (Hernandez, 2005), and the concept facilitates decision making in ways that promote visual-cognitive learning. This thesis identifies two pairs of authors that expands the theory of Cognitive Fit into the realm of GIS, Geovisualization, and Cartographic practice. Smelcer and Carmel (1997) found that GIS maps generally shortened problem solving time when measured against tables holding the same data, and that problem-solving time increased alongside task difficulty – for both display formats Dennis and Carte (1998) continued this line of work, applying their experiments more to a direct extension of CFT by addressing the differences in task type – geographic containment (more analytical – of numbers) and geographic adjacency (more perceptual – of the relations between demarcated regions). Their findings were that higher accuracy and greater speed would come from using maps for geographic adjacency tasks, but that tables were more appropriate for geographic containment tasks - where the analysis was contained within one geographic area and the spatial dimension therefore contributed less to the decision maker.

In an example of similar phrasing (perceptual vs. analytical, above) but separate discipline, cartographic researcher Nyerges (1991) states that maps can have one of two purposes. That of a presentational image, or as a computational tool - communication tool or analytical tool respectively. Written in the same year as Vessey's (1991) CFT paper, Nyerges makes no mention of a link between cartographic practice and that of decision making, building such a bridge is not such a hard task however. The first step is to decide whether the information at hand is *conceptual* or *data-driven*, and whether the purpose of the data visualization is *declarative* or *explorative* (Berinato, 2016). Answering those questions is to place oneself in one of the 4 quadrants of Berinato's '2x2' matrix. A difference was implied between the decision analysis (or consultant) and the decision maker or stakeholder(s), in that way explorative data visualization by the analysist leads in some cases to declarative data visualization for the decision maker (management). Depending on their purpose, Nyerges' (1991) two types of maps (communication or

analysis) can be placed into Berinato's (2016)matrix, and depending on the task (geographic adjacency) these maps are dealing with, good cognitive fit can lead to better decision making (Dennis & Carte, 1998).

4.3.5 Geo-spatial Reasoning

If one decides to enter the realm of Geovisualization, one might also be interested in how good humans are at recognizing and extracting reason from maps and spatial data in general. Human visual capabilities and the dimensions of visual intelligence are studied by Bacic & Fadlalla (2016), and Geospatial Reasoning Ability (GRA) (Jarupathirun & Zahedi, 2007) is studied by Erskine (M. a. Erskine, Gregg, Karimi, & Scott, 2015). This stream of research is similar in spirit to CFT, but GRA focuses more on the 'what' of individual's spatial comprehension, rather than the interplay of spatial factors with task type (CFT). To increase the relevance of his work, Erskine also applied GRA to business practitioners (M. A. Erskine & Gregg, 2011), to draw a concrete link between individuals' and business's ability to comprehend and extract meaning from the rising tide of GIS and geospatial data in today's business environment.

At its most basic understanding, GRA is composed of three dimensions: orientation, visualization, and recall (both the ability to memorize details, and the ability to recall 'chunks'(Bacic & Fadlalla, 2016; Mennecke et al., 2000; Petrusel et al., 2016) of those details). These three dimensions influence how much of a 'benefit' decision makers could realize from the employment of geovisualization, but researchers also agree that in general, the GRA of business is lower than it should be. There is a call from researchers in the GIS and Decision Making fields to include more GIS-focused material in business school curriculum (Farkas et al., 2016; Handa & Vohra, 2010; King & Arnette, 2011). They come to a similar conclusion as this literature review, business has a geographic component that should be respected in future teaching. Certainly, from a SCM and logistics perspective this is even more relevant, global supply chains, logistics footprints, and the data that enables their analysis, are spatial, and (at least for overview) should be viewed in a geographic context, on a map. A higher future level of GRA among SC practitioners would be attractive.

Cognitive fit is also mentioned in the context of which visual cues 'catch the eye' of the viewer/decision maker. Hegarty, Smallman, and Stull (2012) studied eye-fixation of professionals and undergraduate students to test the effect of complexity of maps and corresponding levels of comprehension. Petrusel et

al., (2016) use eye-tracking to study the effect of colour and layout on performance measures like duration and efficiency. The field of cartography also applies here, and geovisualization itself includes references to common standards of map symbols and shading (Farkas et al., 2016; Hennig, 2016) as well as the creativity and attractiveness of different mapping techniques (Kraak, 2003), as well as the level of complexity shown in the map – information complexity and different levels of data aggregation were found to affect map-use performance (Handa & Vohra, 2010; Swink & Speier, 1999). SCM authors such as Farris (2010), have also been inspired to adopt attractively visual cartographic techniques to their Strategic Supply Chain Maps – all in the name of easier comprehension, less cognitive load, and better decisions. Berinato (2016) and Baker et al., (2009) also focus much of their attention on the way that visualized data should 'look'.

4.4 Challenges of Visualization implementation

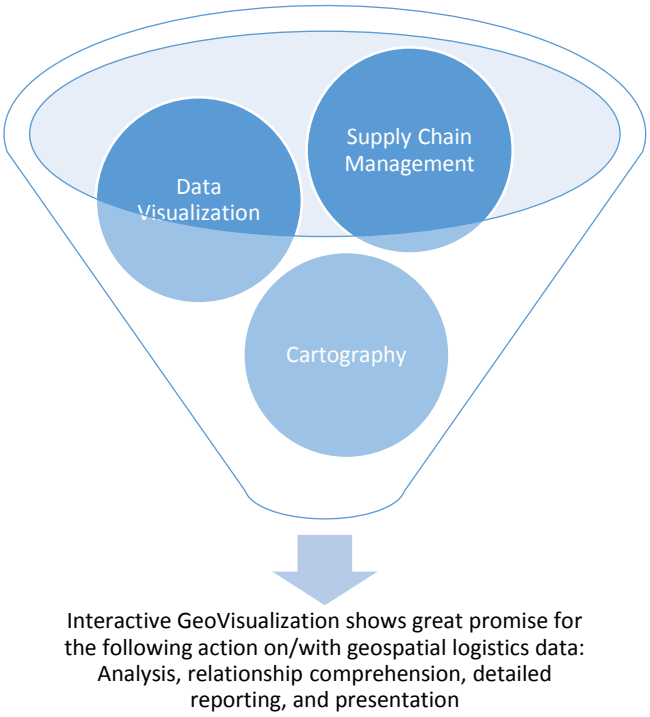
"As pointed out by many before me, GIS is not the magic black box that produces meaningful results of geospatial analysis and creates stunning images. It is the user who influences that process considerably and needs the knowledge about the methods and the science behind the data. The only problem is that often there is a gap between those who are capable of advancing technology and those who are capable of advancing science" (Hennig, 2016)

Just as there were challenges of GIS implementation, so too are there issues of implementation and adoption of geovisualization techniques and tools. Though Trkman et al., (2010) have shown empirically that there is a link between investment in business analytical systems and Supply Chain Performance, the prevalence of spatial and geographic based tools in SCs is lower than could be expected. The situation results in a sort of "'chicken-and-an-egg' situation: without available geovisualization systems users are not aware of potential benefits; without user demand it is difficult to justify new product development" (Hernandez, 2005, p. 55). This Thesis hopes to highlight a useful geovisualization tool, and thereby push in the right direction towards more implementation of similar tools based on its example.

4.5 Literature Synthesis

Maps and their underlying data structures (GIS) are a very present part of today's world (M. A. Erskine et al., 2016), they're important for personal and organizational decisions (Handa & Vohra, 2010; Lin et

al., 2015; Swink & Speier, 1999), and they should be applied to those settings where they 'fit' with the task at hand (Dennis & Carte, 1998). This thesis argues that the logistics activities of a global bioscience firm are a very relevant 'fit' for the practice of geovisualization and the visualization of data upon an interactive world-map – capable of both analysis, relationship comprehension, detailed reporting, and presentation. The synthetization of the scientific fields in this chapter is showed in Model 3.

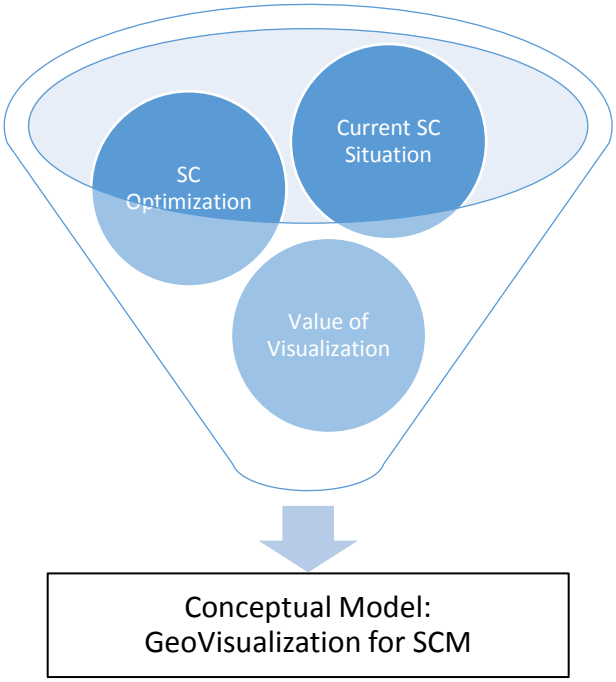


Model 3: Synthetization of Scientific Fields of Data Visualization, Cartography & SCM. Source: Own Creation.

5 Analysis

This chapter was created in the *Grounded Theory* approach to the *Coding* of the expert interviews conducted with multiple SCM practitioners at CH. To investigate the research purpose, and answer the research questions, the chapter is structured in the following way: The relevant part of CH's supply chain is described, followed by an overview of the aspects that require optimization – and concluding with an understanding of the ways in which visualization of geo-spatial data can help in this optimization process. Therefore, the chapter is made up of the following main sections: *Current situation of the Supply chain,*

Supply Chain Optimization, and *Value of Visualization.* Model 3 shows the sections of the analysis, as well as the creation of the Conceptual Model: GeoVisualization for Supply Chain Management (Model 4).



Model 3: Analysis Overview - Creation of the Conceptual Model: GeoVisualization for SCM. Source: Own Creation.

5.1 Current situation of the Supply Chain

This section was created by combining the following categories from the *coding*: SC overview, customer demands, and market conditions. The reason for starting with the current SC situation, is to have a fundamental understanding on how the SC can then be optimized. As will later be expanded, the different aspects brought forward in this chapter will largely influence one another, for instance, customers wanting increased shelf-life on their products will influence the SC manager's decision of route choice and thus product lead time and costs. The next sections will therefore first dive into the communication between the stakeholder in CH's SC. Hereafter, the customer demands will be analysed, followed by an overview of the market conditions and the relevant Incoterms between CH and its customers. Lastly, this section contains an analysis of the existing data sources and the data quality in CH's SAP data warehouse.

5.1.1 Communication Between Supply Chain Stakeholders

Communication between stakeholders in the supply chain is a recurring theme in the coding of the expert interviews. The mentions of internal and external communication that are not related to the value of visualization are included in this section. Later in this chapter, the value of visualization, and the communicative use of Lumira will be discussed.

5.1.1.1 Internal Communication

The coding of the expert interviews suggests that SAP Lumira can positively affect the internal communication between the departments in CH. Respondent 1 expresses a desire to have better internal communication between his business unit, Natural Colour Division (NCD), and the sales department. He says the following about the communication between the two departments: "It has surprised me how much I must continue to say the same things" (Respondent 1: 29). Respondent 1 mentions that many customers are the same across the business units, and that data is already shared across the departments today (Respondent 1: 20). However, data is measured and understood differently across the different departments, business units and CH sites – as Respondent 3 explains, the sales department is often interested in the volume sold, excluding packaging materials, whereas the SCM department is interested in knowing the total weight, including the packaging, because that is what the transportation firm will be basing their charges upon (Respondent 3: 20). Similarly, it is Respondent 3's experience that different departments may have different customer priorities, as illustrated in the exploration, scenario building and internal/external communication sections found later in this chapter.

On the IT side, Respondent 4 (BI department) contends that the use of IT tools (for SC management, analysis, and optimization) is most often best applied to internal cases and internal communication (Respondent 4: 17). People in CH must be continually reminded, and trained, in the uses of IT tools, since it is human nature to forget skills that are not regularly applied (Respondent 4: 39).

5.1.1.2 External Communication

Respondent 3 says that it should have consequences for the customers, when they order products in a sub-optimal manner (Respondent 3: 49). Therefore, he wants to communicate it to the sales department, and to the customer (Respondent 3: 49). Per Respondent 1, if the SC manager is someone with a very

global mindset, and a sales personality, he can sometimes achieve the results that are needed. Specifically, Respondent 1 explains how a SC manager got Kellogg convinced to drop the 70 % shelf-life demand, because they understood the SC costs that it induced upon CH's entire SC (Respondent 1: 10).

5.1.2 Customer Demands

NCD's customers are demanding longer and longer shelf life on the products. Many of the products in NCD have a shelf-life of 3-6 months, and the customers sometimes demand up to 70% remaining shelf-life, when it is delivered: "If the customer demands that, we cannot begin to sail it" (Respondent 1: 9). This has caused many of the business units to be pressured on shelf-life (Respondent 5: 2). It is essential, that the delivery is on time, so the customers are not getting a bad experience (Respondent 1: 13). This is supported by Respondent 6, who argues that product performance and reliability are essential (Respondent 6: 6). As a strategy, CH has decided that no customer in Europe should have to wait more than 7 days for their delivery (Respondent 6: 24).

Respondent 3 experiences that the customers of Enzymes are pressuring them on their prices – while letting CH hold all the inventory costs, which eats away at CH's margins (Respondent 3: 3). As an example, some customers' demand of small orders several times a week results in an unfortunate amount of extra handling costs for CH (Respondent 3: 29). Ultimately, Respondent 3 argues that the solution lies in the search for a balance between trade-offs, where both parties gain from it, as well as the necessary communication of that need for balance (Respondent 3: 45). This win-win situation is reviewed further in the Value of Visualization section, namely in its Exploration, Scenario Building, and communication sections.

5.1.3 Market Conditions & Incoterms

5.1.3.1 Market conditions

Respondent 2 contends that the customers of NCD form a relatively static group: "They are not moving that fast. Some might grow, and some might be losing market share, but nothing extreme" (Respondent 2: 40). The fact however that NCD is a fairly standardized product means that the customer can easily change supplier: "It is important to know the conditions of the market. We have all the big customers,

but they can quite easily replace us" (Respondent 1: 25). Due to their market position, NCD must work harder for their margins and serving customers well is very important (Respondent 1: 7, 25). Adding to the instability, NCD has doubled in size in recent years (Respondent 1: 26) a positive, but SC stressing development.

As mentioned earlier, NCD has many shipments flown to Asia. Sea freight from Denmark-Asia is also relatively cheap, compared to, for instance, South American or inter-Asian sea freight. "Sending things from Seoul to Beijing, is three times more expensive than sending items from DK to Beijing" (Respondent 2: 18). The reason behind this is that air freight is very well-developed in Denmark, and that CH is one of the biggest freight forwarders out of CPH Airport, getting them some very good prices (Respondent 2: 19). In the NCD division, air freight is attractive, but also necessary in many cases, as many of the popular NCD products have only a three-month shelf-life (Respondent 2: 27), of which customers demand 70% shelf life remaining upon delivery. Switching tact, many of the European customers of Enzymes are pressuring CH to cut costs, meaning that there is no budget to send shipments via air freight (Respondent 3: 45).

Looking at the bigger picture, CH's competitors include companies such as Danisco and DSM (Respondent 6: 8). The industry has seen a lot of growth, and CH has managed to have a 12 % yearly sales growth in 2015/2016 (Respondent 6: 8) – this is supported by CH's Annual report (2015/2016, p. 3). When it comes to the different business units, Dairy Cultures is by far the largest department. It is an industry that

Incoterms

CPT – Carriage Paid to Destination. The seller pays for the carriage of the goods up to the named place of destination.

DAP – Delivered at Place. These transactions require the seller to arrange and pay the transportation of the goods to a place designated by the buyer, and the buyer to pay import duties and taxes on arrival of the goods.

EXW- Ex Works. An international trade term that describes an agreement in which the seller is required to make goods ready for pickup at his or her own place of business. All other transportation costs and risks are assumed by the buyer.

CH knows very well, being market leader. As Respondent 6 puts in: “It is difficult to do what we are doing – therefore CH has such a great market position” (Respondent 6: 68).

CH is a minor player in the Pharma industry. The pharma part of CH, the business unit Human Health, operates in a different world than the rest of the organisation, especially in terms of documentation (Respondent 6: 14), with all the implied need for efficient, effective and transparent supply chains – that could be visualized in future studies. Looking again to the customers, out of the global top nine customers, two are currently Chinese, even though sales only started in the country in 2014 (Respondent 6: 18). There is currently no production in Africa. But they are planning to sell to distributors in several African countries. CH does not want their own production on the continent, since they lack an understanding of the present and potential customers and are still unfamiliar with the business landscape.

5.1.3.2 Incoterms

Normally, CH holds the transportation costs, and these are then included in the prices that the sales department calculates (Respondent 3: 42). The Incoterms shows who is paying for the transportation, and when the product is out of CH’s hands (see details on CPT, DAP, EXW in the Info box on the right). Respondent 2 argues, that for this thesis, it is not so relevant to look at the category “customer pickups”, since those do not induce any costs on CH (Respondent 2: 6). According to Respondent 1, the costs vary a lot on the product level. They both have customers that pay for transportation, and some that see it included in the price (Respondent 1: 6). Sometimes the customers believe that they are not paying for it, but they are; it is just getting attached somewhere else. Respondent 6 suggests that the most interesting shipments to investigate are the intercompany shipments, because he assumes that all shipments to end-customers are paid for by them (Respondent 6: 3), one way or another.

5.1.4 Existing Data Sources & Data Quality

Since clean and correct data is a pre-condition to data visualization, this section answers questions of data origin, data quality, and data handling.

5.1.4.1 Data Quality

Respondent 1 contends that very few people are looking at the whole company at once. Most people are looking at one dimension (Respondent 1: 18), and Respondent 4 also noted that the business analyst

would only be expected to use data specific to their area (Respondent 4: 56). There is a lack of transparent data:

> "Things we thought we had optimized, can be going back to the old norm a year after. So, it is a continuous effort. Maintaining the efforts, and standardizing processes is a tough task" (Respondent 1: 28).

It is a problem in CH, that data is not always standardized across national borders. For instance, the Mexico location uses the ambiguous term "0DAYS" to denote a variety of different transport modes (taking less than 1 day) instead of being more specific and recording that the products were delivered via courier, road, or customer pick-up (Respondent 6: 36; Respondent 2: 3). Another recurring problem is that many of the shipments included in the data set that this thesis considers are sample shipments (Respondent 2: 9). This again begs the question of how the information is going to be applied in the case of ambiguous data.

The GPS coordinates that the dataset currently holds are not all completely correct. For instance, the Moscow GPS coordinates are the same for the entire city, though it can easily take a delivery 1-2 days to deliver items internally in the city: "Serving the customers in the Beijing area, or the Moscow area, is not free. Even though the data might suggest that the travel distance is 0km – it is not. There can easily be 1-2 days of transportation" (Respondent 2 33). This problem exists because the initial method for finding latitude and longitude of customers is based on a lookup of zip-codes and addresses, where in Moscow the use of zip-codes does not work to give more specific latitude and longitude.

The time perspective of how SAP Lumira reads the dates must be cleaned up (Respondent 2: 14), an issue that was also experienced when experimenting with filtering Enzyme shipments by date, investigated later in this chapter (Respondent 3: 40). It is necessary that the data is very clean and standardized – both between countries, and between business units – for such a tool to be effective (Respondent 2: 15). Likewise, as mentioned earlier, the sales department, and the logistics department, treat the volume of shipments differently (Respondent 3: 20).

It is worthwhile to note that CH's SC department currently does not have exact figures in terms of inventory costs; though they know the costs of logistics, and the handling costs, they cannot get the finance department to calculate the inventory costs for them (Respondent 3: 43). However, everything

on inventory costs annually around 7 %, in lost yield – and assumption based on an industry average (Respondent 3: 43).

In terms of raw data quality in the SAP data warehouse, proper geographical (Longitude/Latitude) coordinates for all the customers are lacking (Respondent 4: 19) – the 'Cost of Logistics' dataset which this thesis uses had the geographic coordinates added after the data was pulled from SAP by Respondent 8 via the aforementioned zip-code look-up. Both Respondent 6, Respondent 8, and Respondent 4 mention however that this situation is in the process of being remedied: a project is underway to give all new customers this geographical data 'at birth', when they are first entered in SAP (Respondent 4: 20). Thereafter the data can be integrated with the ERP system, as well as the Business Intelligence (BI) system (Respondent 4: 20). Like the problem with Moscow, the zip-code lookup ran into issues when adding latitude-longitude to customer IDs in Mexico "there is a logic behind the zip-code format, that is not working in Mexico" (Respondent 5: 36).

5.1.4.2 Data Sources

The logistics data that this thesis has worked with is based upon an extract from the SAP data warehouse (Respondent 4: 19). The entire organisation – with the exception of Latin America (Respondent 5: 6) – is committed to SAP Business Systems, and every department has access to various reports that allow them to update their areas of responsibility.

Respondent 4 describes the relationship between the BI department, and the rest of the business, as a "never-ending story". Whenever they provide new information from the data warehouse, the business has already moved on to new areas of interest (Respondent 4: 24). The level of detail must correspond to the data needed: what input do you need? what level of granularity? (Respondent 4: 33) There is a difference between training a business user in understanding the data, and the reports, and then the quality of the input (Respondent 4: 37). Respondent 4 argues that the quality of the input often comes back to the source. There is a lot of control in a system like SAP, which he describes as both a good and a bad thing. What you can enter in each of the fields is controlled (Respondent 4: 38). It is almost impossible to enter dates in the wrong fields for instance. It would also be the job of the IT department to help support the controlled input of geographical coordinates 'at birth'.

This does not correspond to how Respondent 5 is describing the data gathering and visual exploration conducted before this thesis's conception: "Right now, the data gathering is from scratch every time"

(Respondent 5: 3). He explains, that the 'Cost of Logistics' dataset provided for this thesis, while drawn originally from SAP data warehouse, has had roughly two years put into the complementary data gathering process – of logistics costs, geographic coordinates of customers etc. (Respondent 5: 3).

5.2 Supply Chain Optimization

This section outlines the aspects of CH's supply chain, which were revealed to hold room for improvement in the expert interviews. The findings include the size and frequency of deliveries, and the mode of transportation (road, courier, sea, and air). Order size and frequency are perceived as highly linked by the practitioners interviewed, as well as often recurring together in the coding of their interviews. These topics are therefore treated simultaneously, and the section to come is divided into the following two sub-sections: Order Size & Frequency, and Route Choice. These topics are analysed based on the influence they have on logistics costs and quality. In the investigation, quality is understood as a combination of the delivery lead time and the reliability of the mode of transportation, including the percentage of damaged goods (Respondent 2: 23).

5.2.1 Order Size & Frequency

Every time an order is made in CH's ordering system, it incurs handling costs, meaning that if CH can send fewer, but larger, shipments, then they could cut costs significantly (Respondent 3: 42, 14) Therefore, CH is interested in not having excessive amounts of orders placed, for deliveries that could have been larger: "Shipments should be in larger volumes, we are sending 6-7 tonnes each time. But the thing is, once we're sending a shipment of this size, we could be sending twice the volume, without paying extra for it" (Respondent 3: 42).

Respondent 1 reveals that suboptimal situations regularly occur in CH's transport logistics arrangement for the products in the Natural Colour Department (Respondent 1: 5), as referenced above with customers who assume that the transportation costs do not influence the price that they are paying, when in reality, it just gets attached elsewhere on the bill (Respondent 1: 6). Per Respondent 3, the sales department is somewhat to blame, since they often do not communicate these realities clear enough to CH's customers: "If the sales people tell the customers to just 'tell us every time they need something', then it will be costly for us" (Respondent 3: 29). Respondent 3 explains how many of the same customers who are

ordering in a suboptimal way are themselves pressured to cut costs, and would thus possibly be willing to wait a little longer for their deliveries, if it meant lower prices (Respondent 3: 46). He says it is about finding a balance, where both parties are gaining the most out of the relationship (Respondent 3: 45). It is a defined strategic goal for CH to be able to support all European customers within 7 work days, including picking and packing.

According to Respondent 2, the small (volume) shipments often hold the greatest room for improvements. Road and sea freight usually comes at minimum fees. Sending 5 kg can be very expensive – whereas sending 100 kg will be substantially cheaper than flying it (Respondent 2: 5). Generally, the prices depend on the place it is going, which further complicates the exercise of optimization. This thesis' next logical step is therefore to investigate the impact that route choice has on supply chain optimization.

5.2.2 Route Choice

Route choice influences logistics costs, lead time and quality. The standard of modes of transportation – road, courier, air, and sea – have similar levels of customer complaints, and should be distinguished instead between their merits of cost and lead time. Generally, air freight is the most expensive mode, and sea is the cheapest, Respondent 2 notes however, that it is impossible to say exactly how much costlier it is to fly than to ship by sea (Respondent 2: 18), and supports his claim with the example of differing air prices and regional air freight capabilities between DK and Asia (low prices high capability), and inter-Asia (very high prices, low capability). Likewise, any mode of transport can be expensive if done in a sub-optimal way. For instance, low profile goods make no sense to fly, because it eats too much of the margin (Respondent 1: 7), and road- and sea freight doesn't make sense in small volumes, since CH usually buys an entire container/truck when using those modes (Respondent 1: 19; Respondent 2: 5).

Respondent 1 recommends making a container available every week for the larger customers, because it creates a steady flow of materials (Respondent 1: 24) - a benefit for global S&OP as well. Additionally, rail transportation was considered, but not used, as it is not cheap for CH when compared to the other modes, and is neither flexible enough in the types of containers it employs (Respondent 2: 27), nor of a high enough quality for temperature control of the super-cold products on the rail to Asia (Respondent 2: 28). Excluding customer pick-up as a mode of transport, Respondent 2 regards the fourth mode, courier, as an inferior mode of transportation:

> "You pay premium price for it, and they are tossing the wares around, the items are beaten – this is the type of transportation, where we have the largest amount of customer complaints" (Respondent 2: 7).

Much optimization has already been done on the logistics costs of the different CH business units. NCD has saved a lot of money of freight; one simple way was simply to prohibit air freight in specific situations, and by better communicating to involved stakeholders the story of the cost difference between the one or the other transport mode (Respondent 1: 24). Likewise, Respondent 3 has already moved all his Enzyme shipments to sea freight, so there isn't any more optimization to be done there, in terms of moving from air- to sea freight (Respondent 3: 48).

The different CH business units have different transport needs, preferences, and optimums. Similarly, the different regions of the world in which CH does business have predominant transport modes. Europe shows a lot of road transportation. Sea and air freight are mainly used for the other continents. Products with longer shelf-life are generally sent via sea freight (Respondent 2: 26). There are many flying shipments to Asia, because the customer-demanded shelf-life on the products needs to be often between 50-75% remaining shelf-life (Respondent 2: 17).

Not only has CH not always been so good at understanding inter-company transaction costs (Respondent 1: 6); it is also a cost area where CH stands to gain the entirety of the cost advantages (Respondent 1: 7). Producing closer to the market will most of the time be a cost-saving (Respondent 1: 27). Respondent 1 argues that it is a continuous effort – since things they thought had been optimized, can be going back to the old norm a year after. Maintaining the efforts, and standardizing processes is a tough task (Respondent 1: 28). In many cases: You save something on warehousing, but you lose something on transportation – again, it is about balancing the two (Respondent 5: 30). Replenishment is simpler. It has a great value. The factories are also DCs in Poland and Romania, Ukraine, and Russia (Respondent 5: 32). Things take longer in Ukraine. If there is no queue, CH does not send anything in the weekends, because of the extra costs (Respondent 5: 32).

5.3 Value of Visualization

From its very inception, this thesis has been grounded in the assumption that GeoVisualization is a valuable pursuit. This section of the analysis highlights an agreement to that notion as well as interest shown by the different experts interviewed for this thesis: "One must not underestimate the effectiveness and usefulness of the visual aspect of this tool" (Respondent 2: 16). The visualization of data has value to SC practitioners, especially the visualization of geo-spatial augmented customer shipment data on a map. A central part of this thesis has been the value of visualization for SCM, exploring its depths in the literature review, ascertaining its relevance to practitioners in this analysis, and synthesising the two in the discussion chapter to come.

VP of Global Logistics (Respondent 6) praises the value of visualization on multiple occasions (22, 23, 33), which is of course fitting as he is a member of the CMR team. The problem formulation, delimitation, legwork and ultimate composition of this thesis are certainly owned by us, but the act of GeoVisualization SC data was inspired by the Deloitte consulting job carried out in 2015 for the optimization of European Distribution Centres (Respondent 6: 19; Respondent 5: 13). Respondent 3 found that the tool gave him a good overview and further articulated that seeing things visually helps in a variety of ways (Respondent 3: 12, 59). Respondent 1 expressed that Geovisualization helps to unearth hard to comprehend patterns and connect meaning to prior understood data that is hard to communicate (Respondent 1: 15). Respondent 4 further stated that the value of the tool is best realised 'in use' by the business users rather than the more supportive IT and BI division (Respondent 4: 14), and that a key contribution of this thesis should be the importance of making explicit the value of a data visualization tool (Respondent 4: 22). That's certainly a goal that this thesis strives for, and in terms of practical experience, whenever we exposed the tool to practitioners the interaction was optimistic and constructive (Workshop held at Chr. Hansen's site, with most of logistics department present), and in the one identified instance that this tool was used by the BI department the reception by the business users was positive (Respondent 4: 11).

The open- and focused coding of this thesis resulted in the following sub-sections related to the value of visualization:

- The use of visualization provides a greater picture and overview of the supply chain and is thereby useful for Exploration, Scenario Building, and as a means of communication; both Internal and External.
- The Limitations of Geovisualization with Lumira are briefly touched upon, including the IT limits of the tool, and the desire for the use of temporal aspects.
- The Formatting of Visualization is addressed in terms of what aspects help understanding and exploration, as well as the required user-friendliness of the tool (Lumira) for effective user interaction.
- Who could end up using Lumira is discussed from both a SC and IT angle, as well as the extent to which the tool could be expected to spread in the organization.
- The sources and quality of data are chiefly important to effective visualization and conclude this section of the analysis. The tool can connect diverse sources of relevant data to provide a richer visualization, while incorrect or incomplete data can sink the best of ships.

5.3.1 Use of Visualization

5.3.1.1 Overview

Geospatial data helps with the overview of the SC (Respondent 6: 33), and seeing every customer on a digital world map is a preferable method for SC overview than that of an Excel spreadsheet with more than twenty columns and three hundred thousand rows of data (Respondent 6: 19, 22). The visualization tool used in this thesis is a (see the delimitation section) solution to the current situation of CH SCM, that they have the data, but not the overview, nor a good way to visualize it (Respondent 6: 22). Exploration of Geovisualized data is a high-level analysis that Respondent 6 is quite partial to, the in-use value of visualization also holds that it reveals what (different or not before conceived of) kinds of information are interesting to look at (Respondent 6: 23).

5.3.1.2 Exploration

For the SC business users of Lumira, Geovisualization can be used for overview, exploration, and hypothesis building (Respondent 2: 10). This section of the analysis will deal with the scenario building that can emerge from the exploration of visualized data, and questions like “could this be the way the

supply chain is supposed to be?" (Respondent 2: 10) are illustrative of what's to come. Lumira gives a "great, and efficient, way of seeing data" (Respondent 2: 29) and all those interviewed mentioned the exploratory value of identifying opportunities for 'deep dives' or more specific analysis of points of interest, that caught their eye. Respondent 2 continues that (when looking at the map) one can quickly identify aspects that need to be investigated, and appreciate where attention needs to be focused (Respondent 2: 29). Respondent 1 continues that though good SC managers 'know' their big lanes, Lumira's visualization of data on a map helps him identify, where a deep dive should be performed (Respondent 1: 4, 17). For Respondent 3, the use of Lumira for exploration was about validating hunches, this was seen most keenly in the interview, when the clustering of distributors in Northern Italy was brought to focus (Respondent 3: 3-11). Respondent 6 saw a lot of value in a more creative exploration of the global dataset, and while he had specific priorities that he wanted to see visualized and analysed – Mexico Air freight (Respondent 5: 9); growth in China (Respondent 5: 15) – he was also clear, that we should have a free hand to just 'try things out' (Respondent 5: 11).

5.3.1.2.1 Exploration in Practice

The interview process of this thesis was largely comprised of collaborative work and demonstration of the visualization tool 'in practice' together with the expert interviewees. A summary of specific areas explored in the different interviews can be found below, and will for the most part be expanded upon immediately in the scenario building section as well as later in the *synthesis/discussion with literature* chapter. Specific cases will also be built upon near the conclusion of this thesis in the implications section/chapter.

5.3.1.2.2 Case 1: Distributors in Italy

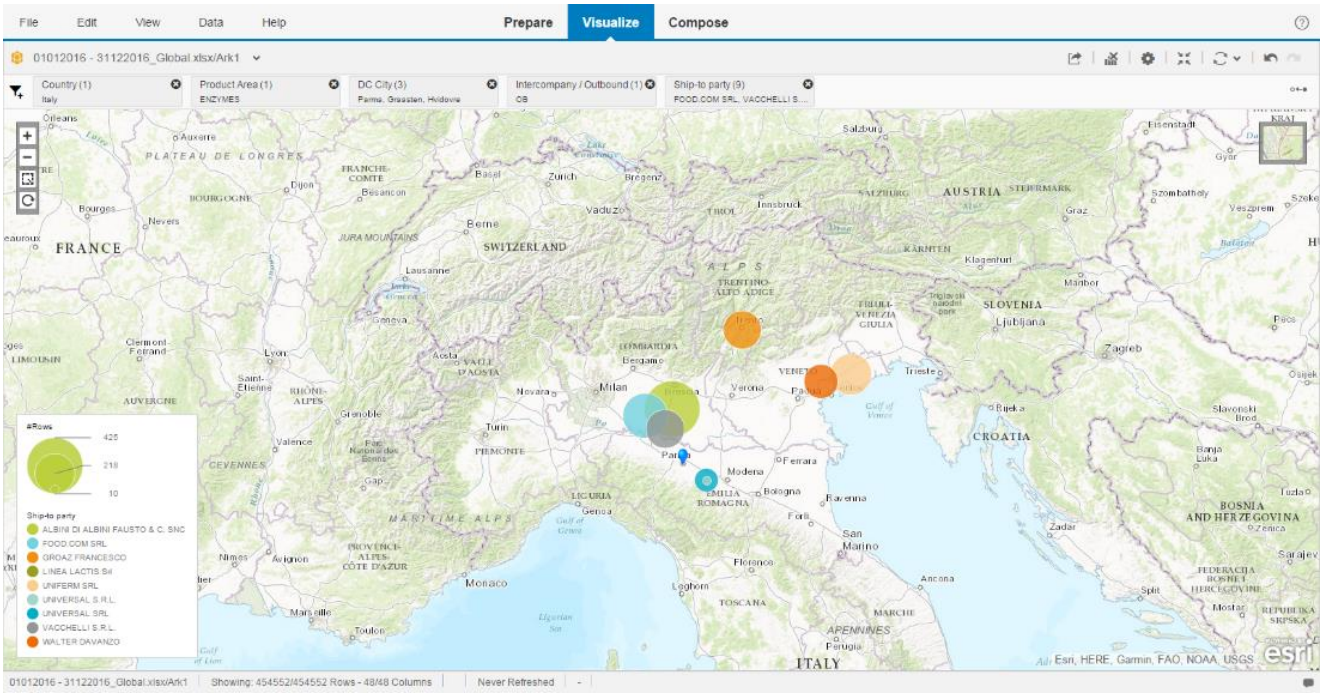


Figure 5: Distributors in Northern Italy: FC&E. Source: SAP Lumira Screenshot.

Respondent 3 had a hunch that Enzyme shipments to Italy were less optimal than they could be (Respondent 3: 3). He wanted to see the volume and order frequency of orders to distributors in Northern Italy, and during the interview that area was visualized and explored. His hunch was correct, and it can be seen here that there is a clear concentration of distributors – Figure 5 presents the top 7 in terms of aggregate order volume – located within a near proximity to the CH site in Parma (Respondent 3: 21, 22). This arrangement is sub-optimal in several ways – delved into deeper earlier in this chapter – and it was visual exploration that quickly and cleanly unearthed this opportunity for improvement.

5.3.1.2.3 Case 2: Couriers in Europe

Figure 6: Couriers in Europe, NCD. Source: SAP Lumira Screenshot

Based on his experience with different modes of transport used by his department, Natural Colours, Respondent 2 believed that the use of Couriers was a problem worth considering (Respondent 2: 8). That exploration was conducted during the interview and Figure 6 shows the pervasiveness of courier shipments in Europe – The same filters were applied to the rest of the globe and the United States, but there was much less use of couriers outside of Europe. In the timeframe studied, there were upwards of 100 tonnes of courier volume in Europe; that is a lot of volume for shipments that are the most susceptible to low quality handling, damages, and customer complaints (Respondent 2: 7).

Respondent 2 experienced that visual exploration was effective, and that the impression of seeing 'all those dots' on the map is significant compared to a similar exploration conducted in Excel via a Pivot Table (Respondent 2: 29, 31). An additional way that Respondent 2 felt that visualization contributed to a better overview is Lumira's ability to show both the large and the small details in a way that effectively catches the eye (Respondent 2: 31). In contrast, it's Respondent 2's opinion that pivot tables can encourage users to look only at the largest areas, thus risking that the small lanes and low-hanging fruits mentioned by Respondent 1 won't get picked (Respondent 1: 4, 20).

5.3.1.2.4 Case 3: Sea freight & Air freight

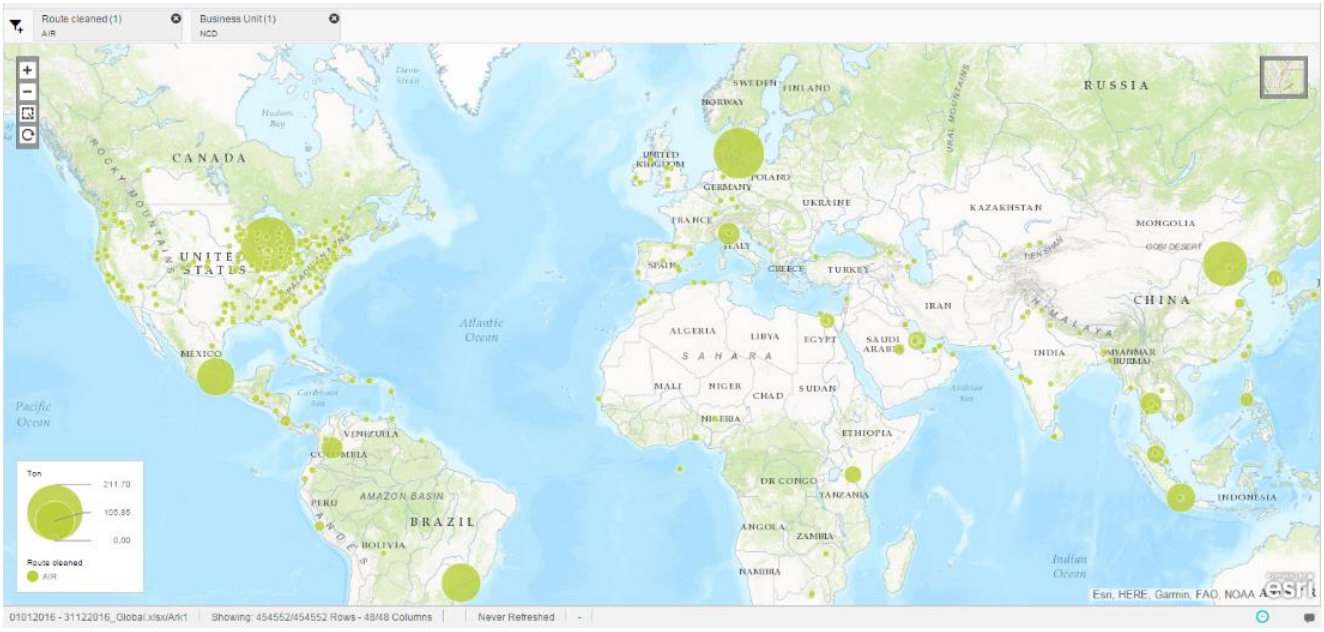


Figure 7: Global Air Freight, NCD. Source: SAP Lumira Screenshot.

Respondent 1 was interested in using visualization to get an overview of 'low hanging fruits' (Respondent 1: 20) that can't be gotten by standard Excel work nor recalled from an experienced SC manager's implicit knowledge of the big lanes of product shipments (Respondent 1: 4). Exploration in this interview was centred more around the small shipments volume-wise than the large ones, as he maintained that much energy has already been applied to the optimization of the large and understood 'lanes'. In contrast, a few small shipments were found to be sent by air (see Figure 7), his assumption was that those small shipments signal a more panicked than planned approach to shipping goods. "Sea creates stability, air creates panic" (Respondent 1: 25). Though it was never his plan to do the entire analysis in Lumira, the visual exploration pinpointed areas for him to dive deep into later – in more traditional analysis (Respondent 1: 4).

5.3.1.2.5 Case 4: Mexico

In his position as VP of Global Logistics, Respondent 6's responsibilities centre around simplifying the global footprint of CH through the establishment of a global S&OP organisation, increasing effective delivery to important customers, building strategic alliances with 3PL service providers, and increasing e-integration with customers and service-providers.

His work is based on higher level analysis, communication, and the creation of optimized frameworks that the SC managers can work within (Respondent 6: 23; Respondent 3: 9). Everyday analysis of customer freight is not his focus, but opportunities for high level optimization of the big lanes of shipment certainly are. A specific area of interest for Respondent 6 and Respondent 8 was air shipments to Mexico (Respondent 5: 9). They felt that there could be opportunities for optimization, and they were interested in exploring those visually. This exploration is dealt with in depth in later chapters of the thesis, in the Caseworks chapter.

5.3.1.2.6 Lumira's Relationship with Business Intelligence

External of this thesis' Lumira contribution, Respondent 4 is one of two CH employees currently using Lumira. The other IT user of Lumira is in the inspiration 'how best should we use this' phase (Respondent 4: 3), and Respondent 4 himself has used Lumira for one small project together with some CH business users. Respondent 4's support of that visualization project was the creation of visuals, of a specific area of interest, that the business users could take forward and use for external communication. The process of visualization was iterative, and the business users were generally pleased with the result (Respondent 4: 11). Existing BI reporting is set up to act as a framework – built and supported by BI – in which the different business users of CH can follow up regularly on some predefined KPIs (Respondent 4: 55, 56). Respondent 4 hasn't experienced that the current BI practice in CH has been explorative, but believes that if Lumira can get into the hands of business users, it can be used in an exploratory way to complement deeper analysis and problem solving (Respondent 4: 17, 22).

Per Respondent 4, Lumira is not a BI tool, but a business tool. Consequently, it should be put into the hands of the business users, since that is where it provides value. But also, because it will encourage a universal demand for better (and more centralized) data going into the SAP warehouse, e.g., latitude and longitude of customer location (Respondent 4: 20). However, the value of the system needs to be proven before the data input quality will be increased (Respondent 4: 22). Also, more use of Lumira by business users will highlight what areas of the tool are worth bringing into a central IT solution supported by the BI department (Respondent 4: 42). In line with that, multiple ideas can be illustrated relatively quickly and simply, and it's therefore much easier (than was tradition) to identify that one great idea worth diving really deeply into, and then bringing that one idea into a central IT solution. (Respondent 4: 35, 43) That back-end process would be slow in traditional usage (Respondent 4: 35), and fast in Lumira 2.0 (if it's

any good) (Respondent 4: 43). The potential is huge from a BI perspective, in that the 'simple' value can contribute to a nice-looking story for the business users, but also highlights the potential of enhancing it as a central solution. If the two options were in the same software – as is promised in Lumira 2.0 – then the short lead time would be great – giving much more business value as well (Respondent 4: 42).

5.3.2 Scenario Building

Scenario building was a code that occurred in most of the interviews, and in most instances flowed organically from those comments related to exploration. Respondent 3 for instance approached scenario building in the same breath as exploration. For him, Lumira was not simply a device with which to explore data, but a tool with multiple possibilities that could *impact* different areas of CH's organization and business activities. To illustrate the relationship between this, the following quote from Respondent 3 is presented, note that it has been coded – shown by [square parentheses] – in eight different ways:

> Seeing things visually helps in different ways [value of visualization, exploration]: Where should we locate our distribution centres [SC optimization, scenario building], in negotiation with customers [external communication], but if we should use it internally [internal communication], we must be able to understand the data, and its sources [data sources and data cleanness]. (Respondent 3: 59)

Scenario building is only one of the codes applied to the above quote, yet it stands to encompass most of the others. Once the explorative usage of Lumira prompts 'what if…' questions, scenario building begins. Specific cases of this – Lumira's support of scenario building and problem solving – occur later in this thesis in the best practice and implications chapters.

5.3.2.1 Scenario Building in Practice

5.3.2.1.1 Case 1: Distributors in Italy

Respondent 3's scenario building focused on alternatives to the undesirable situation discovered during the exploration of customer shipments to distributors in Northern Italy. Scenario building was the next layer for him, and Respondent 3 has already moved all his shipments from air to sea, and it now in 'the next layer', as he describes it himself – he now chooses to focus on order size and frequency (Respondent

3: 48). Respondent 3's 'what if…'s dealt with reducing the frequency and occurrence of small orders per week, while increasing the volume per new order shipped (Respondent 3: 12). Thirty small orders of similar product types were sent to one customer in April 2016 alone (Respondent 3: 48, 49) (See exported Excel records in appendix). "They need to understand that if they are only purchasing a few different products, then ordering three times a week doesn't really make sense" (Respondent 3: 30). As identified in the above section SC Optimization, order size and frequency can affect route choice, and the scenario building fielded during the working interview with Respondent 3 was along those lines. Multiple small orders are basically showing room for improvement (Respondent 3: 41) and are unwanted because of the associated handling charges (Respondent 3: 29). Such a situation could also be indicative of a miss-fit between a general CH strategy of low inventories (Respondent 1: 22) and distributors that are pushing inventory costs upstream and using CH's Parma site as their own personal warehouse. Scenarios fielded during the interview included switching away from a Graasten (CH) to another distributor via Parma (CH), to a Graasten (CH) direct-to-customer. It goes without saying that those direct-to-customer X shipments would also be larger, and less frequent than those previously experienced. Respondent 3 also voiced the scenario of lowering global safety stocks by shutting down CH sites like the one in Parma (Respondent 3: 44). Respondent 3 could of course have arrived at these scenarios via traditional analysis, but the visualization of these customer shipments enabled a quick confirmation of hunches that led to fruitful scenario building.

5.3.2.1.2 Case 2: Couriers in Europe

In an exploration of the customer shipments of 2016, it was found that over 100 tonnes of NCD products were transported via courier in Europe (Respondent 2: 8). This was not satisfactory for Respondent 2, and scenario building began here. Order size was also a condition here, and as it was believed that the small orders with courier were not profitable, sending only larger shipments in the future was suggested. Abandoning the use of courier altogether was also considered, with the condition that a threshold should be understood first (Respondent 2: 11). Use of Lumira helped the 'right' questions come up in the working interview, as well as alternative ways of performing tasks that might have been taken for granted without the aid of visualization (Respondent 2: 32). Simply having the data is not enough (Respondent 6: 22); as a start, visualization, exploration, and scenario building need to occur for meaning to emerge.

5.3.2.1.3 Case 3: Deep Dive & Complementary Analysis

The explorative value of Lumira for deep dives was noted early in the interview with Respondent 1 (Respondent 1: 4). Specific scenario building needs to wait however for the more complete picture that Lumira can create with extra sources of input data, namely cost data. Additionally, the use of Lumira can be complemented by analysis in Excel (Respondent 1: 17). Exporting to Excel via the 'export records' function of Lumira (Respondent 3: 61), as well as connecting extra sources of data (Respondent 4: 25 – 30), will be addressed later in this chapter, as well as in the Caseworks and Discussion chapters. Separately, Respondent 2 considered sending Respondent 1 – as a Lumira business user – to the US as part of scenario building for optimization with the site managers there (Respondent 2: 38).

5.3.2.1.4 Case 4: Mexico

Respondent 6 set some specific parameters for exploration in the cost of logistics report in Lumira. These were in terms of Mexico and the issue of seeing if CH could move away from air freight to sea. Based on his experience and understanding of the cost difference between the two transportation modes, the criterion was determined to be 'intercompany air shipments – from any of the business units – over five tonnes volume' (Respondent 5: 4, 9). This case will later be addressed in depth as an example of best practice usage of Lumira, and the deep dive will include adding context via extra data sources such as product shelf life, thus determining not only if switching from air to sea will save CH money, but also if their customers will accept the extended lead time.

5.3.3 Provide Means of Communication

5.3.3.1 Internal Communication

The communication between the SC managers and the sales people shows signs of being somewhat ad hoc, even though the interconnectivity between them is evident. It is suggested, that the sales people should have access to Lumira as well (Respondent 1: 13). The logistics practitioners continually explain to the sales people, the consequences of a poor SC setup – he thinks Lumira might be the tool to help them tell this story (Respondent 1: 14). If you are a good SC manager, you already know the things that should be visualized, and what they need is graphical means of communication, to help put two lines under the correct number (Respondent 1: 15). This is supported by Respondent 2, who is the manager of

NCD. When it comes to meeting the KPIs, he says the measurements need to be on a specific level. He explains, that people will often say, 'show us a number!' (Respondent 2: 37).

Lumira will be used in multiple ways – but especially as a communication tool, in a graphical way (Respondent 1: 15). The communication will be made easy with the sales department, since they have the same customers across departments, and already share data (Respondent 1: 20). This corresponds to the tale that Respondent 3 tells about Lumira's role in communicating with other departments: "Lumira gives me the opportunity to select the most appropriate distributors – as well as to push back to Sales department, and ask, is this really the smartest way to do it?" (Respondent 3: 14). Respondent 3 argues that it may be that he cannot perform optimization on it right now, but that the next time the sales department is negotiating prices with the customers, they should be able to include this data (Respondent 3: 49).

5.3.3.1.1 Joint Exploration

Respondent 4 explains joint exploration in the following way: "The best use of these kinds of tools is to bring it out to the business users. This is not a technical tool" (Respondent 4: 14). Lumira could thus be used to help the initial stages of a deep dive. How did the last year look? The employees could go to the US, and sit down with the site managers, and they could look at these pictures together, to better understand the SC (Respondent 2: 38). Respondent 5, who is also a member of the CMR team, thinks the work thus far in the collaboration is on point, and he wishes to validate the data with the shipping guy (Respondent 6: 8).

5.3.3.1.2 From Exploration to Communication

Respondent 1 explains his usage of Lumira the following way: "When you are deep diving into your data, you can most often get the big overview yourself. However, when you need to present it to others, it is key that you can visualize it in a convincing manner" (Respondent 1: 3). Respondent 2 supports this notion, by saying: "Another aspect that I see this being used as is to communicate, where I think, it is useful. Take for example, taking snapshots of this, and putting them into a presentation, to support your argument. I think it will be used to communicate to other stakeholders" (Respondent 2: 30). Likewise, Respondent 4 argues: "It is much more successful, if you try to limit the complexities. A business user can, with a little bit of training, show the story they want to, with this tool" (Respondent 4: 15).

5.3.3.1.3 External Communication

Per Respondent 6, CH are missing a good way to visualize and understand their logistics data. The situations where they especially need these insights are when they are entering negotiation with their 3PLs. By bringing the visualizations to such a meeting they will be able to communicate more effectively, and argue better for their cause (Respondent 6: 25).

5.3.4 Limitation of Visualization

5.3.4.1 IT Limits of Lumira

Respondent 2 points of the limitation of Lumira, that you need to know what you are doing, when using it - that you must invest a few hours into the tool. He asks the questions: "Are they going to be using it frequently enough to access all the features of the application?" (Respondent 2: 35). If that is not the case, that is a limitation (Respondent 2: 36). Respondent 4 argues that the limitation of (any) IT business tool is that it is 'the never-ending story', where whenever business users are provided with new information from the data warehouse, they have already moved on to new areas of interest (Respondent 4: 24).

5.3.4.2 Temporal Aspects

Several of the experts interviewed for this thesis put forward a desire to be able to see temporal aspects of the data they were presented with – which is not immediately feasible in Lumira's Geovisualization application. Per Respondent 1, a time perspective could help them understand the overview – especially viewing the monthly data (Respondent 1: 36, 33). This would help them understand the development that they have gone through. Likewise, Respondent 3 says that looking at it in a time perspective could be interesting and relevant (Respondent 3: 41). However, a map is not the best visualization of a timeline. SAP Lumira has other types of visualizations for this type of data – like interactive bar charts.

5.3.5 Formatting of Visualization

This section focuses on the aspects of Lumira that are designed to create meaning for the user, and the different ways in which the user can format the visualizations that are being created. The zooming

function in Lumira allows the user to focus on specific areas of interest, as shown in the interview with Respondent 2, where he wanted to look more deeply into customer pickups in specific geographies (Respondent 2: 2), as well as the size of the bubbles, showing the volume of the end-customers' deliveries (Respondent 2: 3).

In terms of formatting the numbers on the aggregated bubbles, Respondent 2 was interested to know if each bubble could also display the numbers showing their total tonnage values, rather than the number of aggregate data points (Respondent 2: 22). However, he also agrees with the fact that Lumira is already showing this information, through the sizes of the bubbles (Respondent 2: 25).

Extending the limitations of Lumira, mentioned earlier in the chapter, Respondent 4 argues that there are some difficulties when it comes to visualizing some points of interest – specifically the frequencies of the goods deliveries (Respondent 4: 6). Geovisualization with Lumira allows the user to see the number of shipments, visualized on a world map. However, one thing is order lines – another is number of shipments. Ten different products can be included in the same shipment and finding the right level of complexity to sort by and present is challenging. (Respondent 4: 22), The high level of data granularity in the COL report, makes it possible to aggregate shipments per country, as well as specific item lines in individual shipments via the shipment number (Respondent 3: 30).

It is relevant for the supply chain managers at CH to understand what they're looking for, and to be able to export the dataset in the same format as in their regular spreadsheet way of viewing the data (Respondent 3: 38). This is exemplified by the 'export records' function, and the user can be as specific as they like, simply clicking on or off the extra columns of the dataset.

Respondent 4 argues that the level of detail should always correspond to the data needs of the user, just as the format and level of granularity should be fitted to the users' desires (Respondent 4: 33). When it comes to formatting the visual data, some of the data points represent volume, while others represent quantity – and both things matter (Respondent 4: 10), since both aspects of the geospatial data points help provide the user with an overview (Respondent 5: 33). Respondent 5 argues to the fact that a different view can often expand the meaning of the data set: "The depth of the line shows how much we are sending! Different software has different ways of visualization" (Respondent 5: 45).

5.3.6 User-Friendliness & User Interaction

Lumira is a tool to help the employees at CH in their everyday work life (Respondent 1: 4). To fulfil this task, Lumira must be a rapid tool that is user-friendly in several ways; it needs to be intuitive and easy to learn (Respondent 1: 16). Much of the analysis work in the logistics department at CH is performed in MS Excel, and it is therefore vital that Lumira continues to work well in combination with Excel (Respondent 1: 17). Likewise, though few people are looking at the whole company at once (Respondent 1: 18), many of the employees are looking at large quantitative datasets, which must be easily and rapidly analysable using Lumira. If the tool is lagging, and taking too long to load, the employees are not going to use it. The import and export of data between MS Excel is made even more relevant in this context, since it is the tool used by most business analysts at CH.

Conductive comparative data analysis easily in Lumira is something that several of the respondents say is desirable. Specifically, being able to compare two lines of Excel data, via Lumira, by simply clicking the two data points (Respondent 3: 47). Lumira's compatibility with Excel is exemplified in the interview with Respondent 4, where he shows how the customer (of one source, Excel) and the ID of the same customers in the data warehouse (another source) can be put together with very little effort from the user (Respondent 4: 25-28).

In terms of the user-friendliness and applicability of Lumira, Respondent 4 contends that Lumira is suited to create reports that can be shared with maybe a couple of colleagues, or maybe a specific meeting. For such a purpose, it is far too cumbersome to go to the BI team (Respondent 4: 14). The idea-to-action capabilities can be significantly boosted by using Lumira:

"Rather than saying, oh I have ten good ideas, let's make 10 projects, then you can quickly show 10 good ideas, and find out, one of them is a great idea. That is your candidate for the much heavier and slower task of integration to the back-end system" (Respondent 4: 35).

5.3.7 Tool Users

The users of this tool are everyone within the logistics department at CH. Out of the 2800 employees at CH, roughly 2500 of them are users of IT solutions (Respondent 4: 58), such as SAP or BI tools. However, far from every one of these 2500 employees would have use of a tool such as Lumira, let alone

its Geovisualization features. Per Respondent 2, it is also a matter of the industry in which the employees operate: “Some industries are more likely to see benefits from tools such as Lumira” (Respondent 2: 42). Respondent 4 supports this notion, arguing that the employee from his department using Lumira, has met some obstacles – causing him to still be in the inspirational phase (Respondent 4: 3) – and that Lumira should be shared with the business users that have enough of a “certain type of visualization requirements – they should not be experts, but they should become ad hoc users of the tool” (Respondent 4: 15). In a similar way as the consultants from Deloitte did (with the footprint analysis, using the tool, Tableau) – they mapped the customers out on a map, to show their location, and categorized it in terms of volume, sales, and value (Respondent 5: 19). Such work would often be conducted by outside consultants, but the wish is, that the implementation of Lumira will allow more such analyses to be conducted internally in the organisation.

5.3.8 Data Quality

Respondent 1 believes that a smaller dataset will make Lumira play more smoothly (Respondent 1: 18), depending of course, on the type of data. As earlier mentioned, CH’s Mexican department exclusively uses the category “0day” (Respondent 2: 3), and many of the shipments shown (especially in Europe) are sample shipments (Respondent 2: 9). Lumira allows the users to filter by weights (e.g. under 5 kg), which would likely remove most of the samples, thus “cleaning” the Geovisualization (Respondent 2: 9). Generally, this thesis argues that the data must be very “clean” and standardized, both between countries, and between business units, for a tool such as Lumira to be fully effective (visualization of unclean data is sub-optimal). “There is a demand for clean, and good quality, data” (Respondent 2: 32), and adding the increased granularity would likewise provide benefits.

5.3.9 Conceptual Model: GeoVisualization for SCM

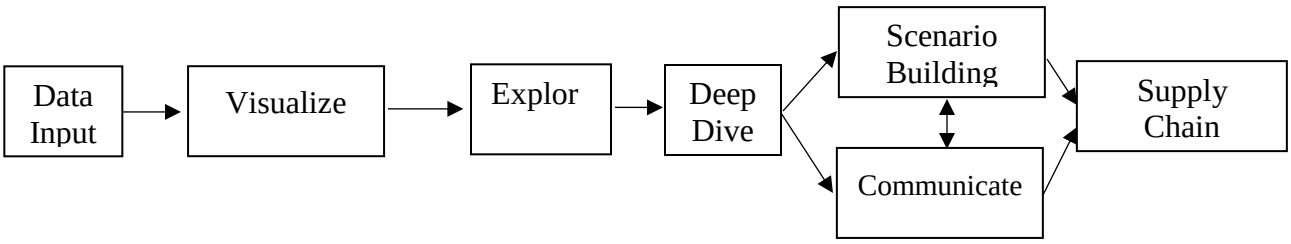
This section presents Model 4, the result of this analysis chapter. Its creation stemmed directly from the coding of the expert interviews, and the circumstances of its creation are presented here. In line with the Grounded Theory approach employed in this thesis, the concepts that appeared the most make up the steps in Model 4. The model was discussed with the CMR team, who provided valuable feedback for modification – however, it was our own inference that ultimately decided the order of the following steps:

Data Input; Visualize; Explore; Deep Dive; Scenario Building; Communicate; Supply Chain Optimization.

Through this model this thesis suggests that, without *Data Input*, there could be no *Visualization*. Without visualization, the speed and comprehensiveness of geovisual *Exploration* would be lost. Without exploration, opportunities for *Deep Dives* would not reveal themselves. Without deep dives, *Scenario Building* could not occur – subsequently inhibiting the *Communication of* the outcomes, or scenarios under development. Lastly, without scenario building and communication, certain opportunities for *Supply Chain Optimization* would never be unearthed and analysed, and hunches never confirmed.

While this thesis recognizes and understands that other means exist to gain SC insights (some of which are presented in the literature review chapter), and thereby SC optimization, Model 4 outlines the cause-and-effect relationship of *GeoVisualization for SC Optimization.*

In the Caseworks chapter, Model 4 will be used to present the explorative, analytic, and presentational capabilities of Lumira by taking the reader through the cases 3 and 4 – since these holds special interest for CH's Global Logistics team. In the Discussion chapter, the results from this analysis will be enrichened by a synthesis of the academic knowledge outlined in the literature review chapter.



Model 4: Conceptual Model: GeoVisualization for Supply Chain Management. Source: Own Creation.

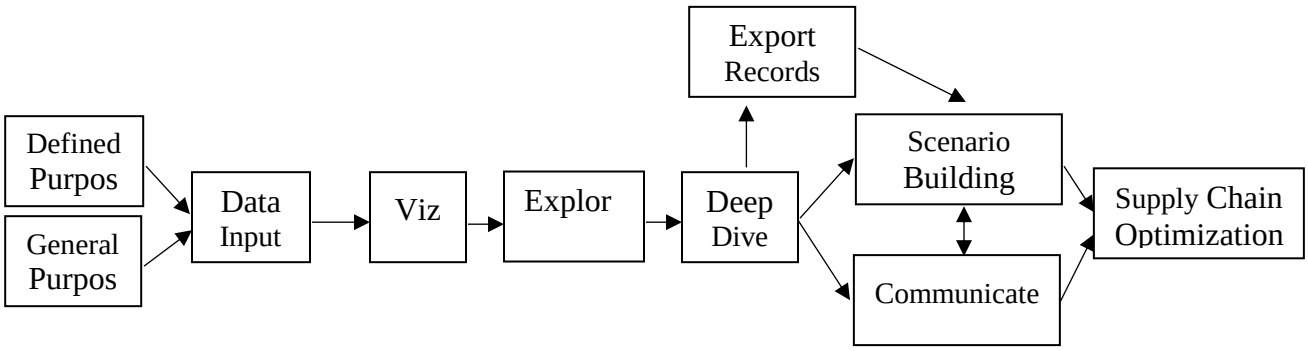
5.4 Lumira Case Work

This section will go through the Conceptual Model for SC GeoVisualization. All steps are touched upon, but it is important to recognize that most of the caseworks action occurs in the exploration and deep dive steps.

Referring to Model 5, data input happens beforehand – 'off-screen' in other words, and is described in the research process. Visualize is of course the entire process, but occurs as a 'step' in the moment that Lumira is booted up and the data is visualized when the measures (volume (size of the bubbles), customer

long/latitude) are dragged into the dashboard. Explore is the first few filters applied, and deep dive is where most of this chapter focuses. Scenario building, communication, SC optimization, as well as modifications to the Model 5 occur in the discussion chapter immediately after this casework chapter.

This chapter contains descriptions of the casework that we conducted in SAP Lumira: the 'action' of collaborative research. In addition to the working interviews conducted under the course of this thesis, we spent much of our time on- and off-site working with Lumira, playing with, and exploring the COL report. On all occasions the use was purposeful, though in some situations it was more inquisitive, and in others (like the working interviews with five of the different SC practitioners), it was more directed. The text that follows will walk the reader through the steps that were undertaken during the search for global opportunities to switch from air to sea freight. This casework process will follow the model that emerged from the grounded theory analysis, and this chapter should be considered as a test of the model's applicability. Additionally, considerations from the methodology, data, and literature of earlier chapters have affected this casework, and they will be applied to the model when considered relevant. Since the work done in this part of the analysis was deductive, we deemed it relevant to add another step to the very beginning of the model: a purpose that initiates the process of GeoVisualization for SC Optimization. This is in line with Berinato (2016, p. 98): *visual exploration vs. visual confirmation.*



Model 5: GeoVisualization for Supply Chain Optimization. Source: Own Creation

5.4.1 The Logic of Exploration

An understanding of the setting in which the exploration will take place is important, and exploration starts with a question, purpose, or hypothesis (Kraak, 2003). While it's conceivable that Lumira could be used purely inductively, it is more likely that practitioners will use the tool with their specific business units in mind, with specific audiences expecting specific visualizations of data (Respondent 4: 55, 56; Respondent 1: 18). In other words, parameters and pre-existing conditions will exist before, during, and

after the software is used, and will affect the overall value of its usage – once it finds its way into the hands of business users in the logistics department.

Our use of Lumira was more abductive than the purely deductive testing of hypotheses, or the inductive building of them – because there are real data available from which to build a model and then to explore and test it for confirmation. The SC practitioners suggested different ways that the use of Lumira could bring value to them. Respondent 3 came to his interview with specific hunches that needed to be explored, and while the exploration that followed was broad (Respondent 3: 5-60), it was primarily deductive. He reckoned that the frequency and size of orders to distributors in Northern Italy were sub-optimal, and that hunch was collaboratively explored and confirmed during the working interview.

The working interviews with Respondent 1 and Respondent 2 followed a more abductive reasoning, including both exploration (Respondent 1: 15, 27; Respondent 2: 10, 11), as well as confirmatory hypothesis testing (Respondent 1: 18; Respondent 2: 10).

The exploration contained examples of both the inductive or deductive approach, and the conclusion, which was based on the available information, was found to be both useful and the *best explanation of the phenomena at hand,* as prescribed by abductive inference (Bryman & Bell, 2011; Egholm, 2014).

This way of using Lumira is supported by the foundational GeoVisualization literature of Kraak (2003): "GeoVisualization implies the use of visual geospatial displays to explore data and through that exploration to generate hypotheses, develop problem solutions and construct knowledge" (p. 398).

GeoVisualization tools, such as Lumira, are best employed in an *interactive environment*, that the business user, and the collaborative researchers, have access to (Kraak, 2003).

The other respondents expressed similar appreciation of the inductive and explorative nature of GeoVisualization, while being quite transparent about their desire to search for specific visualizations that they would use to solve problem areas experienced in their business units and product areas.

As will be described throughout this section, the specific exploration conducted in this section is purposeful, as the findings were deemed useful to CH, having been identified as important to the practitioner members of the CMR team (Respondent 5: 3). While it started deductively however, many 'extra' questions were posited about the insights found, and in some cases these questions drove further exploration. In addition to fulfilling the purpose of this exploration and identifying opportunities to switch high-volume shipments from air to sea, the thesis concludes that the model that emerged from the Grounded theory analysis is not sufficient to every form of exploration, nor each type of research logic.

The model will therefore be further developed, and alternatives will be presented during the argumentation of the chapter.

5.4.2 Switch: Air to Sea Freight

During the working interviews, the authors worked with specific cases and presented visualizations that were deemed actionable and useful to all members of the CMR team. The first such case that is presented in this section relates to switching from air freight to sea freight. Over and above its practical implications, areas of theoretical consideration were highlighted that had heretofore only been touched upon in the literature review chapter. In this example of casework, exploration of specific logistics data led to a greater appreciation of the overall complexity of global SCs, and the theoretical contributions that SC academics have made to solving that.

Two different approaches were applied to explore the dataset for opportunities for reducing SC costs by switching from Air Freight to Sea freight. These approaches are used to show how Model 5 changes, depending on the nature of the exploration.

Our expertise in using Lumira, as well as our general understanding of the SC environment of CH, was developed throughout the different stages of the thesis research process, that were outlined earlier in this thesis. The understanding of the specific context under which a switch from air freight to sea freight could occur, was given to us by the CMR team members in both the expert interviews, as well as the informal meetings. Switching from air freight to sea freight is not simply a matter of volume, lead time or costs. Because sea freight entails a longer lead time, and both IC/OB customers have high requirements of remaining shelf-life, only items with more than 12 months of shelf-life were considered for the switch.

5.4.3 Specific Casework

Since the COL report did not include shelf-life data, this data was added using the 'Merge/append' function in Lumira. This function matches the 'material number' column in the COL report to its equivalent column in the shelf-life report, and appends the shelf-life information in a new column on the corresponding rows in Lumira. After the shelf-life data was brought into Lumira, the column was converted from days to months, and thereafter grouped into easily understood and commonly used (among the interview respondents) groupings of shelf-life: 3 months, 6-12 months, 1-2 years, and +2 years.

To prepare the COL dataset, the ‘grouping’ function in Lumira was used to mathematically differentiate between shipments that had a volume of over, instead of under five tonnes. Hereby creating an extra column, labelled ‘+5 tonnes’, to filter the data by.

5.4.3.1 Process of Exploration: +5 tonnes

Starting with Figure 8, global visualization of the COL report, we took note of the volumes of: the different transport modes Air, Road, Sea, 0days, Courier, and Customer Pickup, as well as the difference between inter-company (IC) and outbound (OB) shipments.

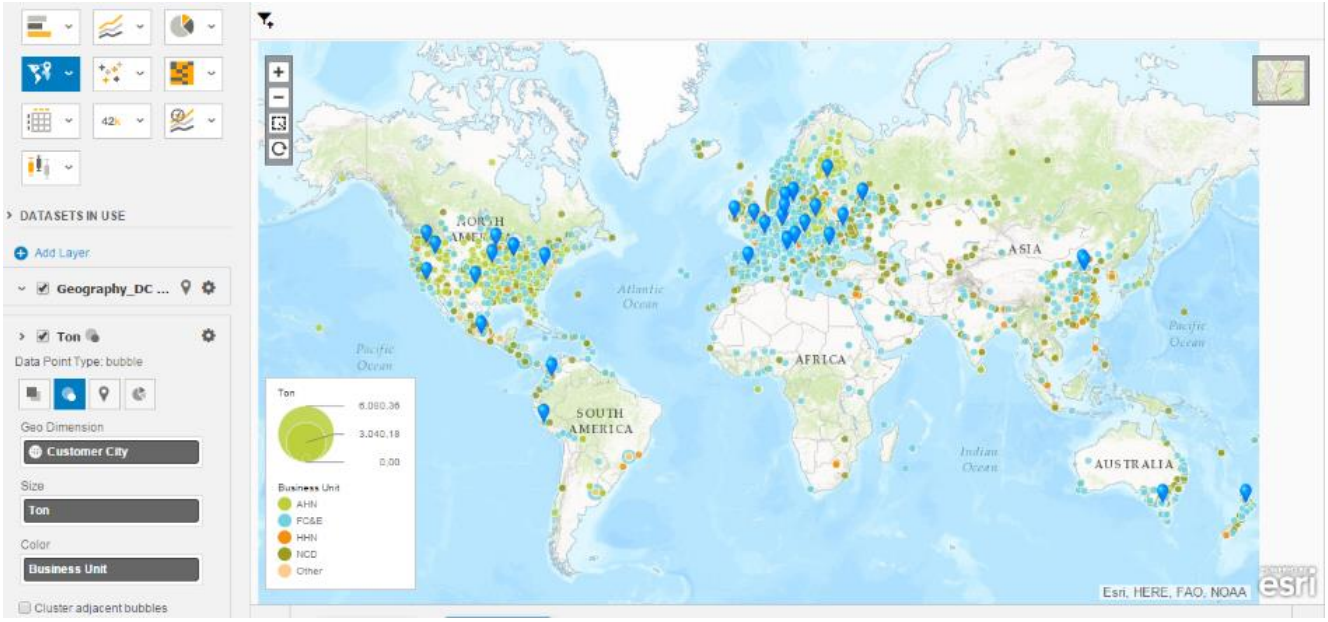


Figure 8: Global Customers/DCs Visualized in Lumira. Source: Own Creation

The first two filters applied were IC and the transport mode Air (excluding all other modes) (Figure 10). At this point, opportunities for deep dives became apparent, as it was identified (thanks to Lumira's sizing of bubbles by relative volume) that the Milwaukee site was by far the largest receiver of Air freight, followed by Beijing as a clear second.

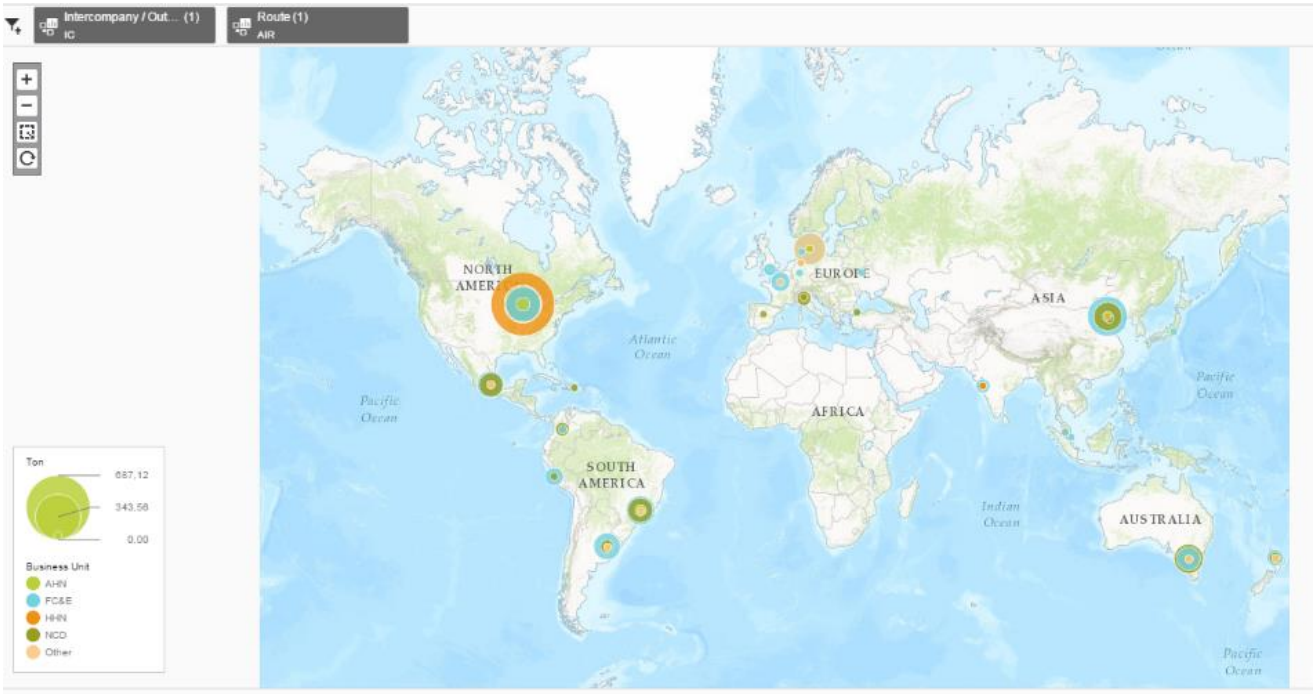


Figure 9: Global Inter-Company Air Shipments. Source: Own Creation

Avedøre, Mexico City, Melbourne, and Sao Paulo all appeared to receive similar volumes of air freight (though less than Beijing and Milwaukee – around 200 tonnes), and Buenos Aires and Arpajon received the only other significant amount of air freight (less than 100 tonnes). There are of course other CH sites that receive air freight and are seen in this visualization, but the amount received was negligible volume wise – and could have been instances of more random one-off occurrences, that hold less potential value (Figure 9).

The next filter applied was volume based, namely, the +5 tonnes filter (excluding all discrete shipments under five tonnes) with the immediate result that all large bubbles except Milwaukee, Beijing and Avedøre disappeared - there was a very small bubble remaining for Mexico City, representing one discrete shipment of just over five tonnes (Figure 9).

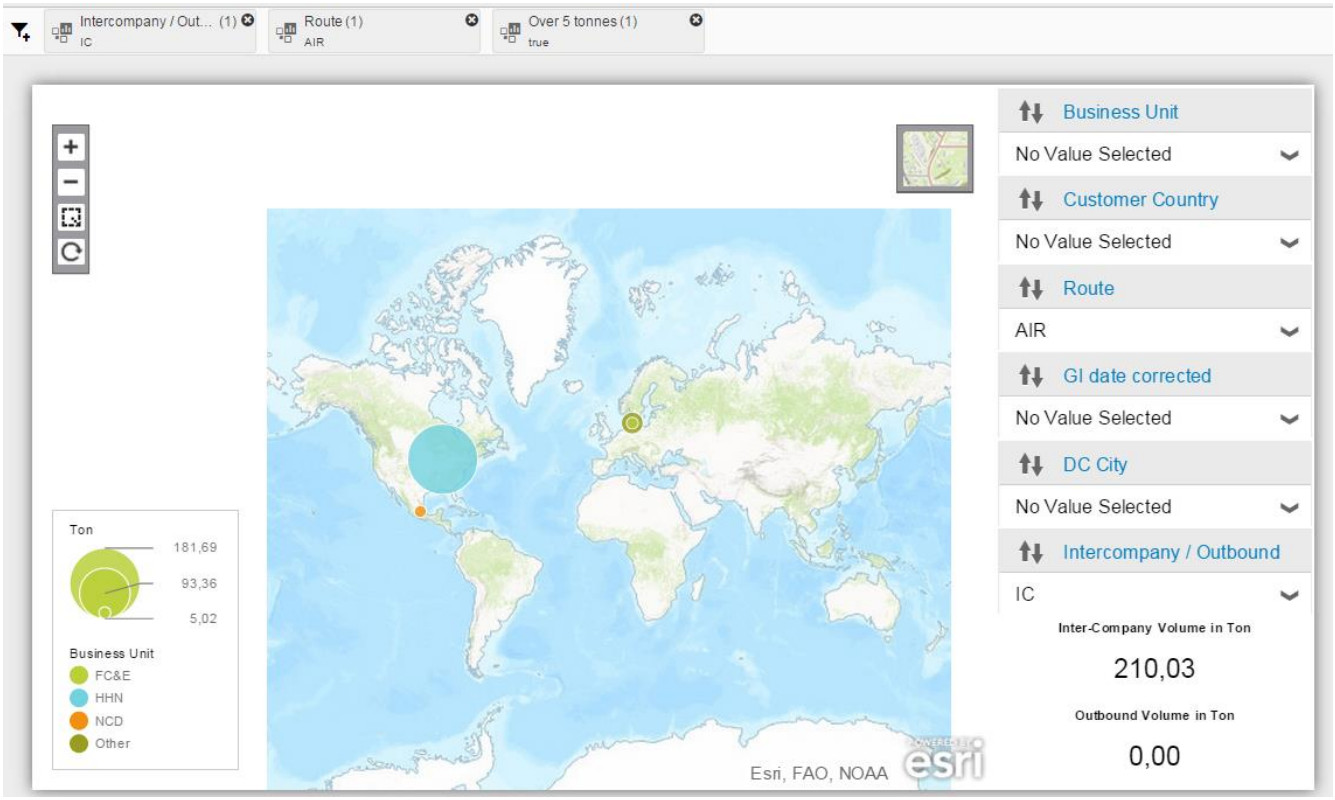


Figure 10: Global Inter-Company Air Shipments, + 5 Tonnes. Source: Own Creation

The final filter used in this case was that of the Shelf life grouping of 1-2 years, and 2+ years. The singular shipment to Mexico City was filtered out (it was a shipment of products with 6-12 months' shelf life), with the large bubbles remaining in – descending order – Milwaukee, Beijing, Avedøre.

Subjective choices were then made as to which CH site to consider more deeply. The volume sent to Avedøre was significantly less than the other two sites, and Beijing represented the anomaly of 'cheap' air freight as described by Respondent 2, 5, and 6.

Milwaukee, and the ca. 180 tonnes that were sent, in large volume shipments, by Air in 2016 was an ideal case**.** Furthermore, the shipments to Milwaukee shared a common point of departure – Avedøre – and business unit – HHN – and though not strictly necessary for the exploration, the final filter applied was 'Shipments DK-US'. In addition to being the lowest hanging fruit, the DK-US shipments identified here originated from the same site that we have been visiting for the last half-year, communicating this result had real value, to SC actors that were involved in, or knew about, the shipments visualized. These results were taken to the CMR team members and they deemed them relevant. We were provided with relevant freight rates, which resulted in the calculations below:

	Unit	Baseline rate/ Euro	Expected rate/ Euro	Saving/ Euro	Saving %
40' reefer	**EUR/BOX**	13,58	7,44	6,14	45%
20' reefer	**EUR/BOX**	13,58	13,00	0,58	4%
40'	**EUR/BOX**	13,58	5,22	8,36	62%
20'	**EUR/BOX**	13,58	8,39	5,19	38%
Average	**EUR/BOX**	13,58	8,51	5,07	37%

Table 3: Freight Rates in HHN. Source: Chr. Hansen

KG/BOX	2,25
KG per TON	1.000
BOX/TON	444
Total TONS	181
Total BOXES	80.444
Saving/BOX	5,07
Total possible Saving	407.652

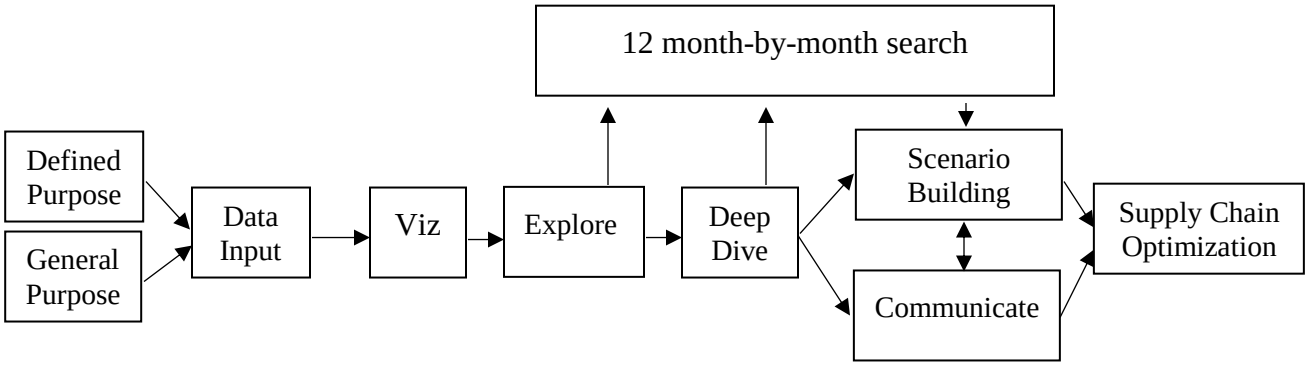
Table 4: Freight Savings Calculation. Source: Own Creation.

As shown in Table 3 and Table 4, the saving potential of a move from sea freight to air freight entails a possible 37 % cost saving. And when accounting for the voluminous shipments sent to Milwaukee in 2016, the possible monetary cost saving for CH is in excess of 400.000 Euro. Naturally, this figure should be taken with a grain of salt, since it is based on averages. However, we do argue that this example provides a strong argument for the case of SC GeoVisualization.

It's worth noting already now, that the process detailed above includes only discrete shipments over five tonnes of volume. It does not identify situations where multiple smaller shipments could have been collected and sent together, thereby bringing their aggregated volume over the pre-defined threshold and justifying a switch from Air to Sea freight. That, slightly lengthier, process of visual exploration is described below, and has a different effect on the Model 5.

5.4.3.2 Temporal Exploration in Mexico

In this exploration, there is no filter applied for the specific volume of shipments. Instead, this section tests the temporal abilities of Lumira by searching for shipment volume over specific time windows. The findings of this inquiry are dependent upon the time hierarchies built earlier in the collaborative process and outlined in the research process chapter. Model 6 below outlines the process for this exploration.



Model 6: GeoVisualization for Supply Chain Optimization. Source: Own Creation.

Refer again to Figure 10: Global IC shipments. There is no need to 'click off' all filters, as we are still interested in seeing specifically IC shipments sent by Air. At this point, there are eight sites that visibly received enough air freight in 2016 to justify a month-by-month deep dive, with the specific goal of switching from air shipments to sea. The sites identified are Milwaukee, Beijing, Avedøre, Mexico City, Melbourne, Sao Paulo, Buenos Aires and Arpajon. Different business units send different goods back and forth between these and other sites, and products shipped have different shelf-lives, as well as shipment and handling requirements, implying differing levels of difficulty of isolating specific opportunities for shipment optimization.

As before, the visualization was filtered for IC shipments (excluding OB) recognizing that IC shipments are directly controllable for CH, and represent direct costs on the organisation. Whereas OB shipments are negotiated with individual customers, who it can be assumed will be paying for the logistics one way or another (whether it is included in the price, or directly paying the cost of logistics). This was mentioned by both respondent 2 and Respondent 5 during their interviews. Extra context regarding the true 'cost' of customers is given in the discussion chapter.

This temporal deep dive focuses on Mexico as it was a specific request from a CH member of the CMR team, early in the collaboration process (Respondent 5: 15). Notice as well, that in the first example up above, Mexico was filtered out of the visual exploration when the filters '+5 tonnes' and '1-2 years & 2+ years' were applied.

Upon choosing Mexico City as the focus of the deep dive, and seeing that 231 tonnes of air freight was sent to that site in 2016, we decided to visualize sea shipments to Mexico City as well, as it was deemed valuable to see not only if air shipments could be moved to sea, but if there were sea shipments existing already, that could be added to – making more optimal use of an already-purchased container. Like the previous Milwaukee decision, we have chosen to look specifically at what Denmark sends to Mexico City, as that is controllable, and of interest, to those SC practitioners we've been interviewing and working with on the CMR team.

At this point, the filters that are applied to the visualized dataset are: IC and the transport modes of Air and Sea. The next step is 'DK to Mexico City' which filters out the rest of the globe, and leaves us with 272 tonnes of Air and Sea shipments to the CH site there. Remembering that both IC and OB customers have high demands for the remaining shelf life of products, our final filter before going month-by-month is the shelf life groupings of '1-2 years' and '+2 years'. This allowed for a specific month-by-month deep dive into shipments that could be reasonably merged together and sent by sea. We have still not sorted for business units, and so it's worth mentioning that any solutions provided here would involve the need for communication, and coordination, between the different SC practitioners responsible for the planning and logistics of the different products from different business units that we are, for the purposes of clear exploration, grouping together. The month-by-month sorting through air and sea shipments to Mexico City are presented in tonnage, in the table below. In most cases the products of different business units can be shipped together, though there are exceptions to that norm. (a brief discussion of these exceptions can be found in the discussion chapter; some CH products are, for example, classified as dangerous goods, with specific handling requirements).

Month	Volume Globe	Volume sea	Volume air	Volume Mexico total
January	230	9	8	17
February	227	7	7	14
March	217	10	10	20
April	303	7	10	17
May	219	10	5	15
June	247	5	14	19
July	360	**21**	**14**	**35**
August	298	**20**	**8**	**30**
September	315	10	8	18
October	276	18	4	22
November	335	**29**	**6**	**37**
December	270	**20**	**10**	**30**

Table 5: Sea Freight & Air Freight Volume to Mexico. Source: Own Creation.

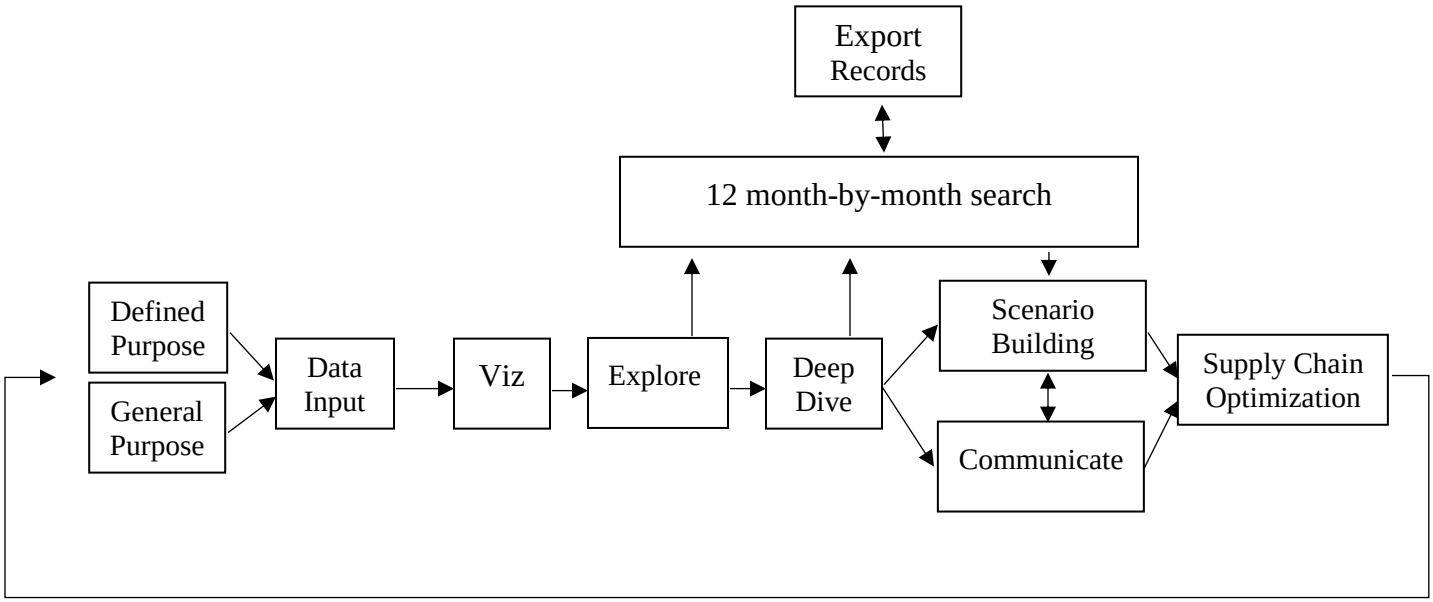
Table 5 contains the sea and air freight volumes to Mexico. With demand smoothing techniques we could suggest that January, February, March, April, May, June, September, October could have had their air orders moved to sea, and shipped once a month.

July, August, November, December were the months with the higher demand, and these months would therefore have demanded two shipping modes; (as happened), or more volume purchased for Sea (to fill an extra container).

We assume, and make a conclusion with abductive reasoning, (best decision based on the information at hand) that CH pays for 1 container per month to Mexico by sea (corresponding to a comment made by Respondent 5), and that the air shipments were made after the cut-off date, and were thus relatively un-planned for. We further assume that the commitment to have one container a month is a pre-existing desire to smooth monthly demand/flow of materials.

We can also see that except for October, the pre-purchased container per month was NOT optimally filled – all sea freight per month was 10 or less tonnes in those months. The conclusion is that a steady demand and shipping schedule would work fine for Mexico, and that these longer shelf-life products the

deliveries could be shipped once a month. This is reasonable, as there should not be high level of supply fluctuation for a product that has shelf-life of two or more years. This Caseworks section concludes/results in Model 7 below – wherein the "Export Records" step is added – and the circularity has been added to the model, to show that the exploration of temporal aspects should be an on-going and continuous task.



Model 7: Circular process of GeoVisualization for Supply Chain Optimization. Source: Own Creation.

6 Discussion

The chapter will synthesize SC and visualization literature, together with our experience with Lumira, and the empirical data gathered in the process. The synthesis should accomplish how visualization can not only reveal the interplay between order size, frequency, and route choice, but also talk about strategic and operational implications of visually looking for a solution. The main issues that will end this chapter are the purposeful exploration and model testing that occurred in the directly preceding casework chapter, the opportunities for moving from air freight to sea freight, and the effects thereof. Also, a discussion about the business value of looking retrospectively at geospatial will take place, along with a general discussion on data quality and data cleanness. Next, a discussion on effective visual communication and

its place in SCM will be had. Lastly, sharing, integration, and training in IT usage of employees (and in specifically in using Lumira) will be had.

6.1 Complexity of Global Supply Chain Management

Chr. Hansen's supply chain is locationally complex and diverse across its various business units – each having industry-specific market conditions and customer demands. In addition, the current nature and context of global SC operations entails structural complexity (Kinra & Kotzab, 2008). The Natural Colour Division experiences a decent position on the market and tough competition with customers who pressure them on prices. On the other hand, the Food Cultures & Enzymes division are market leaders in their industry, and can often negotiate good terms with their suppliers and distributors – thus delivering continuous high financial performance. Common to both divisions, is the necessary – but occasionally troublesome – communication with both internal stakeholders (sales department and subsidiaries) and external stakeholders (customers and distributors).

Because this thesis focuses on the value of visualization of freight, it is worth understanding the characteristics of CH logistics operations. It has been unearthed during the analysis, but also observed during our collaboration with CH, that order size, order frequency, and route choice are all interrelated issues. The abovementioned characteristics of the SC, and the market conditions in which the different business units of CH operate under, affect and are affected by the order size, frequency and route choice.

6.1.1 The Goals of Supply Chain Management

This section compares and discusses the theoretical goals of SCM – outlined in the literature review chapter – to the company-specific goals of CH – summarized in the analysis chapter. As argued in the literature review chapter, supply chains are complex – they involve flows of goods, information, and money between different SC actors, departments, and organizational entities (Gammelgaard, 2010), that have different goals, concerns, priorities, and that operate in different settings, cultures, and countries (Croxton, Garcia-Dastugue, Lambert, & Rogers, 2001). CH's SC likewise contains a high degree of complexity – tackled through the clear objectives: It is a stated goal by the CMR team members to achieve a better overview of CH's SC – through the GeoVisualization tool of Lumira. This thesis has argued thus far that the usage of Lumira could help overcome specific hurdles of SCM: namely, internal and external communication, exploration, and scenario building – in a user-friendly and interactive IT application.

As argued for in the literature review, a firm's supply chain strategy should fit that of its customers (Gammelgaard, 2010). The goals of supply chain management involves fitting the design of your supply chain to the characteristics of your product (Christopher et al., 2006; Fisher, 1997) – resulting in the seamless flow of goods, materials, components, information and knowledge throughout the chain (Gammelgaard, 2010). One of CH's specific supply chain strategies is to be able to serve all European customers within 7 days (Respondent 6: 24); there are both operational and strategic implications to this.

6.1.2 Strategic vs. Operational Supply Chain Management

Lumira arguably contains possibilities for both strategic and operational SCM – though mainly the operational capabilities of the tool have been outlined in the analysis. Respondent 3 says that the strictly strategic uses of a tool such as Lumira would not be employed by him – since he is only involved in the operational aspects of the management of the supply chain. As outlined by the CMR team, visualizing the Inter-company shipment would provide CH with the most value. A general strategy that CH is following is that of maintaining low inventories (Respondent 1: 22), fitting with the description of lean management systems (Levy, 1997) – exemplified in the following quote: "In a global supply chain, managers must plan for longer lead times, expensive air freight, higher inventory levels, poor sales-forecasting accuracy, and significant delays in resolving technical problems. However, the reduction of defects and engineering change orders associated with lean production can stabilize the supply chain" (Levy, 1997, p. 94).

6.1.3 Flexibility of 3PL contract

Perhaps CH has made an inflexible deal with their 3PL, in that they buy a container a month, but are not able to purchase more in their months of high demand. For 8 of the 12 months in case four that makes sense. For 7 out of those 8 they're losing on this deal because they're not filling the entire container. For the 4 months of heavy demand they're losing because they (maybe) don't have a flexible enough deal to buy an extra sea container.

Understanding the ins-and-outs of the deals that CH has with their logistics providers (both air and sea) is just as important as understanding how much is sent. The CMR team members were able to confirm the usability of these conclusions and inferences of the caseworks section. We remember of course that

Holistic, systems theory, SCM includes recognizing different conditions, goals, constraints, and situations across different sites, business units and SC partners.

6.2 The Effects of GeoVisualization

As argued for in this thesis, GeoVisualization is a valuable tool to reach the goals of SCM. This section summarizes and discusses the possible effects on logistics optimization – mainly costs savings – as well as the practical implications of its implementation on the rest of CH's supply chain.

6.2.1 Discussion: Case 1 & 2

We find it relevant to compare the finding of the working interviews with both Respondent 3, who talks about the Italian distributors – as well as Respondent 2, noticing the number of courier shipments in Europe – with the following quote on the effects of GIS usage: "GIS users, upon seeing their data on a map for the first time, respond with, 'Oh, now I see!'" (Smelcer & Carmel, 1997, p. 392). In both the working interviews, the respondents were surprised with what they saw – and immediately made sense of the data they were being presented with. It was easy for Respondent 3 to see that something was not quite optimal with the situation of distributors in Northern Italy, because they *visibly* were within very near proximity of one another and with the CH site in Parma. This is an example of the geographical *proximity task*, addressed by Smelcer & Carmel (1997), for which maps (and GeoVisualization) are a particularly good 'cognitive fit'. Likewise, Respondent 3 – having just explained the costly nature, and poor service of courier shipments – was surprised to see *visual* proof of the sheer magnitude of the courier shipments in Europe. In this instance, the GeoVisual enactment of the data allows him to quickly interpret the information, and thus make better *sense* of it (Bendoly, 2016). One or more of the many functionalities of an interactive tool such as Lumira could complement the usefulness of the visual presentation of the courier shipments, e.g. the 'cluster data point' function – to pinpoint what regions in Europe house the biggest concentrations. Additionally, exporting the data records allows for increased accountability, as well as complementary data granularity to the easily understood visual record – called for in the "Show me a number"-quote by Respondent 2.

6.2.2 Discussion: Case 3 & 4

The conditions under which bad SC solutions occur could be overzealous customer satisfaction searching, or customers having bad forecasting, or a disconnect between the strategy that ought to have been implemented and the operational realities. July, August, November, December were the months with the higher demand, and these months would therefore have demanded two shipping modes, (as happened) or more volume purchased for Sea. (an extra container). It is the intend of CH's logistics department to create a steady flow of goods towards Mexico (Respondent 6: 15). A conclusion from the casework was that a steady schedule could work better for the freight shipments going to Mexico – since the long shelf-life products could go once a month. This is reasonable, since there shouldn't be crazy bullwhip (Lee, 2010) (supply perspective) for a product that lasts for so long (+1 year). With demand smoothing techniques CH could suggest that January, February, March, April, May, June, September, October could have had their air orders moved to sea, and shipped once a month. The other four months could remain with air shipments. It is suggested by Lee (2010), to not always take incoming demand at face value. Rather, understanding the underlying reasons – through a more holistic approach – is the key to taming the bullwhip effect.

We conclude, based on abductive inference, that CH pays for 1 container per month to Mexico by sea (we can remember one of the CMR team members saying it), and that the air shipments were made after the cut-off date, and were thus relatively un-planned for. We assume that the commitment to have one container a month is a pre-existing desire to smooth monthly demand. We can also see that apart from October, the pre-purchased container per month was not optimally filled – all sea freight per month was 10 or less tonnes in those months.

The casework unearthed several potential sub-optimal aspects of CH's logistics setup in 2016. These findings were taken to the CMR team, and they could confirm the usability of the conclusions and inferences. This thesis recognizes of course, that holistic SCM includes understanding the different conditions, goals, constraints, and situations across different sites, business units and SC partners.

If there existed good forecasts, then you would not send anything by air; everything should have been sent by sea, except for the 4 months of heavier demand.

6.2.3 Value of Looking Forward

In terms of Lumira being used as a tool to view data – it was suggested by Respondents 6 and 7 that 'looking forward' – i.e. visualizing forecast data – would be a valuable usage of GeoVisualization in Lumira. Naturally, the forecasts would have to be sufficiently accurate (which is a recurring theme in this thesis: if the data are inaccurate, there is little to no value in visualizing them), though if they were, visualizing where and when to ship deliveries would be significantly easier. If such forecasts were conducted – and they were GeoVisualized - then most of the air deliveries shipped in 2016 could be moved to sea freight, per a comment by Respondent 7).

6.2.4 Value of Looking Backward

This section discusses the practical value of looking at past data. One might ask; what is the value in looking intensively into, and exploring, past data? There are several relevant answers to this question:
It can unearth, and bring attention to, errors or disconnects. If errors that were previously undiscovered are identified through GeoVisualization, the organisation can take measures to ensure that similar mistakes are not made in the future. Whether the mistake is found to be a result of bad processes, communication, S&OP, or it was the fault of specific individuals, there is value in obtaining that insight. Regarding the specific case of HHN air shipments, relevant questions to ask include: Was this simply a result of bad forecasting? Is the market of HHN so difficult to understand the demand curve of? It is notable that the demand curve did not show a jump in the summer – meaning there could be sign of CH experiencing the Bullwhip here (Lee, 2010).
When the authors had questions such as these, the CMR team practitioners were often able to clear things out – contributing to the collaborative nature of the thesis process. The contributing factors had not been investigated, but the CMR team figures that the department was understaffed and thus the planning that happened was not suitable, and panic orders needed to happen for the demand over the summer. So the value of retroactive GeoVisualization here is that it could have enabled quicker discovery of the problem, and possibly better identification.

6.2.5 Purposeful Use of GeoVisualization

Exploratively, Lumira's functionality to filter between various types of data and its feature of exporting records can help identify several logistics issues. However, based on our experience with Lumira, there is the risk that people can get lost in this open-ended searching, and that the desire to add too many variables can lead to a visualization that confuses instead of enlightens (Farris, 2010; Gardner & Cooper, 2003). The solution to that problem is to make the exploration purposeful and directed – as was done in cases 3 and 4 – being more deductive, going for discrete shipment over five tonnes, or looking for specific months, in which smaller shipments could be grouped together.

Visualization is one thing, but knowing what you want to find is another. This is exemplified by the following quote by Respondent 1: "you need to know what you are looking for, for what you are looking for to make sense" (15).

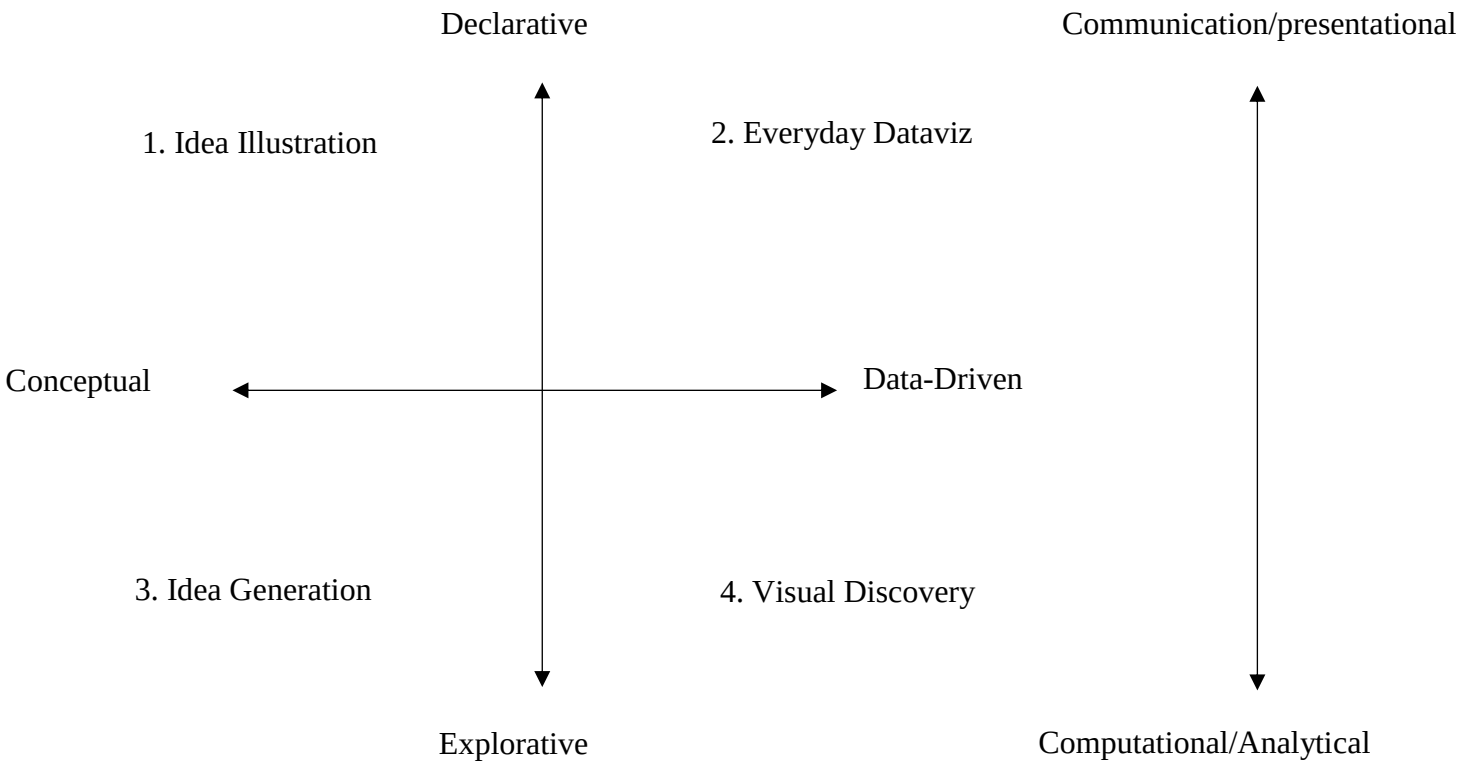
Figure 11: Compose & Input Control Functionalities. Screenshot from SAP Lumira.

Lumira helps in this aspect – both in the "visualize" tab, as well as in the "compose" tab via the input controls (shown in the dashboard on the right side on the figure above) The use of the input controls makes it very clear which filters are applied or not. In the caseworks, the thesis finds that the best way to

do things could be to "send all CH shipments (to Mexico) once a month". However, that might not be realistic, and one needs to ask if there are hidden reasons for this inefficiency. Gardner and Cooper states that 'you can't see everything, nor would you want to (2003, p. 54). The authors believe that such a view shows the relationship between the ideals of planning (inventory, production, order points) and the real situation. Per Respondent 1, sea creates stability, whereas air creates panic; in that context 180 tonnes by air is a lot of panic. A temporal perspective on Case 3 – as was done on Case 4 – could have been attractive, because then it would be obvious that 2 + medium sized orders of the same thing to the same customer was sub-optimal.

6.2.6 Visual Communication

The SC complexity – outlined theoretically in the literature review and practically in the analysis – requires various forms of communication, including visual communication. The SC GeoVisualization presented and explored in this thesis, is, in some uses, an act of visual communication. Berinato (2016) states that there are four primary types of visual communication, shown in the following figure: 1) Idea illustration: Clarifying complex ideas by drawing on the human ability to understand visual metaphors better than rows and columns; 2) everyday dataviz, which involves simply communicating a single message, mapped via a few variables; 3) idea generation: brainstorming and mind mapping – used heavily in the start-up phase of this thesis; 4) visual discovery, through visual confirmation (e.g. prototyping) and visual exploration. (Berinato, 2016).



Model 8: Visual Communication Model. Source: Combining Berinato (2016) & Nyerges (1991)

As an example of its usage for visual communication, Respondent 6 suggests using Lumira to communicate with key account managers in his value stream, thereby bringing greater value and understanding to the inter-departmental coordination that he needs to pull off to optimize the logistics of the business unit he is responsible for. Such an endeavour of visual communication could start in quadrant 4 – Visual discovery, and, depending on the degree of collaboration between respondent 6 and his key account counterpart, the 'outward' visual communication would be in either quadrant 4 or 2 – *Everyday Dataviz*.

Option discovery - If the key account manager was involved in the Lumira exploration, contributing with their interpretation of the data input, or coming with their own data, then the two managers could certainly communicate with each other in the fourth quadrant, perhaps with the help of a Lumira Super-user. On the other hand, if Respondent 6 wanted to control the 'truth' being communicated, then he'd explore first in quadrant 4, then take a 'more-or-less' static version of that to the key account manager – Lumira use

is always in quadrant 4, but if one chooses not to interact, then everyday dataviz can be an output – thereby moving into the realm of visual communication that is quadrant 2.
We would expect such a process of exploration to happen in the 'compose' tab of Lumira, taking advantage of the easy to understand and use 'data input' controls in the 'dashboard' on the right side of Figure 11

This is like the different uses of a map outlined by Nyerges in 1991. Maps can be either communicational/ presentational or computational/ analytical. We've placed Nyerges' distinction between map usage alongside Berinato's matrix, and discuss the fit between the two here. Quadrant 4 of Berinato mirrors analytical map usage, whereas quadrant 2 mirrors communicative map usage. However, the use of Lumira, depending on the interaction level of the users, is both communicative and analytical, always, unless you're only sharing screenshots (everyday dataviz). Nyerges' distinction is of course still relevant, but we assume that 26 years ago, it would be hard to imagine the computational power of Lumira, nor its ease of interactive visual analysis that allows for both analysis, communication and exploration. Berinato contends:

"In some ways 'Data Visualization' is a terrible term, as it seems to reduce the construction of good visualizations to a mechanical procedure […] What we actually do when we make a good chart is get at some truth and move people to feel it – to see what couldn't be seen before. To change minds. To cause action" (Berinato, 2016, p. 100).

The use of GeoVisualization in this thesis is naturally analytical, but it is also an exercise of storytelling, exploration and communication. Berinato's comment about 'truth' and 'action' is very much in line with the pragmatic, useful, collaborative research conducted in this thesis. We hope that the thesis changes minds and causes action.
Likewise, Berinato also outlines two types of visual discovery: visual confirmation – our deductive process – and Visual exploration, our explorative process using Lumira. Arguably, the respondents wanted to do different things with Lumira: Respondent 1 wanted to do exploration in NCD. Respondent 2 wants mostly to do confirmation, but sees occasions where exploration would be valid, as well as

occasions where quadrant 2 would happen. Respondent 3 was confirmatory, but exploration led to the confirmatory. Respondent 5 wanted both visual confirmation, as well as visual exploration.

6.2.7 Future of GeoVisualization: Education in Geospatial Understanding

Introduction of GIS into business school curricula to familiarize students with the concept of spatial analysis tools – as discussed and argued for in both Handa & Vohra (2010) and King & Arnette (2011) – could be expected to increase the 'Geospatial Reasoning Ability' of the average graduate student (M. a. Erskine et al., 2015). Since students would be better able to understand and apply relevant spatial analysis in their fields – in the longer term – it's expected that this could increase the application- and development of GIS tools in the business world, helping to overcome the *chicken-and-the-egg situation*, between the development and application of GIS (Hernandez, 2005). This is supported by Trkman, McCormack, De Oliveira, & Ladeira (2010), who state that the investments into analytics capabilities have an inter-dependent relationship to the impact on supply chain performance.

6.2.8 Training in IT tools and applications

Employees in CH must be continually reminded and trained in the uses of IT tools, since it is human nature to forget skills that are not regularly applied (Respondent 4: 39). Even the most advanced technological GIS needs humans to understand and use them (Handa & Vohra, 2010).

When Respondent 7 (a CMR team member) read our analysis, her feedback included the suggestion that the claim '2500 out of 2800 employees are SAP users' (Respondent 4, 58) was inaccurate. Yes, she continued, there is a great number of CH employees that have access to either SAP or BI reporting (based in SAP), but she expressed doubt that the majority were active users, and that they understood and remembered how to make good use of SAP, its data warehouse, and the complementary applications. Respondent 4 said as much, when he explained the role of BI reporting in CH – the BI department makes specific reports, which 'business users' update with data on a weekly, monthly or otherwise agreed upon time frame – thereby making use of SAP data, but through the filtration of reports, not directly jumping into the Data warehouse themselves. He doubted that use of Lumira would be completely widespread or freely explorative, as his experience with IT implementation and business users 'use' of analytical tools was the narrower 'updating of KPIs', rather than the fresh and excited visual exploration that we experienced using this tool. The general vibe was that he did in fact want Lumira to get into the hands of

(many) business Users. He wanted to use it exploratively and he wants us to prove that that direction of inquiry is valuable. The thesis should prove the value, thus encouraging business users to use the tool, be creative, come up with lots of ideas, and when they start running into limitations, come back to the BI/IT department so that properly integrated and cleverly designed central solutions can be put into the main BI/reporting dashboard. This is evident in Respondent 4's quote about the 10 good ideas, that usually amount to a single great one.

6.2.9 Data Cleanness and Data Sharing

As shown in the analysis, the IT tools of CH are most often best applied 'internally' (Respondent 4: 17). Many customers are shared across the business units, and that data is already shared across the departments today (Respondent 1: 20). However, data is measured and understood differently across the different departments, business units and CH sites – exemplified by the sales people that look at volume excluding packaging materials, whereas the SCM department is interested in knowing the total weight, including the packaging materials (Respondent 3: 20). Per Sanders (2016), data analytics applications require increasingly deeper technical knowledge, which most companies do not have as their core competencies – this supports Davenport's (2006) argument that few supply chains are able to mirror the analytics-based manoeuvres of companies such as Amazon, Dell, and Wal-Mart. For an organisation, whose core competencies are not within data analytics, CH arguably manages their data well – however, for the intended purposes of data visualization, they would surely profit from even higher levels of data sharing, data quality, and employee training.

6.2.9.1 Data cleanness

This thesis visualized the COL report – and added data sources – thus obtained high perceived levels of 'data cleanness'. Since CH has a relatively high degree of data integration across their supply chain, and SAP Lumira allows for interactive mapping, we experienced relatively low *cognitive efforts spent on gathering and analysing the information*, as outlined in Dennis & Carte (1998). This allowed us to focus more on the concrete task-solving in Lumira – in line with our pragmatic CMR approach.

6.2.9.2 Database Integration

"If the map is dynamically linked to a database, then it can be redrawn easily as conditions change, or displayed differently depending on user needs" (Gardner & Cooper, 2003, p. 56). Per Respondent 4,

since Lumira is a SAP application it can integrate with the SAP data warehouse. When driven the SC map from a database it allows for customization for various users, such as different channel members or organisational units.

6.2.9.3 Data Granularity

In most cases the products of different business units can be shipped together – with the exception being 'dangerous goods' shipments that require their own specific handling conditions. This thesis chose not to include filters for this, since it was found that air freight shipments (which the Casework focused on) already excluded the dangerous goods items.

However, the thesis recognizes that the different SC practitioners at CH have specific knowledge that they could put into play here. Someone with more experience than us would be able to look at the findings of this section and understand whether or not all of these shipments could be put together as suggested in this thesis. Lumira could assist with this search, and additional filters based on dangerous goods, ambient vs. reefer, or incoterms could certainly be applied to the dataset if the practitioners deemed it relevant. For the general overview, however, this is an example of extra data granularity that need not be applied – if not asked for.

6.2.9.4 Moscow/Mexico: Data Problem of precision

Data standardization – as outlined by Handa & Vohra (2010) – is still a challenge for CH, in terms of the geographic data. The most prominent example is that the city of Moscow is represented by only a single set of longitude/latitude coordinates in SAP. Per Respondent 6, transportation from one part of the city to another can take up to an entire day – which can thus distort the shipment visualization – as the default view would have all of the Moscow shipments (to different customers located in different parts of the city) aggregated together. Likewise, when CH's Mexican subsidiary labels all shipments as "0Days", it reduces the value of visualizing global data, in SAP Lumira or elsewhere – a data problem labelled 'Babel' by Blanco (2013), because it resembles the language barriers introduced to mankind in the biblical story of the Babel Tower.

6.2.9.5 Data Quality: Problem of Quality.

As argued for – theoretically in the literature review chapter, and practically in the analysis chapter – data must be of certain quality and cleanness to justify the use of data visualization. Beautiful interactive visualization of wrong, or low-quality data is a severely counterproductive task. Low quality data can

stem from either wrong source, wrong filters, wrong data magnitude, wrong business area, or the wrong timeframe. An example that distorts the data quality in CH is the '2005' SAP warehouse – which according to the COL report shipped 4000 tonnes of NCD products to the real physical '2004' site, although the products were never physically moved. To understand such company-specific cases, this thesis relied heavily on the expertise and practical insights of the CMR team members. As suggested by them, the 4000 tonnes were excluded from the analyses conducted in Lumira, by simply excluding all the virtual shipments coming from the 2005-location.

7 Conclusion

The goal of this conclusion is to provide an answer to the problem formulation of the thesis, an endeavour in which each chapter has played its part. A comprehensive summary of the different chapters will therefore be presented here, alongside a final treatment of the model (##) originally arrived at in the analysis chapter.

The **methodology chapter** outlined the pragmatic nature of the Collaborative Research approach employed in this thesis, and included argumentation for how that approach was a direct response to the unfortunate paradox of contemporary business research. This chapter laid the groundwork for the truth that was explored and presented in the thesis. This fed into the **research process** chapter, that provided a detailed walk-through of the steps taken in the literature search and review, as well as the data collection and grounded theory analysis. Hereafter, the **literature review** chapter identified an academic gap, and synthesised the academic literature from Cartography, Data Visualization and Supply Chain Management as the theoretical building blocks for this thesis. The first part of the **analysis** chapter presented the findings that emerged from the collected data and structured coding thereof, and a conceptual model for SC GeoVisualization was introduced. The second part of the analysis included a detailed treatment of two of the cases introduced earlier in the chapter. These two cases contributed with actionable findings for CH, and as an extension of their usefulness, two different versions of the conceptual model for SC GeoVisualization were developed. Next, the **discussion** chapter outlined and discussed specific findings from the analysis chapter in relation to the body of literature synthesised in the literature review chapter. Lastly, this **conclusion** chapter collects the results and findings of this thesis in a cohesive answer to the problem formulation.

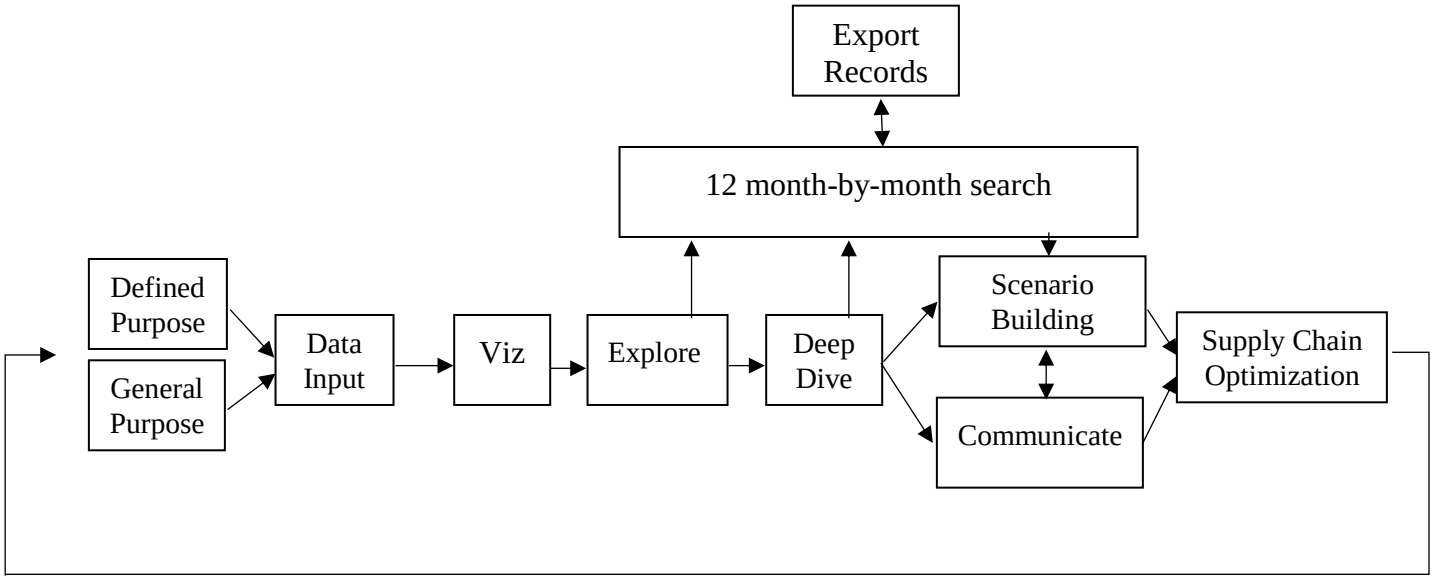
The Conceptual Model for SC GeoVisualization includes the initial steps of *Data Input; Visualize; Explore; Deep Dive; Scenario Building; Communicate; Supply Chain Optimization*. Its creation stemmed directly from the coding of the expert interviews, and the circumstances of its creation are presented here. In line with the Grounded Theory approach employed in the first part of the analysis chapter, it was the concepts that appeared the most that made up the Model's steps. The model was discussed with the CMR team, and their feedback led to slight modifications of the model – it was however our own inference that ultimately decided the order of the initial steps. Grounded in our assumption of what would be most useful, the following argumentation summarises the initial structure of the model. The argumentation is of the 'what if' variety, containing a hypothetical extrapolation of the negative effects that could have arisen *without* the use of SC GeoVisualization. *Visualization* needs *Data Input* to be realized, and without visualization, the speed and comprehensiveness of data *Exploration* would be hamstrung. Slower exploration would hamper opportunities for *Deep Dives*, and without deep dives, *Scenario Building* could not occur – which could be expected to subsequently inhibit the *Communication of* the outcomes or scenarios under development. Lastly, without scenario building and communication, certain opportunities for *Supply Chain Optimization* would not be unearthed and analysed, and some hunches would remain unconfirmed.

It is both recognized and understood that other means exist which can lead to SC insights and thereby SC optimization (some of which are presented in the literature review chapter). We believe however that the conceptual model of SC GeoVisualization reduces the cognitive load needed to come to beneficial conclusions.

In the case work section of the analysis, the model was used to present the explorative, analytic, and presentational capabilities of Lumira by taking the reader through cases three and four.

The analysis chapter, and the case work therein, contributed in **two main ways**. The **first** is both academic and practical, the two revisions of the conceptual model for SC GeoVisualization (Model 4). Model 7 presents and combines the two revisions to Model 4. The first main difference is that of *purpose*, and we found that that could be reflected as either *defined* or *general*. The main body of steps of the model remained the same – Purpose → Data Input → Visualization → Explore → Deep Dive → Scenario Building & Communication → Supply Chain Optimization. Model 7 incorporates the addition of *Export Records* added first in Model 5, as well as the addition of the temporal *12 month-by-month search* added first in Model 6. *Export Records* compliments the Deep Dive step in the original conceptual model, and

enhances the possibilities for Scenario Building as well as increasing the factual context available to communicate. A *12 month-by-month search* reflects the specifc temporal window that was possible to create during our collaborative research. It's possible that CH could achieve extra data granularity at a later point, and in that case, we would expect the logistics practitioners to conduct their temporal searches on the newer and more specific time windows (of a week for example, searching week-by-week over a quarter). Unique to Model 7 is the understanding that the true value of SC GeoVisualization lies in it's interactivity and intuitive use as a visual communicative map. We have therefore added a circular arrow from Supply Chain Optimization back to the (re) defined and general purpose of inquiry.



The **second** contribution of the analysis is mostly practical, and involves the findings and SC implications of cases three and four. Specifically, case three conducted a search for Inter-company air shipments over 5 tonnes, and it was found that 180 tonnes of air freight sent to Milwaukee from Denmark, could likely have been sent via sea instead. Such a move could have resulted in savings upwards of €400,000. This sort of result holds special interest for CH's Global Logistics team. Case four was a lengthier temporal exploration of air and sea freight to the CH site in Mexico City. Taking point of departure in the DK → Mexico City IC shipments, we found examples of sub-optimal shipments that could have been caused by inflexible contracts with CH's 3PL providers. We suggested that in 7 out of the 12 months, CH was losing out – as we inferred that the containers sent by sea were not full. We found that one month out of

the year was relatively optimal for both Air and Sea freight, and that 4 months of the year incurred heavy demand and therefore either *justified the use of air freight*, or implied that CH *could have sent 2 full containers by sea*. All the products considered in this portion of the analysis had a shelf-life of more than a year, and were therefore seen as appropriate for the transport mode of sea. Demand smoothing techniques were suggested as well for this analysis, but the application of them fell outside the scope of this thesis.

The case work, analysis, and discussion of this thesis explored the 'best' usage of Lumira for SC GeoVisualization that we could come up with over the course of the last 6 months. We believe that we have contributed practically to the organization of CH, and that, at the very least, our CMR team has gained much theoretical knowledge and applied benefits due to our collaborative research approach. The holistic complexity of SCM has been discussed whenever relevant, and we see SC GeoVisualization as an adequate and exciting tool to gain deep operational, and strategic insight into data-driven global supply chains.

8 Practical Implications and Future Research

The working process of this thesis has unearthed a variety of worthwhile practical implications and potential for future research. They serve as our final opportunity to holistically approach the outer edges of the phenomena under study, SC GeoVisualization and some of its possible effects and implications. Practical implications will be discussed first, and following that will be a brief treatment of some of areas of future research.

8.1 Future research

Using this thesis and SC GeoVisualization as a jumping off point, there is plenty of potential for exciting, and fruitful research aims. This penultimate section will make note of a handful.

- The Disciplines of Cartography and Decision Sciences were approached in the literature review. Their inclusion helped identify the Academic gap of this thesis, and the definition of the terminology SC GeoVisualization. Approaching the concept from either of those two disciplines could be a fruitful avenue of research.

- Likewise, SC centred, interdisciplinary research could be fruitful and useful to all the fields mentioned previously.
- Academics need to consider what the usefulness of their research is, and we suggest that the emerging field of green logistics could greatly benefit from a treatment of SC GeoVisualization.
- Collaborative Research has been a very interesting and engaging research approach with which to write this thesis, we suggest, that more SC research is conducted using this approach, and we hope that we have provided a good example of how to do so, for graduate studies at the very least.

8.2 Mapping Emissions

During our on-site time in March, we held (one of many) an informal meeting with our CMR team. It was here that the practitioners of our CMR team shared some their ideas about what some of the 'other' future uses the Cost of Logistics report could have. They mentioned recent inter-departmental meetings that they'd had with the CH Corporate Social Responsibility (CSR) team. GeoVisualization of CO2 emissions was the topic at hand, and after the informal meeting we reached out to their contact, an engineer who was supporting the CSR team with approximations of the emissions involved with CH's logistics activities. Unfortunately, while interesting and contemporarily relevant, this interview was deemed irrelevant for the specific purpose of answering our problem formulation. This does not mean it is not a valuable future usage of SC GeoVisualization with Lumira. The potential being that if measurable, and readable by Lumira, the visualization of emissions data can help CH fulfil their corporate strategy of being 'natures number one'.

8.3 Lumira 2.0

A new version of Lumira – the software behind the practical work of this thesis – will be released in autumn 2017. At the invitation of our contacts in the BI department, we attended a webinar explaining the dual functionality of the new release. We learned the following, this new version of the software will incorporate both 'design' and 'develop' functions, which *could* expand the potential for company-wide adoption, as well as BI integration with central solutions and BI reporting. Unfortunately, while the 'design' function promises to be similar to the use of Lumira outlined in this project, the promise of the 'develop' function (expect BI to be the chief users of this part of the program), is an unknown. From the

perspective of Respondent 4, the 'develop' function could easily be over-promising, and at worst could be a complete compromise in its attempt to combine the dual functionality.
There is a positive however. Assuming both the 'design' and 'develop' functions work properly, it could easily and quickly enable the 'development of a central solution' of SC GeoVisualization that Respondent 4 was interested in (Respondent 4, 42).

8.4 Keep the fire burning

Per Berg (2004), the goal of collaborative researchers should be understanding real-life practice, as well as solving immediate problems. Practitioners that are involved in collaborative approaches to research tend to reflect, incorporate new information developed together with the researcher, and implement interventions that may possibly affect lasting changes in the focal organisation. Unfortunately, Berg finds that the outcomes from such projects tend to be associated with the change agents; consequently, interventions can be under-prioritised, when the researchers leave the system (Berg, 2004). Buy-in and engagement from those who are responsible for SC decisions would be important to counter this. It has been our experience that our CMR team has been passionately engaged in the collaboration of this thesis, and will continue to be after our hand-in in May. While that is encouraging, we feel that it is worth accepting the wisdom of Berg (2004) as 'words of caution'. The project does not have to leave the organization when we do, and we hope that SC GeoVisualization will become an integral part of the SCM function of CH.

8.5 Map more tiers

At the workshop that we held in early March one of the logistics personnel mentioned their desire to look deeper into the SC network of CH. She was interested in expanding the amount of downstream data that CH had access to, and expressed her exasperation when our it was suggested that this 'extra' data was not available yet to visualize. As Farris (2010) states in his Strategic Mapping paper, and as Respondent 5 mentioned at the workshop, mapping the *entire* SC involves getting a hold of proprietary data of the associated SC actors. This is not an easy task, and it was decided at the workshop that pursuing this stream of inquiry was not worth the effort, *yet*.

While we agreed with Respondent 5 at the morning workshop, we came across something exciting in a re-read of one of our periphery articles: Supply Chain Analytics by Gilvan Souza, (2014) contains a brief reference to a software developed by MIT researchers. This software is named Sourcemap, (MIT, 2016) and from what we can see it shows great potential for SC GeoVisualization. The application is different than what we have become used to with Lumira, as it seems that the focus is more on the network than on actual shipments. For CH, a company with clean access to so much logistics data, the interest in Sourcemap could be cursory, but the potential for complimentary SC GeoVisualization certainly exists. Here are two examples of its functionality, Sourcemap sends out automated cascading RFIs to the suppliers of an organization(MIT, 2016), and depending on the level of response, maps a *more or less* accurate Supply Chain Network. MARS chocolate has used Sourcemap to help them get a selective overview of their SC activities from the cocoa bean to the production plant (MIT, 2016).

We believe that Sourcemap could be expected to accomplish the visualization of more SC teirs, but with less accuracy. Whereas the usage of Lumira as prescribed by this thesis accomplishes incredible detail but with, as of now, less tiers. Future efforts by CH should certainly include an attempt to a) get more data from upstream suppliers as well as downstream customers and b) try to bring that data into Lumira and employ SC GeoVisualization.

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10 Appendix

10.1 Subjective scoring of the top journals – inspired by SCMresearch.org

Thomas Reuters grade conv.		ABS - JOURQUAL 3 conv.		ABS Journal Guide conv.	
4+	5	A+	5	4*	5
2.5 - 3	4	A	4	4	4
2 - 2.5	3	B	3	3	3
1.5 - 2	2	C	2	2	2
1 - 1.5	1	D	1	1	1

The grades that the different ranking systems give are converted to a 1-5 scale in the above table, and the results of the scoring are presented in the table below. The column 'Adjusted' represents the scores if ABS were valued as half while Reuters and VHB were valued in full.

10.2 Journal ranking results

	Reuters	VHB	ABS	Total	Adjusted
Journal of Supply Chain Management	5	3	3	11	9,5
Journal of Operations Management	5	4	5	14	11,5
Production and Operations Management	2	4	4	10	8

10.3 Subjective Scoring of Top SCM Journals

Literature reviews are not only composed of the more broad and open parameters of database searches, they should also adopt some of the principles of Newton, and 'stand on the shoulders of giants', namely, by identifying the Top Journals in the field and searching within them. Most of the top journals cited by SCM professionals are included in the EBSCOhost database, but specific searches are worth conducting as well.

The SCM research blog mentioned above brings attention to studies and reports tracking the best cited and best scored SCM journals (Wieland, 2011 – 2017). This thesis presents a subjective rating of the top three SCM journals based on three different journal rankings that the blog recently identified: Thomson Reuters 2015 impact report (Wieland, 2016). the VHB-JOURQUAL-3 report (Wieland, 2015a), and the ABS Academic Journals Guide 2015. Wieland was critical of the quality of the ABS

ranking, noting that certain 'low quality' journals were given top grades while other consistently 'high quality' journals were either missing from the ranking or received mediocre grades. This could be because the ABS ranking is devised by a panel of experts, while the VHB ranking is the result of a survey of more than a thousand industry and academic professionals (Wieland, 2015b). The inclusion criterion of this thesis therefore gives full points to the first two rankings, while giving only half-scores to the ABS ranking.

The three journals that were put into the subjective journal ranking are: Journal of Supply Chain Management, Journal of Operations Management, as well as the Journal of Production and Operations Management.

10.4 Results of the subjective scoring

Journals Searched in Literature Search. Source: Own Creation

Presented in appendix entry XX, The Journal of Operations Management is seen to be the most influential according to the devised scoring, with Journal of Supply Chain Management sitting in the second spot, and Production and Operations Management taking third. Note that although the adjusted scores do not affect the overall placement of ranking, the percent difference between the top two spots does shrink, from 24 % to 19 % between the two scores, signalling that perhaps the general difference between the two is not so great. These three journals were also identified as relevant to the field of SCM by Shollo and Kautz (2010). Accordingly, a decent number of (See ***Error! Reference source not***

***found.**) articles from these 'top' journals made it into both the preliminary and refined literature pool. The specific searching within them gave little results, and they were undoubtedly included because they were found during the database search phase, or included based on their status as vetted-curriculum articles.*

Criticism of Journal Rankings

SCMresearch.org also mentioned that there is a danger in relying too heavily on the standing of the 'top' journals (Wieland, 2012, 2015a, 2015b, 2016). The researcher referred to the article by Mckinnon (2013), an article that was used earlier in our argumentation for our research approach. Such an over-reliance could have been an issue if the thesis process had been completely inductive and unbounded in its literature search. Had we had no other means of direction, the possibility exists that we could have been blinded by the well-cited examples of those that came before us – and thus missed one or more academic works, that were obviously relevant to the thesis process, though published in less celebrated journals.

We contend that the selective and narrow nature of top journals did not cloud the literature search and review process of this thesis, since we had a defined purpose going in. The main issue was therefore to define which scientific disciplines to bridge; which disciplines to place the academic gap in, and which past works were the best 'shoulders to stand upon'.

10.5 Transcriptions

Respondent 1

Discussing the purpose of the thesis. SC optimization – visualization of geospatial data.
Discussion the process.
Data vis as a tool

Key insights from Thomas:
2 NCD: last two years he has done transport optimization, and SC optimization. Both on costs, delivery, quality factors.
2 They had help from outside consultants
3 when consultants left the company, the tools they had left CH

3 when you are deep diving into your data, you can most often get the big overview yourself. However when you need to present it to others, it is key that you can visualize it in a convincing manner
3 you cannot present with excel
4 when you get it visualized, you know faster where you need to deep dive
4 we all know the big lanes, but we do not know the many small lanes. They are warranted as well.
4 it is a tool to help us in our everyday life
5 freight optimization costs: the costs are very individual on the product level. We both have customers that pay for the transportation, and customer where we pay for it
6 sometimes the customers do not think that they are paying for transportation, but they are, it is just getting attached somewhere else
6 cost of logistics: outbound transactions (costs) are possible to see.
6 intercompany: we have not been so good at understanding these costs
7 understanding IC will help reduce costs
7 it is really expensive to fly items
7 NCD needs to work harder to perform the same margin
7 low profile goods makes no sense to offer to fly – it eats the margin
8 it can cost up to 40 % of the product price when you choose to fly it
9 the products last for either 3, 6, or 12 months
9 customers are demanding longer and longer remaining time the product stays good. Demand 70% shelf-life
9 if the customer demands that, we cannot begin to sail it
10 global salespersons might be able to convince the customers. Interest for 70 % shelf-life sometimes convinces the customers.
11 Thomas is not the one talking to the customers.
12 The SC guy that was present at the customer meeting with Kellogg's – helped convince them to drop the 70 % shelf-life demand.
13 we need to deliver on-time, so the customers are not getting a bad experience
13 this tool, sap Lumira, might also be taught to sales persons
14 it all has consequences, and the also thing we can do is to continue to tell the sales people about it. And here, we might have the tool that helps us tell this story

14 it becomes easier to tell both the customers, and the sales people, about the internal costs of logistics of a product in NCD

15 If you are a good SC manager, you already "know" the data that SAP Lumira can show you. However, you get an easier time telling the story, and you have an easier time putting two "lines under the correct number".

15 SAP Lumira will be used as everything – but especially as a communication tool. Graphical.

16 Speed is important as well. And user-friendliness. It needs to be easy and intuitive.

17 Normally the numbers are done in Excel. And I could see it in combination with SAP Lumira.

17 you get shown where you need to look, and then I know where to perform a deep dive

18 A smaller data set will make SAP Lumira play more smoothly

18 Also depends on the types of data

18 Very few people are looking at the whole company at once. Most people are looking at one dimension. That would remove most of the data

19 The difference between sea freight and air freight: In air freight you pay per kg – in sea freight you pay for an entire container, meaning if you are not filling it up you are not doing it optimally

20 We have the same customers across departments, and we do already share data

20 We should be careful not to sub-optimize. Though it does not happen very often.

20 there are surely made low-hanging fruits, for all of us

21 the importance of costs: getting a higher degree of detail. Putting on costs is not possible today. But if you can but an average cost on it. That would tell us which lanes are the most important. And make sure that the customer pays for the expensive transportation costs.

22 earlier we had a theory that we needed to have as little inventory as possible. But it is often a question of balancing the inventory costs, and the transportation costs. A trade-off

22 going into customer level is important

22 material numbers – looking into the less profitable items. Are we making money on this product, or is there some places we need to cut off, because it is too expensive

23 going from product to product. Being sharp on the upper levels will be the first order of business.

24 We have saved a lot of money of freight. Some of the simple ways of doing it has been to say: you can't fly things. Telling the story of the cost difference between the one or the other.

24 making a container available every week creates a steady flow of materials.

25 sea create stability, flying creates panic.
25 this is not a very stabile marked. The costs of changing products is quite easy for the customers.
26 it is important to know the conditions of the market. We have all the big customers, but they can quite easily replace us
26 part of the story of colour: have doubled in size in the recent years.
27 producing closer to market will most of the time be a costs saving. Route optimization is more complicated.
27 the next couple of projects that we will be running will be more strategic, and thus needs to be more explorative. Production footprint should be a factor here as well.
28 We are lacking transparent data. Things we thought we had optimized, can be going back to the old norm a year after. So it is a continues effort. Maintaining the efforts, and standardizing processes is a tough tasks.
29 it has surprised Thomas how much he needs to continue to say the same things
31 Wish list: delivery to the US, from the production in Europe within NCD. Volume and number of customer orders – intercompany only. From the production sites in Italy and Denmark.
32 Wish list continued: Milwaukee buys all the products, IC.
33 Is it possible to put in a time perspective. On a month timeline
34 it could be useful to view a development over time. We are stressing our supply chain over time. It could be interesting to see an overview of the timeline – to understand the development.
35 A map is not the best visualization of a timeline. SAP Lumira has other types of visualizations for this.
35 Temporal aspects: (will be interesting in combination with the theory we have gathered)
36 Time perspective could help us understand the overview
37 He believes they have the licences, but he is not sure he is able to use the application now.
38 (The forecasting aspect might interesting for us as well). Connected to Nina's question in the group interview, earlier that day. Cultures and other business units have useful forecasts
39 Nina has Master Data on the global scale.

Respondent 2

0 we have created the requested layer. We are viewing customer data on city level. Bubbles represent volume. Colours represent the route used. Outbound is seen right now.
1 what are we seeing? (He wishes to see “from and to”).
2 Zooming: the red ones are interesting: customer pickups.
3 the bubbles are the end-point of the logistics data points.
3 Mexico uses 0days only
4 looking at air only
4 there are many small shipments
5 the small shipments: price depends on the place it is going. Road transport can have minimum fees. Sending 5 kg can be very expensive – whereas sending 100 kg will be way cheaper than flying it.
6 It is also interesting to understand who is paying for the transportation. Customer pickup is not interesting, since that is the customers who are paying for that. (From a SC perspective, this is still interesting).
7 courier: As a rule, is costly and worse. You pay premium price for it, and they are tossing the wares around, the items are beaten – this is the type of transportation where we have the largest amount of customer complaints.
8 maybe we should send only larger shipments – since the smaller ones with courier are not profitable.
8 looking at Europe – there are a lot of courier shipments. Over 100 tonnes of courier volume.
9 many of these shipments are samples. (Is it possible to clean for samples?)
9 maybe we could filter by weights? Maybe the most shipments under 5kg are samples.
10 what is the plan for this tool: I have someone, who would really like to use it, Thomas.
10 I would think, that simply sitting and working with this tool (SAP Lumira), you would be able to set up different hypotheses: Could this be the way of supply chain is?
11 From there you would start working with the data, and perform the more thorough analysis. This is giving a good picture. Should we not take a look at courier in Europe?
11 What happens if we stopped using courier in Europe, and what is the threshold for profitability
11 It should be used exploratively. Like: This looks weird, let us look deeper into that.
12 is it possible to look at dates meanwhile? It would be very interesting to view the data in a historic perspective.
13 (The data must be clean, before it enters SAP Lumira)

13 do we have super users in this application? Bjarke perhaps, but otherwise, us.
14 (Time perspective needs to be cleaned up).
15 A timeframe would be very interesting. When we perform analysis, we like to use a year.
15 (The data must be very clean and standardized – both between countries, and between business units, for such a tool to be effective).
16 One must not underestimate the effectiveness and usefulness of the visual aspect of this tool.
17 Many raw materials are received on this facility.
17 there are many flying shipments to Asia, because our shelf-life on the products needs to be often between 50-75% remaining shelf-life.
18 it is impossible to say exactly how much costlier it is to fly than to sea.
18 from DK to Asia: flying is extremely cheap, compared to flying to e.g. South America.
18 Inter-Asian transport is more expensive, than sending the items from Denmark. Sending things from Seoul to Beijing, is three times more expensive than sending items from DK to Beijing.
19 the reason behind this is that air freight is very well-developed in DK
19 we are one of the biggest freight forwarders out of KBH Airport, getting us some very good prices.
20 A large portion of what is being shipped from DK is via air freight.
20 Is it possible to see the shipping destinations? (This is a recurring theme – the lines would be one way of showing the shipments of data. But we have not figured this out yet).
21 It would be interesting to view things leaving Hvidovre only.
22 Could we insert the tonnes numbers, rather than the number of data points? (I am not sure this would make sense – since showing the volume via bubble size is what Lumira would always be doing.
23 (Clustering number: shows the number of clustered data points)
24 (Different ways of doing this would involve other types of visualization. But Lumira is trying to stay away from maps, when visualization geospatial data
25 It is already interesting to visualize the numbers. The way it is done now is actually okay (He concedes, after realizing that Lumira most likely cannot do it the way he first preferred).
26 Europe shows a lot of road transportation. Sea and freight is mainly used for the other continents. Products with longer shelf-life are generally sent via sea freight.
27 but many of the popular products have only a 3month shelf-life.
27 rail has been looked into. It is not cheap. They have trouble handling different types of containers.

28 it is mainly a marketing stunt, it is very few industries where it makes sense.
28 the super cold products e.g. cannot be handled on the rail to Asia.
29 On the possible effects of GeoVisualization: It gives a great, and efficient, way of seeing your data, giving you input as to where to focus. When you have the data, this way (Lumira) is way faster than a pivot table. But in principle, it works the same way. You can't show things here, that can't be shown in a pivot table. But this happens way faster. You can quickly identify aspects that need to be investigated. It gives an entirely different impact what you see all those dots on the map. Help you realize the where you need to focus your attention. It works – it gives you a visual impression.
30 Another aspect that I see this being used as, is to communicate. Where I think, it is really useful. Taking snapshots of this, and putting them into a presentation. To support your argument. I think it will be used to communicate to other stakeholders.
31 what is also does: (On the difference between Lumira and a pivot table) When looking at a pivot table, you have a tendency to only look at the largest areas, and the most important areas. You will forget the tail. Whereas in Lumira, it is very easy to catch all the details on a subject.
32 (Lumira) helps you to ask the relevant questions: Why are things done in this way, and is there some obvious other way to perform these tasks?
32 Normally you are not looking at the smaller aspects (småting).
32 (On the limitations of Lumira) There is a demand for clean and good quality data.
33 also, getting GPS location would also provide additional value
33 Serving the customers in the Beijing area, or the Moscow area, is not free. Even though the data might suggest that the travel distance is 0km – it is not. There can easily be 1-2 days of transportation.
34 the extra granularity could be useful.
35 Another limitation is that you need to know what you are doing (when using Lumira). A limitation of the tool is, how long do you need to spend, and are they using it frequently enough, that they can access all the features of the application.
36 if not, that is a limitation
36 I would not use it as a KPI report. That visual picture will not look significantly different in three months, from how it is looking today – visually.
37 on a KPI, I need to measure on specific levels. "show us a number" is what people say.

38 it could also be used to help the initial stages of a deep dive. How did the last year look? Again, Thomas could go to the US, and sit down with the site managers, and they could look at these pictures together.
38 that could feed into new analysis.
39 (it works fine to export the data afterwards.)
40 our customers are relatively static. They are not moving that fast. Some might grow, and some might be lose market share, but nothing extreme
41 (explaining the story telling aspect of Lumira)
42 It depends on the industry – some industries are more likely to see benefits from tools such as this one
43 Communication device: to the key account managers
44 Center of gravity analysis – it could play an important role in the initial stages
47 (Does the data show inbound – raw materials etc.) (It is most likely not included in the dataset)
48 End of interview

Respondent 3

0 Enzymes: he would like to know what we seek
1 we got through the research purpose
3 It could be interesting: Italy – the way we sell our products, it is often through distributors. And we can see that they order many times a week. So, we are holding the inventory costs, and we are supporting them. They are pressuring on the prices, so we are losing margins here.
4 What would be interesting to see is, where are we located, where are the distributors, do we have the right setup.
4 are we sending via the Italian warehouse, or the Danish warehouse.
5 product area: Enzymes
5 what would be interesting to see. Where are they located? They are in Northern Italy, but we also must support Southern Italy. It could be interesting to see the frequency with which we send them.
6 the frequencies are hard to see here

7 we are sending most of it via our own warehouse, and then we distribute it out. It would be interesting to see what it would mean for our transportation costs if we selected large distributors, and supported it via Graasten – instead of having inventories at both places. What would it mean if we only sent shipments to them every two weeks, rather than several times a week.
8 (he wants to know what we are seeking)
8 I want to optimize the shipments I have – especially towards Mexico. For the bigger picture, it is placement of warehouses, which is SW's area
9 SW creates the framework, in which I operate
9 I know the costs. They should be included in the data sets.
11 we have a lot of distributors in Northern Italy – many big ones. Does it make sense for us? Are we supporting the distributors – and taking their inventory costs.
12 this gives me a good picture, that tells me, maybe I should reach out to one of the distributors down here
12 Parma should support the small customers – but the bigger distributors should not.
12 It can help me see some volumes, and give me a picture of what it the optimal way to do things
13 We know, that when we send a full truck, it is this many tonnes.
14 if I can send some bigger shipments, it becomes more optimal
14 (Lumira) gives me the opportunity to select the most appropriate distributors – as well as to push back to Sales department, and ask, is this really the smartest way to do it?
16 there are two times customer service (When sending directly from Graasten to end-customer in Northern Italy). So naturally, it is expensive as shit to send it from Denmark – but if we can send some big shipments, it is worth it
17 the costs data should be able to give an indication as to whether the bigger volumes are less costly
18 (Looking into how certain distributors can be filtered out)
19 looking at specific customers: Food.com, a distributor close to Parma, with approximately 50 tonnes of shipment volume
20 (Interesting discussion of the units of measurement: how tonnes are decided: with or without the packaging material. From a sales perspective, it is reasonable to assume that the packaging material, pallets etc., are not relevant to include in the volume, but from a transportation perspective, the total weight should be included, since this is weight that CH pays for).

21 (looking at other customer: Vachelli, having two distributors, with a very small distance between them.
22 There are only 20 minutes between the two distributors
23 One thing is order lines – another is number of shipments. 10 different products can be included in the same shipment. So it is interesting to see the data on that.
24 (Counting distinct lines)
27 (Understanding bubble size in Lumira)
29 It has handling costs every time there is something done within the system. If sales tell the customers, just tell us every time you need something, then it will be costly for us.
29 we are sending to them 3 times a week, and that is costing us a lot
30 they are currently exploiting our goodness right now, since they are not holding any inventory
30 if they are purchasing 4 different products, then order 3 times a week doesn't really make sense
30 there is a shipment number to sort by: (Simply called "Delivery"). (Has been sorted out).
32 Is it not possible to include more measurements? (it is, but showing when hovering mouse over data point is a longer list – this is really interesting).
34 (Point to be made about the previous comment: The many lines included does not necessarily share a common plant 0 etc. therefore, it is unlikely that Lumira will show that, when hovering over the data point).
36 (Testing out the feature "Export records". It exports into excel in a very elegant manner).
38 It is relevant to be able to export the dataset in the same format as in the regular (excel) way of viewing the data.
39 (Doing second "export". See the excel sheet "kasper2" to see the exported lines).
40 (GI date corrected, did not work as expected). (Date needs to be done in a different manner)
41 Looking at it in a time perspective could be interesting and relevant.
41 as you can see, there are many products, which we regularly send small shipments of small batches to the same customers. Basically, showing that there is room for improvement.
42 Shipments should be in larger volumes, we are sending 6-7 tonnes each time. But the thing is, once we're sending a shipment so large, we could be sending something double so large (or larger) for basically free (freight cost wise)

42. It comes down to handling costs. If we were sending fewer large(r) shipments, then we could avoid paying for handling on the more often and more smaller shipments.
42 Normally we hold the transportation costs, and these are then included in the prices that the sales department calculates
43 the inventory costs we do not know – but the costs of logistics, and handling costs we know. We cannot get the finance department to calculate the inventory costs for us.
43 Everything on inventory costs us annually around 7 %. In lost yield. We don't have a number, but from an industry perspective, around 7 % makes sense.
44 maybe we can lower our global safety stock values, if we shut down some of the sites, e.g. the one in Parma.
44 if we could pull it back to Graasten, we could reduce transportation costs, as well as inventory costs. But naturally it lower increase of delivery-time.
45 the goal is to be able to support all European customers within 7 work days, including picking/packing. But these customers are in a situation where they need to cut costs. So, it is about finding a trade-off balance, where both parties are gaining something out of this.
47 to find out if it is profitable to send: We need to be able to compare two lines for instance.
48 I have already moved all my shipment to sea freight, so there isn't any more optimization to be done there (in terms of moving air to sea).
48 Now I am in the next layer: Where should I send the goods from, and how often should I send them.
48 look now how many deliveries there are in April last year
49 →30 have been sent many times within the same month.
49 It may be true that I cannot perform optimization on it right now. But next time the sales department is negotiating prices with the customers, that they include this data. They need to understand this. It should have a consequence for the customers that they are ordering in this silly way.
50 (Putting in six distributors: Food.com, Vacchelli, albinidialbini, groaz, linea, uniferm, walterdavanzo, universal).
51 is it not possible to get the customer name shown, rather than the customer city.
52 it is rarely that you can understand some customer city
57 with the setup we have right now – we should tell the customers to change their patterns.
58 with the way they are located, we should not be sending shipments so scarcely.

59 placement is important to me (we are sending him the screenshot).
59 seeing things visually helps in different ways: Where should we locate our distribution centres, in negotiation with customers, but if we should use it internally, we must be able to understand the data, and its sources.
60 Incoterms: shows us who is paying for the transportation, and when is the product out of CHs hands.
61 it is effective to export data it seems.
62 end of interview

Respondent 4

0 setting up the interview meeting
1
2
3 (discussing the other person in CH that focuses on visualization). He is in the inspiration phase.
4 there is an innovation department. They use the tool power-BI. They have also worked with trying to visualize it.
5 There are three people, besides ourselves, and then the IT department, in terms of being able to support on the IT end
6
7
8 (Describing the micro project that Bjarke did, where he used Lumira). Well, it was a very limited data set, and a short time to deliver. The conclusion was, I would take a look, and try to clean up the data, which was 90 % of the work. I used the same ESRI map that you did, and the output was a PDF that they took to the meeting. To say, where are we located.
9 How good are your postal codes? Because to me, that is one of the challenges. I want to hear about your experience with Lumira. It's focused on these predefined cities. The hard part is the matching.
9 How do you aggregate it?
10 You really want to say, this is the important part. There are some major hubs, and there the peripherals.

11 (Did the PDF have an effect?) Like all such projects, it was an iterative project, but yes, they were very positive.
11 some of it is volume, and some of it is quantity, and both things really matter.
12 the important part is, how do you visualize that?
14 The best use of these kinds of tools, is to bring it out to the business users. This is not a technical tool. Me from a reporting, and data development type of work, I run into of the limitations, and find those very frustrating.
14 in my opinion, this tool is suited to create reports that can be shared with maybe a couple of colleagues, or maybe a specific meeting. For such a purpose, it is far too cumbersome to go to the BI team.
15 it is much more successful, if you try to limit the complexities. A business users can, with a little bit of training, show the story they want to, with this tool.
15 it should be shared with the business users that has enough of a certain type of requirements. They should not be experts, but they should become ad hoc users of the tool
15 I was actually at a conference last week, where I discussed this with a former colleagues, and what they are doing is they are putting Lumira out to the users, and then sometimes the users come back and ask for their help.
16 and if the users require something more advanced, you move the task from this tool to a more traditional dashboard. Having the ideas, and the visualization helps significantly with this.
17 With traditional tools you actually spend a bit of time before you show the user anything, and sometimes they do not like it. With (Lumira) it is much easier for both parties to show what you mean, and then you show the different solution.
17 and that is where it would really work well. (internal communication, whereas the other conversation has been about the external communication).
18 the end-use of the report/stories, could be either internal or external, but as a tool, it belongs more toward the business (internal).
18 much of the data is based on the data warehouse.
19 I would expect that the data you have been supplied with also originates from there.
19 The way to do that (data integration) is that you can connect Lumira to the back-end system. So you don’t have to go through excel. Or some other flat source. And the challenge with that is that for any

type of geographical visualization, is that we currently do not have geographical (long/latitude) data in the data warehouse.
20 But an on-going project that we have is that when we create new customers, they must verify, we might as well collect the longitude/latitude of the customer. It can get the data “at birth”.
20 and when we have that, it can go into the ERP system, and the BI system, and it would be available for Lumira as well.
21 such a case, Lumira should be connected in the smarter way
21 you can connect Lumira to certain types of back-end systems
22 I don’t know. I think it half a year down the line.
22 part of your job is putting attention to the value of such a system. If we once and for all get this information into our master data system. So there is an interest, since this would benefit us in several different places.
23 (external sources, and manipulation of data).
24 It is the never-ending story. Whenever you provide new information from the warehouse, the business has already moved on to new areas of interest. Or you may have something that is specific to an areas, a purpose, or a project. Tools like these are created to match: say 90 % of my data is coming from the warehouse, and import your own data.
25 and then you can actually do separate visualizations, or you can join the sources in the tool. You can match the customer ID in the one source, and the ID in the data warehouse.
28 what is relevant to you is: pre-delivered sourced, BW system. (I could not connect). What you do here, is you add a new “possible” data source. Then you have two sources: for instance, your excel-sheet, and your BI data source
29 then you specific: this data is corresponding to the data in this column.
30 the join is to say, whenever you meet this customer, enhance the row with the data from longitude and latitude.
31 (Technical stuff)
32 (Technical stuff regarding the virtual machine)
33 level of detail must correspond to the data need
33 what input do you need, what kind of granularity

34 If you need some of the visualizations to be dynamic, then you should do a true BI project. Where you connect the back-end database, and extract the information that way.
34 taking the good ideas from a tool like this, and moving it into a central solutions.
35 and that is the important point to make here. Rather than saying, oh I have ten good ideas, let's make 10 projects, then you can quickly show 10 good ideas, and find out, one of them really IS a good idea. Then that is you candidate for the much heavier and slower task of integration to the back-end system.
36 (technical stuff: virtual machine)
37 There is a difference between training in understanding the data, and the reports, and then the quality of the input.
38 the quality of the input, comes back to the source. There is a lot of control in a system like SAP, which is both a good and a bad thing. It is controlled what you can enter in each of the fields.
38 you cannot enter dates in the wrong fields etc.
38 the training of employees: this is also why we are interested in your findings. Training the business also comes back to what our focus is.
39 this is a constant challenge: which tools are we using, what are the tasks.
39 it is one thing to train a user in using a tool. But if they don't use it regularly, it is sort of wasted. It is a challenge to find the tools and the users, to find the right tools.
39 there are users who use reports regularly, who have forgotten the very basic skills required to successfully use the applications/tools.
40 that is an ongoing challenge. When is it worth it to send people on training programmes, and when should it be reviewed.
40 we mostly do training sessions mostly when there is something new coming out. Like a main tool for finance, and other areas.
40 there was a big process for a new report tool
41 SAP has recently announced that they will make a version 2.0 of Lumira. The very big thing about 2.0 is that they are actually supposed to be a merge of Lumira and design studio.
42 design studio Is way over in the side of BI tool, very complex. Get the best from two worlds.

42 The potential of this is huge. Because of the user develops something useful in “the simple”, gets a nice looking story, and they wish to enhance it to be central solution. And the short time would be great.
43 Like I mentioned earlier, if you develop 10 ideas, and one of them is good. If the lead time to get it into a central solution is short, because its within the same tool, we could see a great potential.
43 but from my perspective, I see these two tools as very different. In the way they are created.
43 This can either be something that has the best from two worlds. Or it can be something that is neither easy to use, or has the central knowledge perspective. (released in the late autumn).
45 Do we really want to start training people in the 1.3 version, if the layout of the two versions are very different. Will it be wasted time? This is also why we are not pushing people towards Lumira. It does will a niche right now.
46-51 (technical stuff, and us talking)
51-55 (Bjarke shows capabilities of the compose feature)
55 (is the analysis in CH used to support already-made decisions, or is it used to explore new data areas) it is more used to follow up on predefined metric KPIs, things that you have decided at some point to follow up on, and then use BI to follow up on that regularly. It is not used so much in the more explorative way, where you look at all your data and ask, am I missing something?
56 I assume that the people who work with this on an everyday basis are following up on their areas of expertise. So our reports are not set up to catch that type of things. It is more some way of making sure that the reports are updated and consistent. And then check, are we on schedule. Comparing the KPI to different areas.
57 (on reports) a normal misconception is that reports are a long document of text. Reports, in a BI world, is a refreshable document with a certain structure. So I have a structure of profit/lost, or my late deliveries, compared to my on-time deliveries. And the report is the structure for getting the data in there. And then: today, I’m going to do that and tomorrow I am going to do that.
57 (report) is a dynamic document. And it is a document of numbers, not so much a document of text.
57 we are creating the structure, and we are creating the data flows that feeds them, and then the loads are scheduled.
58 so the users can update to the newest data without our involvement. That is the main usage of the reports

58 we have 2500 users, out of 3000 employees. Many people have access. Each one refreshing their business areas.

Respondent 5

0 five tonnes bar
1 find a manageable number of routes that could be optimized
2 I think there is a number of routes to the US, that are not optimal. You can also try to look at bulk to the US – if it is within one week, or even one month. Could we have send it via ship by a single shipment.
2 some of the business units are pressured on shelf life
3 I am thinking, in terms of choosing some criteria. It should be single shipment, over 5 tonnes. What would be the total tonnage, over 2-4 weeks? Focus on the intercompany shipments. If it is to an end customer, then we would assume that they would be paying for it.
4 so the low-hanging fruits are IC, >5 tonnes. And air freight. That is how we identify the potential.
4 also if you see that finished goods are moved a lot. If we are moving things from DK to France, and then selling it in Germany.
5 there is a difference between finished goods, and half-finished goods
5 the half-finished goods are usually very large bulks. We don't send small shipments
6 do the distinction on value chains, e.g. animal health.
7 if we have the lines, that would be extra valuable
8 (Søren thinks the work we have done so far is really great, and on point. He also wishes to validate the data with Klaus, who is the shipping/transport guy)
9 in terms of Mexico, it could be a global view on opportunities. The criteria, at least in terms of the 5 tonnes. If you find the time, try picking a single lane, and then later you can maybe convert the lane to other parts of the value chain
11 (we should do an APS (ah prøver squ) by SW)
12 (We are discussing which screenshots bring the most value)

13 Remember the screenshot from Deloitte. We could do something similar. Say we wanted to only the Cultures division. So, it is not a global view, but so that it creates the size of the bubble, on a smaller geographic area.
15 could you do a screenshot from China – because we have the current project with DB Schenker. Could we try it now?
16 (talking about the technical requirements of Lumira. And about the virtual machine).
17 (When SAP Lumira doesn't work because of a bad connection) The IT department simply MUST start paying more, and making sure that these types of issues are fixed. I mean, we are now sitting four engineers, or soon to be, waiting for this, and wasting our time.
18 Can we do they lines between the DC and the customers?
19 (Talking about Galigeo) I would expect the IT function to do the coding if that becomes necessary. I see you two as the super-users, but you shouldn't have to be coding.
21 you could have different layers, or presentations, one for each of the countries. But also, one that is global in its view.
21 if you could send us the screenshots – of the different views, and clustered as well.
22 end of interview

Respondent 6

1. Alignment of expectation
    i. The triangle is shown to CH
    ii. Understanding, design, implementation
2. In SW's eyes, we are consultants
    a. He wants us to create a global overview (1st priority)
    b. Second priority: Mexico. Deep dive.
    c. Cooling store and frozen store
    d. In source or outsource
3. Supply optimization
    a. From the gathered data, we could look to optimise the freight logistics flows

b. Right now, the data gathering from scratch every time
c. 1-2 years have been put into the data gathering

4. Katarina: ABC. Cost of logistics
    a. For every shipment, CH knows the cost of transaction costs
    b. All transport is outsourced
5. (Looking at a company presentation about CH)
    a. Three business units, under CH
        i. Culture and enzymes (largest, and most profitable)
6. Product performance is essential. Reliability.
7. The take away the risk of the dairy producers.
    a. Much effort is put into research as well
8. Competitors: Danisco, DSM
    a. 12 % sales growth
9. Enzymes: Collected from the stomach of stock animals
10. Meat and wine cultures.
11. New area: Bio-protection
    a. Protection of yoghurt
12. Dairy culture: big business
    a. The other ones are expected to grow
13. Health and nutrition: Pills against bad stomach e.g.
14. Pharma world is a different world, especially in terms of documentation
15. Plant protection. (Sukkerrør in south America.)
16. Natural colours: Mexican she-lice are used for getting red colour

(CH Footprint)

17. The blue dots are distribution centres
    a. In Europe, many distribution centres are placed here.
    b. In North America, everything is delivered from the Milwaukie/Chicago area. From one place.
    c. China: Until two years ago, no activity. Before 2014 CH just sold their goods to a distributor. But it has been growing a lot – primarily the yoghurt production.

18. Out of the global top 9 customers, 2 are currently Chinese. No production in Africa. But they are planning to sell to distributors in several African countries. CH does not want their own production down there. They are lacking the customer part.
19. I want it shown on a map, rather than a table.
    a. In Europe, with the footprint analysis, we hired Deloitte. They have used a tool called Tabloid. To enter data. Data source: ZIP codes. They then mapped it out on a map. To show WHERE are the customers. Categorized in terms of volume, sales, value etc.
20. The map shows a picture, based on the selection that has been made. A characteristic could also be the type of product. Expand the scope: If I e.g. click on Australia, I want to be able to see the demand of the customers in Australia. Data foundation is there. Take CH's raw data, and create a tool that is able to view this.
21. Data records are there: Value, weight, volume, freight calculations (cost of logistics)
22. We have the data, but we do not have the overview (Data is there, but not *information)*
    a. CH are missing a good way to visualize it. It is used e.g. when doing an offer for logistics companies
    b. Three different tools: (QV e.g.)
23. Looking into what kind of information is actually interesting to look at. It is all about visualization. High level analysis.
24. Looking at Europe: The yellow are warehouses, and the blue are factories. CH wants seven days of delivery time.
25. CH might have to keep the wares, so that they are not sending wares to somewhere, where they are not needed.
    a. A couple of years back, each place had its own logistics agreements
26. There was no way of getting products send directly from CPH to Italy, in one shipment
    a. A big deal was made, now: West Europe; Freja. East; DB Schenker. Division between them was needed.
    b. SAP needed to be set up to fit this move
27. Pharma: What are the cost of logistics, from the manufacturing, and out to the customer.
    a. Lead times in Europe: Map of lead times. Each picture is one day of lead time!

    b. You just count the number of boxes between the sending country and the receiving country.
28. Analyses: How does the current setup look – and costs. What would happen if we only had the factories, and no other DC? What is we had only one DC in east Europe. Or what if we kept the current ones in Poland and Romania, and closed the other ones. Simulation of 2019, in terms of growth. What if we grow 8 % in West Europe, and only 2 % in Eastern Europe? Would there be a shift?
29. We are calculated the stock costs, the freight between us and the customers. Intercompany, and the last journey out to the final customers. The model told CH that they could make some small modifications to how they are currently operating, and then save half a million euros.
30. What if we had 1 or 2 hubs – and then they did sensitivity analysis. What they chose to do is: ()
    a. There is not the biggest of differences between the options, and there were some uncertainties. In many cases: You save something on warehouse, but you lose something on transportation.
31. Replenishment is MORE SIMPLE. It has a great value.
    a. They cut down on the number of DCs
32. The factories are also DCs.
    a. In Poland and Romania, and Ukraine, and Moscow. Things take longer in Ukraine. If there is no queue, CH does not send anything in the weekends. (Because of costs I assume)
33. The geospatial data helps with the overview
34. Deep dive on Mexico: What tendencies are we seeing? What are the current situation? What are the costs of flying products?
35. Your job could be to tell us what you think would be the optimal thing to do in terms of freight to Mexico (Ship or airfreight)
36. Understand the flows. We don't have the ZIP codes for Mexico. There is a logic behind the ZIP code format, that is not working in Mexico.
37. Katarina, understands /creates the costs of logistics.
    a. Talk to Brian Dunfelt, who own the IT systems
    b. Ask about what he suggests that we do

    c. Create the global overview, and deep dive in Mexico.

38. Scope will be found later in the data process
    a. Hard core supply chain issue
    b. DSV made a colour analysis for CH
39. Food colour
40. Contact info being shared
41. –
42. Small talk
43. –
44. Drawing the dots. They want to be able to do these kinds of analysis themselves
45. Another view: The depth of the line shows how much we are sending! Different software has different ways of visualization.
46. What is the costs of operation in different countries: Doing calculation, what is costs of logistics/warehouses in the different countries, what are the annual salaries?
47. –
48. –
49. He sends us the data. All the data is there!
50. He explains the characteristics of the data. Customer, shipment ID, shipment type, ambient or refrigerated,
51. –
52. –
53. The final data set will look much like the data example that he sends us there. Display mode.
54. The data shows prices, volume, sales, product description, receiver, transportation type, ZIP
55.
56. Our data foundation will be unchanged over the period that we work on it.
57. –
58. Talking about SAP
59. –
60. (Talking about previous analyses that has been done, and the general application of tools such as SAP.) Czech was found to be the optimal location for a warehouse (form a center of gravity

analysis). However, this did not mean that the simply placed the warehouse at that location – they just looked around the area, and ended up placing it in Germany either way. Another way to use the tool is to input a location first, and then do the analysis afterwards.

61. Colour: Location planning in terms of DC location. The calculation often creates a foundation for the discussion – gives a sense of direction.
62. Talking about SAP: Started with a financial module. Demand management has really moved. Big data has been implemented. Graphical Gantt chart.
63. –
64. SAP: When creating a factory – you need to create a factory in the system.
65. –
66. Capabilities of SAP
67. Forecasts (No Kanban cards). The re-order points are calculated.
68. CH is an interesting company with a nice value chain.
69. It is difficult to do what we are doing – therefore they have such a great market position