MOT2910 MSc Thesis Project

Supply Chain Trends impacting the Air Cargo Industry

Assessing Trends and their Impacts in three Industry Sectors

Florian Schmidt

MSc. Management of Technology

Faculty Technology, Policy and Management

Section Transport and Logistics

Delft University of Technology

In cooperation with Seabury Cargo Advisory B.V.

August 2013

TU Delft Delft University of Technology

SEABURY

SUPPLY CHAIN TRENDS IMPACTING THE AIR CARGO INDUSTRY

- ASSESSING TREND AND THEIR IMPACTS IN THREE INDUSTRY SECTORS -

Student: Florian Schmidt
Student Nr: 4180534
E-mail: f.schmidt87@yahoo.de
Program: MSc. Management of Technology
Course Code: MOT2910 MSc Thesis Project (30 ECTS)

THESIS COMMITTEE:

Chairman:

Prof. Dr. Ir. Lori (L.A.) Tavasszy
Delft University of Technology & TNO
Faculty Technology, Policy and Management (TPM)
Department of Transport and Logistics (TLO)
L.A.Tavasszy@tudelft.nl

First Supervisor:

Ir. Marcel (M.W.) Ludema
Delft University of Technology
Faculty Technology, Policy and Management (TPM)
Department of Transport and Logistics (TLO)
M.W.Ludema@tudelft.nl

Second Supervisor:

Dr. Eric den Hartigh
Delft University of Technology
Faculty Technology, Policy and Management (TPM)
Department of Technology, Strategy and Entrepreneurship (TSE)
E.denhartigh@tudelft.nl

External Supervisor:

Ryan Keyrouse
Associate
Seabury Cargo Advisory B.V.
RKeyrouse@seaburygroup.com

Preface

During my Bachelor and Master study, the aviation industry and the field of logistics have drawn my attention more and more. An internship at Fraport, the operator of the Frankfurt International Airport, enabled me to get a first insight to the aviation industry while an internship at Mercedes-Benz in South Africa brought me detailed knowledge in the field of logistics engineering. After attending elective courses at the Faculty of Aerospace Engineering of TU Delft, participating in a one week exchange course organized by Air France and École de Mines in Paris and choosing the specialization of Supply Chain Management within my master program Management of Technology, it was my aim to graduate with a research study combining both of my interests: aviation and logistics.

I consider the way goods are transported across the world to be fascinating and interesting to research. Especially the air cargo industry, which is indispensable for moving time-sensitive, valuable or perishable goods to nearly any point in the world, captivated my interest. Hence, it is not a surprise that the content and the objective of this master thesis can be summarized in the following statement:

> *To research global supply chain trends that have an impact on the air cargo industry by conducting interviews and a questionnaire with international shippers in three different industries.*

The result of this master thesis, which was done in collaboration with Seabury Cargo Advisory in Amsterdam, is a comprehensive analysis on current and near future supply chain trends that have an impact on the main market players of the air cargo industry. Besides a validation and falsification of the proposed trends, an assessment on the magnitude on impact of each trend was done.

To complete this research within the set time and to fulfill its aim required hard work. This master thesis would not have been possible without the contribution of many individuals from TU Delft, Seabury and the many shippers that have participated in the interviews and the follow-up questionnaire. In this preface, I would like to thank those who supported and motivated me throughout the challenging but interesting and insightful course of this master thesis. I would like to thank Marcel Ludema, my first supervisor from TU Delft, who supported me and helped me with difficult decisions. I am grateful for the valuable feedback and comments he gave me especially in the last months of this master thesis. Next to him, I would like to thank my graduation chair, Professor Lori Tavasszy, for valuable suggestions in the beginning of this master thesis. Furthermore, I would like to thank my second supervisor Erik den Hartigh for his guidance during the course of this research via Skype from Istanbul.

From Seabury, I would like to thank all colleagues of the Amsterdam office for the exiting time I had. Especially, I would like to thank my first external supervisor Ryan Keyrouse. Even though he was on many business travels during my time at Seabury, he always made sure to guide me and give me valuable feedback in regard of the content of this project. Next to him, I would like to thank Marco Bloemen, who was the key person in arranging most of the interviews. I am thankful for learning a lot on how to conduct interviews with key managers. Besides the colleagues at Seabury, I would also like to thank some of the key account managers of the large network forwarders such as Ceva and Kuehne & Nagel that introduced me to many global shippers. The same is true for Joost von

Doesburg of EVO (Dutch shipper council) who supported me by supplying me with contact details of EVO members and who distributed the questionnaire to many EVO members. Furthermore, I would like to thank all the supply chain managers of the many shippers that have participated in this research. Without their valuable input during the interviews and the follow-up questionnaire this research would have never been possible. Lastly, I would like to thank Eva Veldman for reading along and giving valuable input for writing this report, my parents for their advice and everyone else who has supported me in any way during the last six months.

Looking back at the last six months, I am happy and proud that I had the chance to finish my study and master thesis in a field that interests me to such extent. I am grateful to learn a lot from Seabury in regard to the air cargo industry and consulting. Lastly, I would like to mention that conducting interviews was very challenging but most of the time very interesting. I especially appreciated the openness of the respondents and the possibility to visit the headquarters or national branches of global shippers.

Florian Schmidt

August 5, 2013

Executive Summary

Background of the research

The air cargo industry is indispensable for the transportation of many time-sensitive, valuable and perishable goods to nearly every place across the world. After tremendous growth during the last decades of the 20th century, the air cargo industry was doing poorly within the last 10 years. Growth rates were declining and from 2011 to 2012, air cargo volume actually decreased by 4%. The air share of total transportation dropped from 2.9% in 2000 to 1.7% in 2011. Complemented by that, were decreasing load factors and an increasing imbalance between demand and supply.

As the air cargo industry is deeply integrated in the global supply chains of many shippers, it is necessary to research supply chain trends that have an immediate impact on the air cargo industry. This would make it possible to respond to these trends as a countermeasure to the lost momentum of the air cargo industry.

Seabury Cargo Advisory, the problem owner, is interested in researching which global supply chain trends have an impact on the air cargo industry in order to better advice its large client base. Furthermore, this research is trying to 'de-mystify' some of the discussion on certain trends in literature and put proof and numbers to them.

Scope of the research

The scope of this research is defined by three characteristics. Firstly, the research focuses on three industry sectors (high tech, pharmaceuticals and automotive) that are considered to be very important for the air cargo industry. Secondly, the impact of supply chain trends on the air cargo industry is investigated in two main fields: air freight and air express. Hence, air mail will be excluded from this research. Thirdly, supply chain trends are considered to be current trends or trends which will be evolving within the next five years.

Research approach

A series of different research techniques are used to answer the main research question:

What are the global supply chain trends and how are they impacting air transportation?

To research supply chain trends, this research project is based on a framework of Zografos and Giannouli (2001). In their framework, drivers impact the emergence of supply chain trends which have an influence on the air cargo industry.

By conducting a comprehensive literature review, the current state of the air cargo industry is identified. Apart from that, literature is used to identify social, technological, economic, environmental and political drivers that influence the development of various supply chain trends. The identified supply chain trends are verified or falsified by means of in-depth interviews and a follow-up questionnaire with global shippers in three different industries. During the interviews and the questionnaire the impact of these trends on the air cargo industry is examined qualitatively while a statistical data analysis of Seabury's databases is used to examine the impact of certain trends on the air cargo industry quantitatively.

Identification of supply chain trends and their possible impact

Based on an extensive literature review, 21 supply chain trends are identified and grouped in four categories. Structural supply chain trends deal with the physical structure of a supply chain and relate to the number, location and capability of manufacturing plants and stockholding points as well as sourcing and distribution trends. Product characteristics and production trends refer to changes in product design, the length of the product life cycle and to the developments on how goods are produced and manufactured. Product flow trends are related to changes in the way products are transported. This includes the speed of product flow, the transport mode, the shipment size and frequency and the trend towards direct door-to-door deliveries. The last group of trends deals with a wide spectrum of developments in the supply chain that could not be matched to one of the other groups.

Structural supply chain trends	Product characteristics and production trends	Product flow trends	Current supply chain focus trends

• Wider geographical sourcing and distribution
• Vertical disintegration of production
• Rationalization of supply base
• Spatial concentration of production and inventory
• Shifts in production
  ◦ Near shoring
  ◦ Movement to lower labor cost area/country
  ◦ Movement of industry clusters
• Development of cross-docking/transshipment
	• Shorter product life cycle
	• Changing value-to-weight ratio
	• Changing packaging
	• Dematerialization of products
	• Postponement
	• 3D printing
		• Speed of product flow within the supply chain
		• Modal shift
		• Increased direct deliveries and disintermediation
		• Smaller and more frequent shipments
			• E-commerce
			• Cost awareness
			• Increased outsourcing of logistics activities
			• Increased supply chain risk and resiliency
			• Sustainability

To measure the impact of these trends on the air cargo industry six impact criteria were identified:

- Air cargo volume
- Commodities
- Trade lanes
- Type of carrier
- Type of service
- Required carriage

The first criterion deals with the growth or decline of the air cargo industry in terms of transported freight. Whether or not a certain good becomes air eligible, is related to the impact of commodities which is directly influencing the air cargo volume. Trade lane changes are related to shifts in origin and destination movements of products. The type of carrier differentiates the two major supply streams in the air cargo industry: airport-to-airport carriers and integrators. Each of these carrier types offer different service levels which can be regarded as express (time-definite) and deferred (day-definite). The last criterion is related to the required carriage and includes impacts such as ‘main deck’ carriage or ‘cool chain’ compliance.

After an initial analysis on these impact criteria, eight trends are discarded from the further analysis as they did not have any visible impact on the air cargo industry. One trend is discarded because it is out of the five year time scope. The remaining supply chain trends are tested by means of in-depth interviews and a follow-up questionnaire with various shippers.

Testing of trends in form of interviews and a follow-up questionnaire

To test the identified supply chain trends, 19 in-depth interviews are conducted with supply chain managers of different shippers in three industries. During these interviews it becomes apparent that trends such as 'e-commerce', 'direct deliveries', 'smaller and more frequent shipments', 'sustainability' and 'a shorter product life cycle' are not taking place on a large scale and hence have no major impact on the air cargo industry. Therefore, these trends are excluded from further analysis. The remaining trends impact the air cargo industry to a sizeable extent and are therefore further quantified in form of a follow-up questionnaire.

Based on the results of the interviews and the questionnaire the following trends are most apparent and have a sizeable impact:

- Structural mode shift from air to ocean
- Wider geographical sourcing of supplies
- Wider geographical distribution of finished products
- Production shifts to China, emerging Asian countries and Latin America
- Dematerialization of products
- Less voluminous packaging
- Increase in supply chain disruptions
- Speed of product flow
- Mode shift from integrator to air cargo carrier or vice versa
- Increased usage of larger gateways

Impacts on the air cargo industry

By using Seabury's databases, some of the trends and impacts on the air cargo industry can be identified. A continues mode shift from air to ocean led to a loss of more than 250,000 tons of air freight to ocean transport, representing around 4.2% of the total air trade in 2011. On the other hand, a temporary mode shift due to supply chain disruptions is only marginal. Over the last decade, the average value-to-weight ratio increased between 50% and 100% for high tech goods, pharmaceuticals and automotive parts. Still, this does not necessary mean that more products become air eligible and therefore increase the air cargo volume. Major trade lanes between different regions have changed within the last five years and are expected to change continuously. Especially China and emerging Asian countries will increase its share in producing high tech and automotive parts and hence more air freight will originate from these places. For pharmaceuticals, production will predominately stay within Europe and North America. In terms of consumption, China and emerging Asian markets will import more goods by air in all three industries and hence become more important as a destination. The majority of air freight traffic is concentrated around large hubs and remained relatively stable over time. The type of carrier selection as an impact for the air cargo industry is rather small. Still, in all three industries, integrators are expected to grow faster than airport-to-airport carriers. Finally, a small shift from time-definite to day-definite air express shipments of integrators and express like products of forwarders was visible.

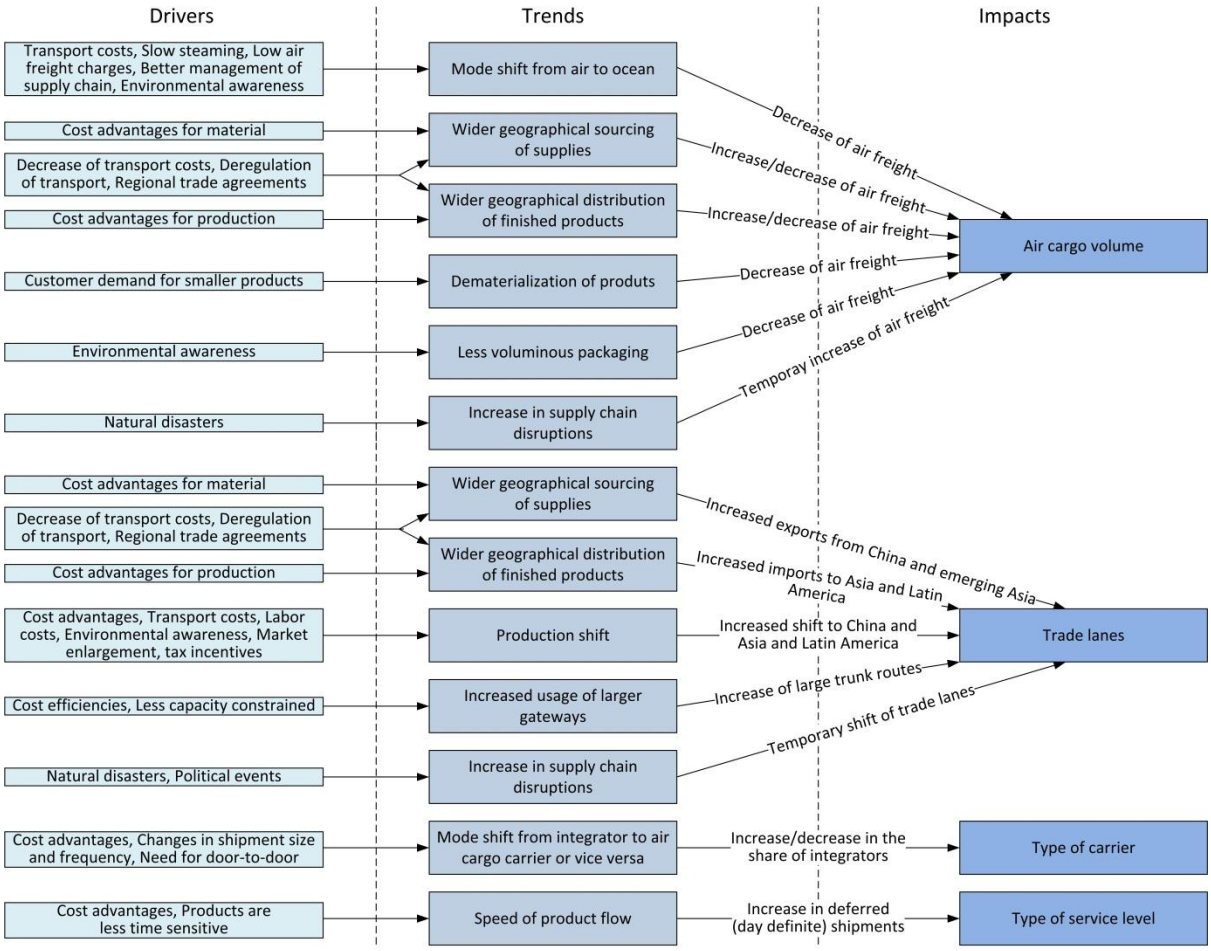
Results

By using the framework of Zografos and Giannouli (2001), the predominant supply chain trends on the air cargo industry and their drivers are illustrated in the following figure.

The most coherent development among shippers is a mode shift from air to ocean. This also has the largest impact on the air cargo industry in terms of air cargo volume. Wider geographic sourcing of supplies and distribution of finished products increases on the one hand the air cargo volume since many shippers source and distribute more globally. On the other hand, a number of shippers also source and distribute goods more locally which decreases the air cargo volume. These two trends also have an influence on trade lanes. The dematerialization of products as well as less voluminous packaging reduce the weight and size of shipments and therefore decrease the air cargo volume to a small extent. On the other side, supply chain disruptions, temporarily increase the air cargo volume. Furthermore, it can shift the origin and destination of trade lanes temporarily.

Besides the trend of 'wider geographical sourcing of supplies and distribution of finished products' and an 'increase of supply chain disruptions', production movements influence the shape of trade lanes. Furthermore, the trend of shipping more to and from larger gateways results in a shift of trade lanes and leads to consolidated trunk routes.

Another important trend is the reduction of the 'speed of product flow' in the supply chain which results in a change of the service level from express (time-definite) to deferred (day-definite) shipments. Lastly, there is a minor shift in the selection of the carrier types.



Conclusion

It can be concluded that several supply chain trends have an immediate impact on the air cargo industry.

The largest impact is caused by a continuing mode shift from air to ocean. However, it is expected that this mode shift will be less strong as it has been in the last years. Since the majority of goods are getting smaller in size and lighter in weight it is further expected that air cargo volume will decrease by a small percentage. The decline of air cargo volume is complemented by less voluminous packaging. Furthermore, air cargo volume will decrease because numerous shippers opt for local sourcing and distribution and consequently produce closer to their customer which eliminates the need for air transportation. The decline of the air cargo volume is however also partly offset by the fact that other shippers, especially in high tech, will continue to source, produce and distribute globally. Furthermore, shippers expect to increase their sales which will consequently increase the amount of air freight and possibly offset a major part of the decline caused by the aforementioned supply chain trends.

In respect to trade lane changes, the movement of geographical production locations as well as a shift of sales markets will have a sizeable impact. Especially, China, emerging Asian countries as well as Latin America will increase its share of importing and exporting goods that are transported by air. The development to ship more from and to larger gateways will strengthen large trunk routes.

The trend to shift the type of carrier from integrator to air cargo carrier or vice versa is most apparent for high tech shippers. The remaining two industry sectors (automotive and pharmaceuticals) are not expected to shift significantly to either one of the two carrier types in the future.

Since the need for highly time sensitive shipments within air freight and air express are decreasing, shippers are consolidating more of their consignments. Hence, there is a decrease of express (time-definite) and an increase in deferred (day-definite) transportation.

The remaining trends were less apparent and therefore did not influence the air cargo industry to a large degree. However, this might be caused by the choice of the researched industries. Hence, a trend research with a different population i.e. fashion or retail could have a different outcome on certain trends and the air cargo industry. Therefore, the identified trends and their findings cannot be generalized for all industry sectors that manufacture goods.

List of Abbreviations

3PL	Third-party logistics provider
ACMI	Aircraft, crew, maintenance and insurance
AFTK	Available freight ton kilometer
ASA	Air service agreement
ASEAN	Association of Southeast Asian Nations
B2B	Business to business
B2C	Business to consumer
CAGR	Compound annual growth rate
COMESA	Common Market for Eastern and Southern Africa
EVO	Eigen Vervoerders Organisatie (Dutch shipper council)
FTK	Freight ton kilometer
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
JIT	Just in time
LTL	Less than truckload
NAFTA	North American Free Trade Agreement
RTK	Revenue ton kilometer
STEEP	Social, technological, economic, environmental, political
TEU	Twenty-foot equivalent unit
TIA	Trend impact analysis
ULD	Unit loading device

Table of Content

List of Figures

List of Tables

1. Introduction and Research Framework

1.1 Research Context

The air cargo industry is driven by international trade. The thousands of trade lanes on which goods are transported by air can be understood as the arteries of global supply chains. Air transport enables the shipment of time-sensitive, perishable and highly valuable goods over large distances to nearly every location across the world. For example, due to air transportation Apple's tablet, the iPad, can be delivered in nearly 48 hours from the assembly plant in Shenzhen, China to its customer's door in New York travelling more than 13,700 km (Rodrigue, 2013).

From 1980 to 2000, air cargo in terms of volume measured in freight ton-kilometers (FTK) increased fivefold (Leinbach & Bowen, 2004). As a consequence, growth rates during the 1990s outpaced the growth of passenger traffic. However, in comparison with passenger transportation, the air cargo industry operates in a much more volatile environment, mostly depending on the economic climate and global trade (Doganis, 2010). For instance, during the economic crisis, passenger transport declined in November and December 2008 by 4.6% compared to November and December 2007, while air cargo traffic declined in the same period by 13.5% and 22.6% respectively (IATA, 2008a; 2008b). This is especially surprising since these months are usually periods of high demand as inventory is build up for the Christmas time. As this decline in demand was caused by the financial crisis of 2008, in general it can be concluded that the air cargo industry has been doing poorly over the last decade. This structural change is illustrated by the following examples (Seabury, 2012a):

- The 10-year average growth rate has declined from 8-12% in the 1970s, to 7-8% in the 1980s, to 6-7% in the 1990s and staggering 2-7% for the last decade
- Air share of international trade dropped from 2.9% to 1.7% in terms of weight and from 49% to 40% in terms of value between 2000 and 2011
- Cargo revenues of major carriers declined on average by 8% during the first half of 2012
- Cargo load factors steadily declined from around 55% in 2000 to around 50% in 2011
- Between 2007 and 2012 absolute capacity grew by 20 percent while demand grew only by 14%, increasing the imbalance of supply and demand

Based on this brief analysis the following question needs to be asked: How can the air cargo industry regain its lost momentum? As already mentioned before, air cargo is deeply integrated in the web of global supply chains and indispensable for the transportation of many commodities. However, developments within the supply chain of shippers that have an immediate impact on the performance of the air cargo industry are not yet clearly identified and researched in academics. Therefore, knowing which of the current supply chain trends are real, and being able to make judgments about their impact on the air cargo industry closes the abovementioned knowledge gap.

Seabury Cargo Advisory, the problem owner of this research, is a leading consulting firm being dedicated to the air, ocean and logistics sector and advising many industry leaders in the air cargo industry. Seabury works for many of the world's best performing cargo airlines (Lufthansa, Cargolux, Air China, Korean, China Airlines, IAG, Atlas, Etihad, etc.), forwarders (DHL Global Forwarding, CEVA, Kuehne & Nagel, Panalpina, etc.), integrators (FedEx, UPS, DHL and TNT) and airports (Singapore Changi, Amsterdam Schiphol, Toronto, etc.). Seabury is interested in researching current and near

future global supply chain trends and wants to identify which trends are really impacting the air cargo industry.

Currently, Seabury advises its clients by using its industry knowledge as well as by employing their supply and demand database which gathers data of customs offices across the world and data of the United Nations Comtrade. Even though the database has a five year forecast option, forecasts are made on certain assumptions which might lead to errors between forecasts and actual values. Therefore, the way Seabury advises its clients can be described as ex post. This study aims to identify current trends as well as developments in the near future (up to five years) within the supply chain of industries in which air transportation plays a vital role. This will enable Seabury to advise its customers on a more ex ante approach. Furthermore, by implementing the findings into the database, the quality of the database might be improved.

1.2 Research Objective

As Verschuren and Doorewaard (2010, p.33) state that "*each research project aims to provide knowledge, insight and information that can contribute towards solving a problem*", it is important to first outline a research objective.

This research project represents the graduation project for the MSc. program *Management of Technology* at the Delft University of Technology. This project is done in collaboration with Seabury Cargo Advisory B.V. (Seabury). Hence, research findings should be beneficial for Seabury's consulting work and help them to better advise their large client base.

The objective of this master thesis is to close the identified knowledge gap of researching supply chain trends that impact the transportation of goods by air which will ultimately contribute to the consulting work of Seabury. The master thesis is practice-oriented and therefore will give limited insights on theory development or theory testing.

The research project consists of the following objectives:

The first objective of this master thesis is to gain a better understanding of the air cargo industry and its special characteristics. When doing this, it is important to demarcate industries that ship a large amount of goods by air and are therefore relevant for the air cargo industry.

The second objective of this research is to identify global supply chain trends. After the identification, it should be determined if these trends are relevant for air cargo and to what magnitude they impact the air cargo industry. This will enhance Seabury's knowledge of current supply chain trends and their impact on the air cargo industry which can deliberately be used to consult Seabury's clients.

Thirdly, high-level recommendations for Seabury should be outlined on how to use the findings of this research project for Seabury's operations.

The last objective of this research is to start a continuous and structured dialogue between Seabury and shippers by means of interviews and a follow-up questionnaire. These interviews and questionnaire aim for a periodic participation and continuous feedback on the latest trends between Seabury and the shippers in the future. Therefore, this research can be regarded as the starting point to facilitate a constant knowledge sharing between the shipper community and Seabury in the future.

1.3 Scope

Since the research project should be completed within a time span of six months, it is important to clearly define the scope of the project to be able to obtain the desired result. Therefore, several choices have been made to keep a certain focus and enable the project to be manageable. Firstly, the conceptual model of this research will shortly be elaborated. After that, key concepts will be defined and the scope of this research will be delineated.

Conceptual model

A conceptual model represents the assumed causal relationships between core concepts of the research project. It tries to demarcate the research subject and helps to formulate the presumed connection between core concepts while linking the master thesis to existing theories (Verschuren and Doorewaard, 2010).

The conceptual model of the research project is based on the work of Zografos and Giannouli (2001) and is illustrated in Figure 1. **External drivers** (external forces) have a direct impact on **supply chain trends** which can be seen as the generalized reaction on external forces of corporations and individuals within a supply chain. These emerging supply chain trends have on the other hand a direct impact on the entire supply chain system of which the **air cargo industry** is an indispensable component, especially when looking at a global perspective. Furthermore, certain **drivers** may also have a direct impact on the **air cargo industry**, while the transportation of goods by air may also influences certain supply chain trends building a feedback loop between supply chain trends and air cargo. This research focuses especially on the relationship between supply chain trends and the impact on the air cargo industry. To understand the emergence of certain supply chain trends it is also necessary to identify drivers that influence the development of supply chain trends. This will be explained further in the next paragraph.

Figure 1: Causal scheme (adapted from Zografos and Giannouli, 2001)

Definition of key concepts

A driver can be defined as an external factor causing a particular phenomenon or behavior to happen or to develop. According to Zografos and Giannouli (2001, p.154), *"a driver is a force originating from the environment of a system which leads to changes in the system configuration"*. There are multiple frameworks to classify different drivers. The basic model is the PEST analysis which identifies political, economic, social and technological drivers. From that model many derivatives have been formed by adding further categories such as environmental and legal drivers (Mićić, 2006). In the context of this master thesis, drivers are external factors which are derived from a social, technological, economic, environmental or political background (STEEP) and trigger the emergence and development of supply chain trends.

The term trend has numerous meanings. It can be regarded as a gradual change due to certain conditions in a process or its output. In statistics a trend can be described as the general tendency of

a series of data points that move in a certain direction over time. In the field of fashion, a trend is represented by a current style. Zografos and Giannouli (2001, p. 154) define a trend in the context of supply chain management as the "*collective manifestation of the influence of drivers and their factors on the configuration of the system*". Furthermore they argue that at any point of time a trend becomes prevalent when a certain intensity of usage of system elements in their environment is reached. For the purpose of this master thesis, a trend represents a shared appearance or generalized reactions at a micro economic level (corporations or individuals within the supply chain) which are influenced by the emergence of wider macroeconomic or external drivers.

As illustrated in the causal scheme, supply chain trends can have a certain impact on the air cargo industry. The impact can be manifold and range from a change in trade lanes (origin-destination) or a change in commodities being transported which ultimately leads to an increase or decrease of the air cargo volume. Furthermore, a change in required carriage, carrier type and service level can be the result of different supply chain trends.

Delineation

The focus of this master thesis is to identify global supply chain trends and their preceding drivers impacting the air cargo industry, hence its main market players such as cargo airlines, integrators and freight forwarders. Within the air cargo industry special interest is laid on air freight (heavy/large shipments) and express services (small time-sensitive shipments). Therefore, impacts on air mail services (documents and letters) will be excluded from the scope of this research project. As shown in the conceptual model, the feedback loop between the air cargo industry and supply chain drivers as well as the causal link between external drivers and the air cargo industry will not be researched in this master thesis. The researched trends should be present on a global scale and should not be company specific trends. Industries of special interest are the following:

- High tech (e.g. semiconductors, computing and telecommunications)
- Automotive (especially parts)
- Pharmaceutical

These industries were chosen by assessing the value and weight share of each industry in terms of total air transportation. Besides that, the growth and the market share of individual shippers were taken into account. The three industries represent a weight share of 27% and a value share of 56% of global air transportation.

In regard of time span, the researched supply chain trends should either be ongoing trends or emerging within a timeframe of the next five years. Trends that deem to evolve in more than five years from now are consequently out of scope. In Figure 2, the scope of the research project is illustrated.

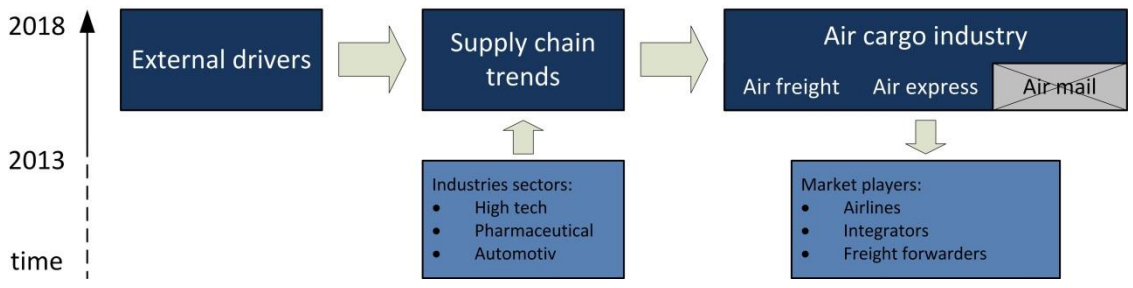


Figure 2: Scope of research project

1.4 Research Questions

After identifying the research objective and constructing the scope of the research project, research questions are formulated. Research questions are formulated to identify what knowledge or data is necessary to fulfill the research objective. This master thesis consists of one central research question which is unraveled in five sub-questions.

The central research question that should be answered during this research project is the following:

What are the global supply chain trends and how are they impacting air transportation?

To be able to answer the main research question, several sub-questions need to be answered in advance.

Sub-questions:

1. *What is the current state of the air cargo industry?*

To answer the first sub-question, a thorough analysis of the air cargo industry is conducted. This is seen as a basis and necessity to understand the characteristics of this complex transport industry.

2. *What industries are relevant for the air cargo industry?*

This sub-question aims to give an answer on which industries and what types of products are prone to be shipped by air. This analysis identifies the population of this research and justifies the selection of shippers in these industries that will be researched in more detail by conducting interviews and a follow-up questionnaire for the remainder of this research project.

3. *What are drivers influencing the development of supply chain trends?*

The third sub-question is aiming to identify drivers. As illustrated in the causal scheme, drivers have an impact on supply chain trends and the transportation of goods by air. It is important to delineate drivers from supply chain trends since they might be used interchangeable and therefore cause confusion.

4. *What are global supply chain trends and which of them are relevant for the air cargo industry?*

To be able to answer this sub-question, a broad spectrum of different supply chain trends will be researched. These trends can range from geographical shifts in sourcing, production and distribution to trends in consumption patterns. Furthermore, a large variety of other trends such as product characteristic as well as trends in how products flow through the supply chain but also current supply chain focus trends will be assessed. The identified trends can be seen as a basis to commence with the research project. While not all identified supply chain trends will impact air cargo to a large extent, it is important to identify the key trends which most likely pose an impact on the air cargo industry. Furthermore, it is important to demarcate key trends to be able to finish the master thesis within the projected time limit.

5. *What are the impacts of the supply chain trends on the air cargo industry?*

With the help of in-depth interviews, a qualitative assessment of the impact of supply chain trends on the air cargo industry will be performed on the basis of six criteria:

- Air cargo volume (increase or decrease of the amount of cargo being transported by air)

- Commodities (products becoming air eligible or not)
- Trade lanes (shifts as well as emerging and vanishing trade lanes)
- Type of carrier (a shift from freighter/airlines to integrators or vice versa)
- Type of service level (a shift from expedited to deferred shipments and vice versa)
- Required carriage (the need for main deck or belly hold as well as other special transportation such as cool-chain)

These six impact criteria were chosen after an internal discussion at Seabury and deemed to be the most important one. Nevertheless, it needs to be acknowledged that there are other possible impacts of supply chain trends on the air cargo industry.

Besides a qualitative analysis, a follow-up questionnaire is used to quantify the findings of the interviews. Apart from that, the impact of certain trends is also researched quantitatively by employing Seabury's databases.

1.5 Research Methodology

After describing the conceptual design of this master thesis by outlining the research objective, framing the scope and formulating a set of research questions, this part focuses on what methods will be used and how these will be employed to effectively and efficiently give valid answers to the aforementioned research questions.

In general when choosing a research strategy, the researcher has to be aware of tradeoffs in terms of control, realism and generalizability. While quantitative research methods opt for external validity, qualitative research determines internal validity to a larger extent (Golicic et al., 2005). Golicic et al. (2005) further argue that in the past, quantitative research within logistics and supply chain management was primarily done. Since the environment of logistics and supply chain activities is becoming increasingly complex, Golicic et al. (2005) recommend that researchers should make use of more qualitative methods. However, Näslund (2002) claims that quantitative research should not be replaced by qualitative methods but that both methodologies should be used since not all research questions can be answered by just one approach.

The research methodology of this research project is a combination of a desk research (literature review and descriptive statistical data analysis) as well as qualitative analysis in form of a survey research (interviews) which is complemented by a follow-up questionnaire. This approach represents the triangulation method which aims to cross-check one research topic through different channels to find regularities between the different sources (Jick, 1979).

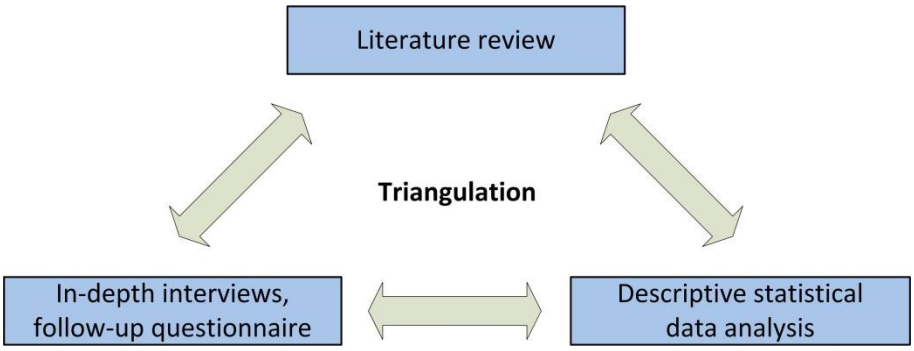


Figure 3: Triangulation approach

To be able to achieve the research objective and answer the research questions, it is decided to use such an approach to gain a better understanding from literature on supply chain trends but also to gain empirical insights that will opt for depth by conducting in-depth interviews with shippers as well as breadth by means of a follow-up questionnaire. By using statistical data of customs offices that are compiled in Seabury's databases, it is tried to assess the impact of certain supply chain trends in a less biased way.

Literature review

Fink (1998, p. 3) defines a literature review as *"a systematic, explicit, and reproducible design for identifying, evaluating, and interpreting the existing body of recorded documents by researchers"*. This implies that a researcher does not need to create new findings based on lengthy data collection.

A **literature review** will be conducted to gain a better insight of the air cargo industry and to answer the first sub-research question. Literature will also be used to identify drivers of social, technological, economic, environmental or political origin. This approach aims to answer the third sub-question of the research project. Additionally, existing literature will be analyzed to compile a list of global supply chain trends enabling to answer the fourth sub-question. It is important to clearly demarcate drivers from supply chain trends since they might be used interchangeable. Based on that, interrelations as well as cause and effects between drivers and supply chain trends will be outlined and mapped.

After mapping the trends by conducting an extensive literature review it is necessary to assess the trend and their impacts. Therefore, an appropriate assessment methodology of the proposed supply chain trends needs to be done by conducting in-depth interviews and a follow-up questionnaire.

Survey research – In-depth interviews and follow-up questionnaire

According to Sekaran and Bougie (2009, p. 193), interviewing and administering questionnaires are apart from observing people and phenomena, the two main methods in collecting data for survey research. Within supply chain management, questionnaires and interviews are rated the two most used research methods among logistics educators (Larson & Halldórsson, 2004). Another study of Halldórsson and Arlbjørn (2005) revealed that the majority of supply chain management articles published between 1997 and 2004 is grounded to empirical evidence by means of a literature review in combination with a qualitative analysis, a quantitative analysis or triangulation.

In-depth interviews with shippers of different industries will be conducted to gain insights on their general perception on the proposed supply chain trends. Also, current and future changes within the supply chain of the shipper will be assessed. For every in-depth interview, a report will be written based on the most important statements of the respondent. These statements will be the basis for analyzing the interviews which enable the researcher to find valid conclusions of which trends are actually taking place and to determine the degree of impact of each supply chain trend on the air cargo industry. Due to the time constraint and since the interviews are not recorded extensive coding with ATLAS.ti to map interrelations cannot be done. The analysis of the interviews will be done similar to the approach of thematic analysis (Braun & Clarke, 2006).

The assessment of the trends and their impacts on the air cargo industry by means of interviews will be based around the following four topics:

- Customer behavior affecting product development and operations

- Product characteristics changing the operations
- Changes in sourcing and production
- Changes in distribution patters

A **follow-up questionnaire** will be administered to get a quantitative understanding of the shipper's perception on the supply chain trends based on the findings of the in-depth interviews. The responses of the questionnaire will be analyzed by using Microsoft Excel.

The follow-up questionnaire will take the findings of the interviews into account and therefore the structure is based on the following topics:

- Sourcing, production and distribution
- Transportation of goods
- Product developments

The in-depth interviews and follow-up questionnaire aim to answer the fourth as well as the fifth research sub-question. Additionally, by conducting interviews and a questionnaire with shippers this thesis is intended to start a structured dialogue between Seabury and shippers which should lead to a periodic participation and continuous feedback on the latest trends in the future.

Descriptive statistical data analysis

Apart from the interviews and the questionnaire, a **descriptive statistical data analysis** will be conducted to be able to make quantifiable statements about the possible impact of certain supply chain trends on the air cargo industry. Therefore, this analysis also aims to answer the fifth research sub-question.

Interrelations of the research methods

The literature review serves as a basis for the entire research. By gathering a list of current and near term future supply chain trends, the literature review is used prior to the other two methods and furthermore serves to validate the need for this research. On the basis of the literature review, in-depth interviews will be conducted to qualitatively assess the gathered supply chain trends in the context of large shippers. The analysis of these interviews sets the ground for a follow-up questionnaire which enables the researcher to quantify the prior findings of the interviews. In the end, a descriptive statistical data analysis is performed to gain conclusions about the impact of supply chain trends that derive from customs data which are less biased than the preceding interviews and questionnaire results.

By employing this approach, findings of the interviews and follow-up questionnaire as well as the descriptive statistical data analysis can provide feedback on the completeness of the literature review and aim to validate or falsify some of the supply chain trends. Furthermore, it is tried to put the supply chain trends in a time-related context by assessing if trends are ongoing or emerging within the next three to five years.

1.6 Research Material and Data

In this section the required research material is described which is needed to conduct the research project. This section also gives insights on how and where the research material is gathered from.

Literature review

Literature will be used as a knowledge source in which authors describe their theoretical findings (Verschuren and Doorewaard, 2010). Due to the complexity and the abundance of supply chain trends as well as the time constraint to finish the research project within a predefined time span, a selected amount of literature per trend will be analyzed. The main form of literature will include scientific papers as well as monographs and editorial volumes. However, since the focus of the literature review is on drivers and supply chain trends, it is also essential to include trade magazines as well as company reports, news magazines and newspaper articles in the literature search as well to be able to obtain knowledge on the most recent developments.

In-depth interviews

In total, 19 interviews were conducted with experts of three different industries. Most interviews are conducted by telephone since respondents were contacted globally. For experts located in the Netherlands it was tried to arrange face-to-face interviews to be able to identify non-verbal signs from the respondent (Sekaran and Bougie, 2009).

As a sampling frame, multinational companies operating in industries where air freight plays a significant role are chosen. Therefore, shippers within the high tech industry (computing, telecommunications, imaging and semiconductor) as well as automotive industry but also pharmaceutical, responsible for nearly 27% of all air freight shipments by weight and about 56% by value, are of special interest (Seabury, 2013a). Experts should hold a managerial position within supply chain functions such as purchasing, procurement, forwarding or distribution. The interviewees will be drawn on a judgmental basis taking into account their position within the company and their experience. It has to be acknowledged, by using a judgmental sampling technique, findings cannot be generalized to the total population and therefore lower the external validity of the research findings (Kotzab, 2005).

Follow-up questionnaire

After conducting in-depth interviews, a follow up questionnaire will be administered to obtain a quantitative perspective on the perception of certain trends. Opposed to mail or postal questionnaires, a web-based questionnaire of 'Surveymonkey' is used. The advantages of web-based questionnaires compared to traditional mail questionnaires are a higher and faster response rate as well as lower costs (Griffis et al., 2003). Furthermore, web-based questionnaires have all data digitalized which closes the gap between paper and analysis software (Grant et al., 2005). The same experts from the in-depth interviews will be selected as the sampling frame. Additionally, supply chain managers which have not been interviewed will be used as a sample to be able to assess the data in a quantitative manner. Due to judgmental sampling of respondents, it is acknowledged that generalizability is comparatively low. Furthermore, it has to be mentioned that the follow-up questionnaire is used as a means to quantify the findings from the interviews of shippers on supply chain trends and not for the purpose of theory building. Therefore, the structure of the questionnaire is rather straight forward.

Descriptive statistical data analysis

To identify industries that are relevant for the air cargo industry as well as to quantify some of the impacts of supply chain trends on the air cargo industry, Seabury's cargo databases will be used. Seabury generates its databases from data of customs offices and the United Nations on

international freight movements. This data is compiled in its demand (Global *Trade (Air/Ocean)*, *Air Express*, and *Traffic*) as well as supply (*Capacity*) databases (Seabury, 2012b). For the purpose of this research project the *Global Trade* and *Air Express* database will mainly be used. More information on the databases of Seabury can be found in Appendix A and B.

The *Trade* database captures historical air and surface trade from 1994 onwards in terms of weight and value between 200 countries. For each trade lane, data is available for 2000 commodities such as laptops, cell phones or footwear. Apart from historical analysis, a five year forecasting module enables to forecast air and sea trade per trade land for 70 key industries.

The *Air Express* database is similar to the *Trade* database and comprises data on all transported express products. It provides data on express freight on trade lanes between 200 countries and 70 industries. Furthermore it allows a breakdown into 2000 commodities and distinguishes between small and large shipments. Express freight can be retrieved in terms of weight, value and number of shipments. Additionally, the *Air Express* database has a five year forecasting module.

1.7 Structure of the Report

This section describes the structure of this master thesis with the connection to research methodologies as well as the research questions and research objectives. The thesis is divided in nine chapters.

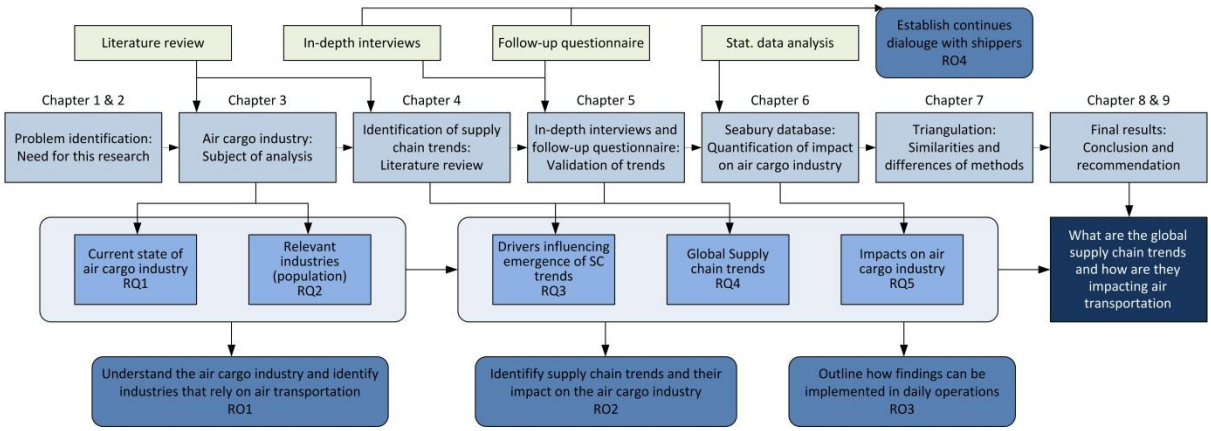


Figure 4: Thesis structure and the connection to research objectives and research questions

In Chapter 1, the research problem and the research objective is described. To be able to achieve the research objective in time, the scope of this research as well as research questions are formulated. After that, the research methodology and the necessary research material are identified.

In Chapter 2, trend research as a research methodology is described by defining what trends are and how trends can be analyzed. Different trend analysis techniques are compared with each other and the most suitable techniques for this kind of research are described in more detail.

Before, global supply chain trends can be identified, Chapter 3 will give a comprehensive introduction on the current state of the air cargo industry. In this chapter, recent air cargo statistics as well as current struggles will be described. The key market players and the air cargo environment will be explained. To determine the population of this master thesis, an analysis of relevant industries for the air cargo industry will be conducted. The chapter finishes by outlining the air cargo supply chain.

Chapter 4 represents an extensive literature review on drivers and supply chain trends. The drivers will be gathered using the STEEP framework while the supply chain trends can be categorized in four groups. After that, all trends and their connection towards each other will be mapped. Based on the identified supply chain trends, six potential impact criteria for the air cargo industry will be described. The chapter ends by selecting the trends that deem to have the highest impact on the air cargo industry which will further researched by means of interviews and a follow-up questionnaire.

In Chapter 5, the results of 19 in-depth interviews with different shippers of three industries will be presented. Additionally, the results of a follow-up questionnaire based on the findings of the interviews will be described.

Chapter 6 quantifies some of the impacts of certain supply chain trends on the air cargo industry by using Seabury's databases. This aims to quantify the snapshot of data gathered from a limited number of shippers by looking at official customs data that comprises the entire population.

Chapter 7 triangulates the different research methods. Thereby, similar but also opposing findings within the three different research methods (literature review, survey research and statistical data analysis) will be shown.

Chapter 8 discusses the findings of the literature review, the interviews, the questionnaire and the database analysis of the prior chapters and enables to formulate a thorough conclusions and recommendations for Seabury.

The last chapter reflects on the process of conducting this research. Thereby, it will be focused on problems that occurred during the project. Additionally, research limitations as well as future research opportunities will be discussed.

2. Trend Research as a Methodology

2.1 Introduction

"*Social Forecasting is of course notoriously chancy. Even in the field of meteorology, detailed predictions are not practicable for more than a few days ahead; and, if social or political forecasting is even harder, that should come as no surprise*" (Toulmin as cited in Buck et al, 2010, p. 5). This chapter aims to clarify what can be understood with the broad meaning of the term 'trend'. Therefore, the term trend will be discussed in its most generic form. After that the importance of trend research is outlined. The chapter finishes by identifying different methods for trend analysis and assessment. These methods and techniques will be compared with each other and a selection of methodologies will be explained in more detail. The result is the decision for the proposed trend assessment that will be done for the remainder of this master thesis.

2.2 What are Trends?

The term trend has numerous meanings in literature as well as in every-day life. It can be regarded as a gradual change due to certain conditions in a process or its output. In statistics a trend can be described as the general tendency of a series of data points that move in a certain direction over time. In the field of fashion, a trend is represented by a current style such as color or material.

According to Straube et al. (2010, p. 32), a trend can be understood as "*the tendency towards substantial changes in economic and social structures and processes that will take effect in the near future*". However, trends should not be mistaken as a temporary fashion or short-term fad as well as Zeitgeist movements (Buck et al., 1998; Straube et al., 2010). Müller-Stewens & Müller (2009) define a trend as a significant, time consistent and homogeneous development of one or more variables. They distinguish between a mathematical and a socioeconomically trend. The former understands a trend as a statistical time series while the latter refers to textual development which is built up of various phenomena.

Additionally to the abovementioned definition, trends can be regarded as complex and multidimensional phenomena that have a high degree of impact. Trends are mostly context-dependent and are linked and mutually impacting other trends. Often one trend engenders a trend in the opposite direction. For instance, if companies react to certain environmental changes other companies might not react to such changes at all. Furthermore, trends usually have a long often perennial duration of effects which distinguishes them from hypes or fashion trends which last only for a short time period. Lastly, Müller-Stewens & Müller (2009) argue that trends are characterized by a high stability over time and their development can therefore be predicted with a high accuracy. To distinguish trends from each other, Straube et al. (2010) differentiate trends among their duration and the scope of their impact. The shortest interval of a trend can be as little as a season while by assuming a certain degree of stability the development of trends can only be researched up to five years. In terms of scope, Straube et al. (2010) distinguish between social trends (cultural and social changes), consumption trends (impact of social trends on goods and services) and industry trends (developments within a sector). Buck et al. (1998) distinguished trends according to the time span (short-term, long-term), the degree of concentration (niche, broad) as well as trends that develop in the surroundings of corporations (exogenous trends) and trends that are set by corporations (endogenous trends).

As already mentioned earlier, trends can be compared by looking at their development over time and by their degree of impact. In Figure 5, the degree of impact of different types of trends over time is illustrated. A so-called *hype* has a very short lifecycle, while it achieves a rather high importance which diminishes quickly over time. Most *niche trends* do not reach a certain threshold or become a *broad* or *'real' trend* by advancing beyond a predefined range of scope (Straube et al., 2010). *'Real' trends* achieve the trend threshold, usually slower than hypes but have a longer life cycle. The graphical distribution is characterized by a parabola or hyperbola. Most *fashion trends* have a sinus-like distribution and their impact fluctuates over time.

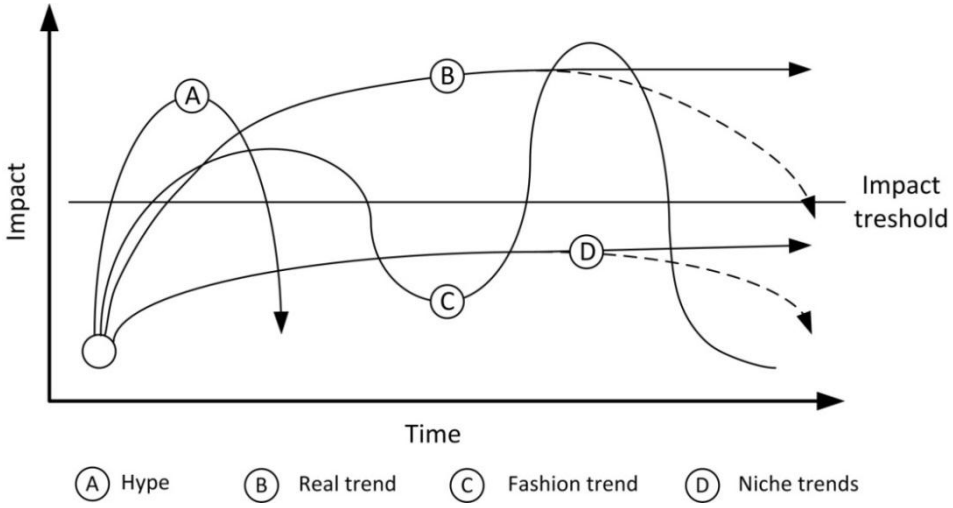


Figure 5: Trends and their impact over time

To capture the most relevant trends Buck et al. (2010) argue to focus on the center of the trend environment, as illustrated in Figure 6. Trends in the center have an intermediate time span and an intermediate degree of impact and penetration. In comparison to short term fashion trends and hypes but also in relation to long-term niche trends and general tendencies, trends within the center have relative high trend relevance since the degree of penetration is large enough to justify sunk costs and not too high to be able to differentiate from competitors.

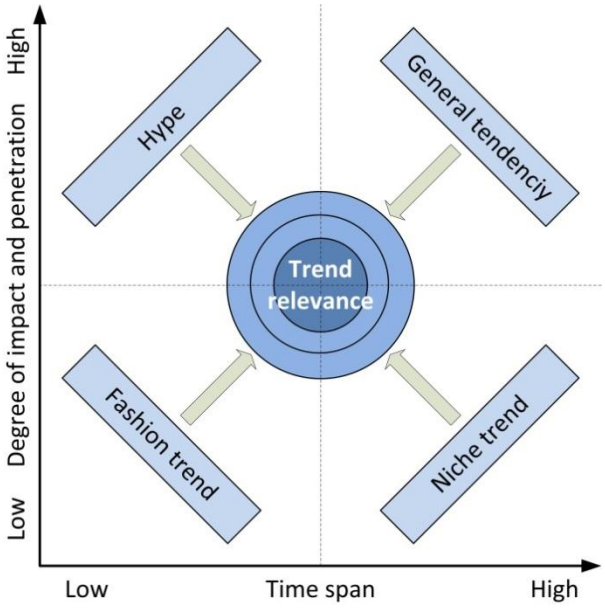


Figure 6: Trend concentration (adapted from Buck et al., 2010)

2.3 Importance of Trend Research

Due to the increased pressure of being innovative to stay competitive as well as a higher need for strategic decision making within the last years it becomes more important to develop methods and insights in the field of trend research. Trend research can be defined as the identification and interpretation of social, economic, technological and cultural developments. The aim is to identify, interpret and assess relevant shifts and change processes as soon as possible by using quantitative and qualitative research methods (Müller-Stewens & Müller, 2009). The importance of trend research is also illustrated in a survey of McKinsey (2008) conducted among 1,300 executives. Around 70% of the respondents reported that the importance of global trends for strategic decision making is increasing. However, only 17% of respondents which are actively acting upon trends can report significant benefits. While trend research tries to focus on what will happen if a current development will continue in a similar way, the field of future studies focuses on how the future might look like and what needs to happen in order to achieve certain future scenarios (Müller-Stewens & Müller, 2009).

2.4 Trend Analysis

After discussing the term trend, it is now important to explore different assessment methods within the field of trend research. In general, trend analysis can be understood as the practice of collecting information and trying to identify a pattern or development within this information. To be able to identify the most appropriate method or technique, to analyze supply chain trends impacting the air cargo industry, a review of different methodologies is given. The chosen method should be in compliance with the capabilities and resources of the researcher as well as the objective of the problem owner.

In literature, various scholars tried to distinguish different methodologies of trend analysis. One way to classify trend methodologies is by distinguishing contrasting pairs such as quantitative versus qualitative as well as normative versus explorative (Steinmueller 1997). Makridakis et al. (1983) explored quantitative methods like time series and causal methods. However, such methods require the existence of quantitative data which deems to be difficult for this kind of research. Hammer (1998) identified quantitative methods such as trend extrapolation, regression as well as input-and-output analysis. Within qualitative methods he distinguishes between normative methods such as relevance trees and system analysis as well as explorative methods like Delphi, scenario planning and historical analogies. A simple taxonomy of trend research methods can be seen in Table 1. While Hammer already distinguishes between normative and explorative methods for qualitative data, Gordon (1992) allows the combination of normative and quantitative trend research methods.

Table 1: Outline of trend research methods (Gordon, 1992)

	Normative	Explorative
Quantitative	• Scenarios • Technology Sequence Analysis	• Scenarios • Time Series • Regression Analysis • Multiple-Equation models • Probabilistic models - Trend-Impact - Cross Impact - Interax • Non-linear models

Qualitative	• Scenarios • Delphi • In-depth interviews • Expert group meetings • Genius • Science Fiction	• Scenarios • Delphi • In-depth interviews • Expert group meetings • Genius

Gordon (1992) sees the left hand side of the table as the space for visionaries who either express their views of how the future should be in terms of numbers (quantitative) or without numbers (qualitative). The lower right quadrant expresses the possible future in non-numerical terms while methods in the upper right quadrant employ mathematical models on how the future might be.

This simple classification was extended by Gordon and Glenn (2004) within the Millennium Project Version 2. Again it was distinguished between a quantitative versus a qualitative technique and a normative versus an explorative approach. The table presented underneath serves as a taxonomy of methods and shows their most common field of usage. For a short description of each methodology please refer to Appendix C.

Table 2: Taxonomy of trend research methods according the output (Gordon and Glenn, 2004)

Method	*By technique*		*By Purpose*	
	Quantitative	*Qualitative*	*Normative*	*Explorative*
Agent Modeling		X		X
Bibliometrics/Text Mining	X	X	X	X
Causal Layered Analysis		X		X
Cross-Impact Analysis	X			X
Decision Modeling	X			X
Delphi Techniques		X	X	X
Econometrics and Statistical Modeling	X			X
Environmental Scanning		X		X
Field Anomaly Relaxation		X		X
Future Wheels		X	X	X
Genius Forecasting, Vision and Intuition		X	X	X
Multiple Perspectives		X	X	X
Participatory Methods		X	X	
Relevance Trees & Morphological Analysis		X	X	
Road Mapping		X	X	X
Scenarios	X	X	X	X
Simulation-Gaming		X		X
State of the Future Index	X	X	X	X
Structural Analysis	X	X		X
System Dynamics Modeling	X			X
Technological Sequence Analysis		X	X	
Trend Impact Analysis	X			X

To classify methodologies by its technique and its purposes has two advantages (Steinmüller, 1997). First methodologies can be demarcated by identifying the required data (quantitative versus qualitative) which clearly limits the usage of certain methodologies. Secondly, by distinguishing between a normative and explorative approach one can either focus on how the desired future should be (normative) as well as explore how the future might be (explorative). The most recent work of Gordon and Glenn currently accumulates up to 37 different methodologies for trend research which can be closely related to each other and often be used in combination.

Apart from the work of Gordon and Glenn is it also possible to classify different methods for trend research in relation to inductive, deductive and intuitive methodologies as well as the non-restrictive creation of ideas through associations (Steinmüller, 1997). While trend extrapolation, Delphi and decision trees are regarded as inductive methods, trend and structural analysis as well as game theory and morphologic analysis are viewed as deductive methods. Examples of intuitive methods which usually are non-formalistic are scenario technics or simulation and modeling. Brainstorming and science fiction are regarded as the non-restrictive creation of ideas through associations.

Graham May classified trend and foresight methods according their approach they take on the future: foreseeing, managing and creating (Karlsen & Karlsen, 2013). In Table 3, the classification is summarized by looking at the approach, concept, method and assumption. Foreseeing tries to predict the future in advance and therefore obtains knowledge about the future before events occur based on the assumption of predictability. Managing the future acknowledges the unpredictability of the future and therefore tries to manage change. Creating assumes that the future can be shaped and hence is dependent on certain actions of human beings.

Table 3: Taxonomy of trend research methods according the approach to the future (Karlsen & Karlsen, 2013)

Approach	*Concept*	*Method*	*Assumption*
Foreseeing	Prediction	Surveying	Predictability
	Extrapolation	Linear input-output Analysis, Time-series analysis	Stability/consistency
	Analytical forecasting	Integrated assessment	Modeling ingenuity
Managing	Judgmental	Delphi, Expert panels	Expert opinion
	Forecasting	Cross impact, Input-output analysis	Interactions
	Management	Integrated assessment scenarios, Cost-benefit analysis	Analytical skills
Creating	Policy Making	Relevance tree, Back casting, Road mapping	Logical steps
	Speculation	Trend spotting	Imagination
	Imaging	Brainstorming	Creativity

Apart from the proposed classification attempts, Zografos & Giannouli (2001) identified Delphi, pairwise comparisons techniques, fuzzy analytic hierarchy process (AHP) and focus group discussions as viable methods to research trends especially in relation to logistics and supply chain management. Furthermore, Tsai & Chi (2010) used a bibliometric analysis to examine journals of the social science citation index (SSCI) database whereby logistics and supply chain trends can be identified by the frequency of keywords used by authors.

It can be concluded that there is an abundance of different methodologies available to research and analyze trends and the future. In the following part, four methods will be reviewed in more detail as these methodologies deem to be well suited to research supply chain trends and their impact on the air cargo industry.

2.4.1 Environmental Scanning

Scanning the environment for changes is always necessary to identify new developments which might contest historic assumptions or enable new views on future developments. In every trend research, a fundamental practice is to first scan the environment to figure out what remains constant, what is changing and what is constantly changing (Gordon & Glenn, 2003).

According to Gordon & Glenn (2003) environmental scanning can consist of methods such as e*xpert panels, database literature reviews or tracking of key persons.*

Within an expert panel, participants are asked about their view on important developments which are currently evolving or expected to evolve. Panels are in general similar to Delphi studies. However, panels are done in a systematic and periodic way which means that participants come together and have various discussions over time. Therefore, participants of a panel are known among each other.

With the help of the internet, an abundance of different databases can be accessed to review citations, abstracts or full texts. Multiple keyword search engines enable to scan the directory of different databases. Besides peer-reviewed databases such as ebscohost.com or sciencedirect.com where many scientific articles are stored, one can also access newspaper articles, trade journals or industry related magazines. This approach of environmental scanning equals the necessary literature review that is most often conducted for any scientific research. One drawback of the exponential growth in literature databases is the difficulty of maintaining an overview of current findings as well as the quality and reliability of certain claims.

Gordon & Glenn (2003) further argue it is efficient to 'scan the scanners'. This means, it might be beneficial to sign up for industry newsletters or visit websites of key persons in a certain field to track their thoughts and information.

2.4.2 Delphi

The Delphi technique was first introduced by the RAND Corporation in the 1960s to address the potential of future military technology. In the classical Delphi study, experts are identified based on their expertise to the researched topic. The anonymity of respondents is usually guaranteed. After that, a number of sequential questionnaire rounds are conducted whereby questions are adapted to statements between the respondents in earlier rounds. The aim is to find a consensus between the respondents on a certain topic. Due to the small number of participants, Delphi studies do not aim to be statistical representative. The value of Delphi studies is the generation of different ideas that cause consensus or not. Furthermore, it is important to identify the right respondents that have the needed knowledge.

According to Gordon (2003a), classical Delphi studies are difficult to conduct since questionnaires need to be accurately prepared and pre-tested to reduce ambiguity. Due to the many rounds of questionnaires, Delphi studies also tend to be quite time consuming. Therefore, Gordon (2003a) proposed to use in-depth interviews to obtain the view of experts on certain issues. Again experts are selected and invited for participation. The anonymity of their answers should be assured and a report of the interview could be delivered to them. If there are two rounds of interviews, feedback can be used to adapt interview questions. However, the majority of this kind of Delphi studies only includes one round of interviews. Again, the findings of the interviews are usually not statistically significant but represent an excellent means to obtain the views of experts regarding a certain issue.

2.4.3 Scenario Planning

Scenario construction or scenario planning goes back to Herman Kahn of the RAND Corporation in relation to military and strategic studies in the 1950s. He distinguished between three different scenarios (Glenn, 2003):

- Surprise-free or business-as-usual scenario where trends are extrapolated
- Worst case scenario based on mismanagement or bad luck
- Best case scenarios based on good management or good luck

Shell was one of the first corporations that employed scenario planning in the 1970s to anticipate fluctuating oil prices. Nowadays, public and private entities use scenarios for strategic planning processes and decision making.

Glenn (2003, p.2) defines a scenario as a *"story that connects a description of specific future to present realities in a series of causal links that illustrate decisions and consequences"*. Glenn also mentions that scenarios are often mistaken with projections and forecasts. Projections and forecasts are part of scenarios which discuss the cause and effect of scenarios. Scenarios usually entail a certain issue and a specific year and describe what might occur and how this development could evolve from the present.

There are numerous ways how to create scenarios ranging from simple to complex as well as from quantitative to qualitative. However, most techniques require the understanding of the system of interest and its environment and evolving trends as well as driving forces and possible events that deem to be critical for the system (Glenn, 2003). The main value of scenarios is to identify existing trends and uncertainties and combine them to draw pictures of the future, but not taking all possibilities in to account. Furthermore, scenarios should establish different types of futures and not variations of the same (Schwarz, 2008).

2.4.4 Trend Impact Analysis

Trend impact analysis (TIA) was developed in the 1970s by using historical data as a baseline which is extrapolated taking into account perceptions and developments that could have a severe impact on the future. Therefore, TIA opposed to trend extrapolation is not surprise free (Gordon, 2003b). To properly use TIA it is necessary to build a database of potential external forces or events with their probabilities and their corresponding impacts. The events can originate within the political, economic, demographic, technological, environmental or societal sphere.

TIA consists of two fundamental steps. The first is to extrapolate a surprise free trend. Secondly, expert judgment is used to identify a set of events which could deviate from the surprise free extrapolation.

One advantage of TIA is that the analyst needs to identify certain future events and therefore cannot predict the future on blurry assumptions. On the other hand, TIA requires quantifiable data to be able to extrapolate the trend. Also, the list of events will most certainly never be complete and additionally leaves doubt about the accuracy of the used probabilities and their impacts (Gordon, 2003b).

2.5 Selection of Research Methods

In the previous sub-chapter four methodologies for trend research have been discussed in detail. The following part will explain the selection of two of those methodologies for this master thesis. The sequence as well as their relation towards each other is also discussed.

To comply with the research objective and to take into account the nature of this research, it is decided to first conduct an extensive literature review which is followed by a round of in-depth

interviews and a follow-up questionnaire. The databases of Seabury will be employed to quantify the impact of certain supply chain trends. Figure 7, illustrates the sequence and main goals of each method.

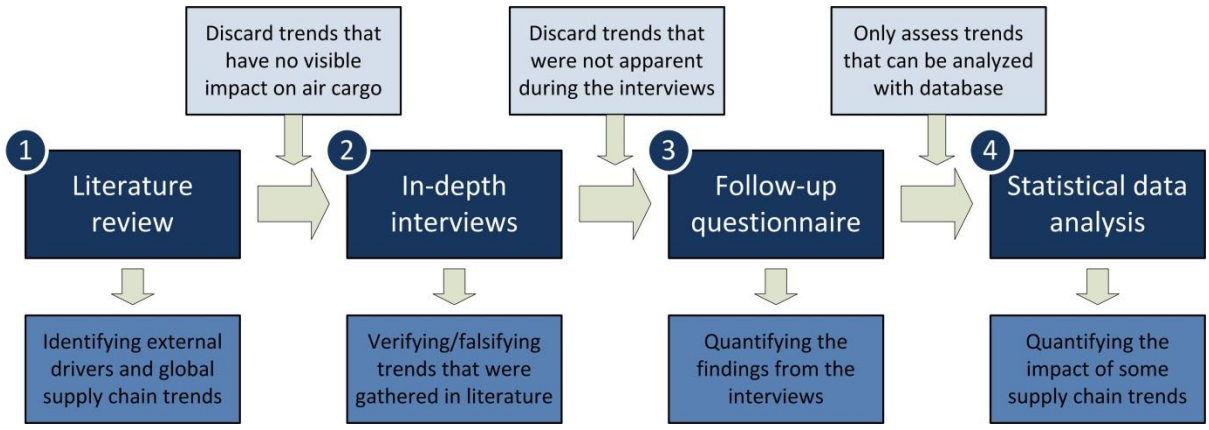


Figure 7: Research methods

The basis of this master thesis is an extensive literature review on supply chain trends and is similar to the environmental scanning of the aforementioned research methods. During the literature review, a comprehensive list of supply chain trends is gathered. These trends are analyzed in terms of their possible degree of impact on the air cargo industry in regard to six impact criteria (see Chapter 4.6). Supply chain trends that deem to have no major impact on the air cargo industry are discarded and will not be taken into account for the remainder of this thesis.

The supply chain trends which have an impact on the air cargo industry are tested in the course of in-depth interviews with experts of shippers that belong to one of the following industry sectors: high tech, pharmaceuticals or automotive. The interviewees are questioned on the appearance or development of certain supply chain trends in their company and on the potential impacts on the air cargo industry. Hence, several trends from the literature review will be verified or falsified. Furthermore, new trends might be identified in the course of the interviews that were not found during the literature review. The trends which will not be evident from the interviews will be discarded from a further analysis. Trends that were apparent from the interviews will be quantified in form of an online questionnaire that is send to shippers. The interviews as well as the follow-up questionnaire can be regarded as a similar approach as the modified Delphi study described by Gordon (2003a). Conducting interviews and sending a follow-up questionnaire is regarded the most effective way to get into contact with shippers to start a continuous process of knowledge sharing between Seabury and the shipper community. In this way, this approach also serves to fulfill the last research objective.

Trend impact analysis is not chosen as a research method since it deems impossible to acquire a large set of quantitative historical data on the appearance or development of certain supply chain trends which can be used to extrapolate the data into the future. To leave the environment of surprise-free projections, TIA also requires taking into account future events, their probability and impact. To come up with a list of events that should consists of 10 to 40 events, should be done by conducting a literature research and interviews with experts. After that, the probability and the impact of each event needs to be identified. Apart of the lack of quantitative data, TIA is considered as not suitable for this research for two more reasons. Conducting interviews with experts to identify the events would exceed the scope of this research in terms of the projected time frame for

completion in six months. Also, it is difficult to find specific future events that will evolve within the time scope of the next three to five years.

Scenario planning is not used as a research method for the following reasons. The time scope of a scenario is usually beyond five years and hence focuses on long term issues (Wulf et al. 2010). For this research the time scope of trends was set to be the next three to five years. Such a short time horizon bears the possibility to only describe a current snapshot of the present. Furthermore, scenarios usually rely on the findings of unstructured interviews (Shell, 2008). Therefore, scenario planning is considered a vital option to be done after completion of this research, especially if the time scope is set to be longer than five years.

2.6 Chapter Conclusion

As seen from the analysis above, there is not a consistent and continuous classification of methodologies. Methodologies are developed and used in respect to various and often random viewpoints (Steinmüller, 1997).

Most of the proposed methods, especially quantitative methods such as TIA, require a certain amount of quantifiable data to assess the expected developments of trends. However, it deems to be very difficult in respect of the proposed study to obtain data in absolute terms i.e. to find out how many companies out of the total are responding to certain drivers with a particular trend. Because of the limitation to be bounded to quantitative data, TIA is not used in this master thesis but deems to be a good method if quantitative data is available. Furthermore, most methods are complex and sophisticated and therefore require the knowledge to use them as well as the involvement of decision makers to obtain the required data.

Based on these limitations, it is decided to first conduct a comprehensive literature review on supply chain trends. Besides this literature review, experts will be consulted by conducting in-depth interviews as well as a follow-up questionnaire with decision makers inside the shipper community. This is done to assess the proposed trends which were found during the literature review as well as identifying new trends which were not revealed during the literature review. The consultation of experts closely relates to the methodology of Delphi study by conducting in-depth interviews in a first round and a follow-up questionnaire in a second round. This methodology also fits the objective of this research project to start a continuous dialogue between Seabury and the shipper community of different industries. After the consultation of experts, Seabury's database will be used to quantify the impacts of some supply chain trends.

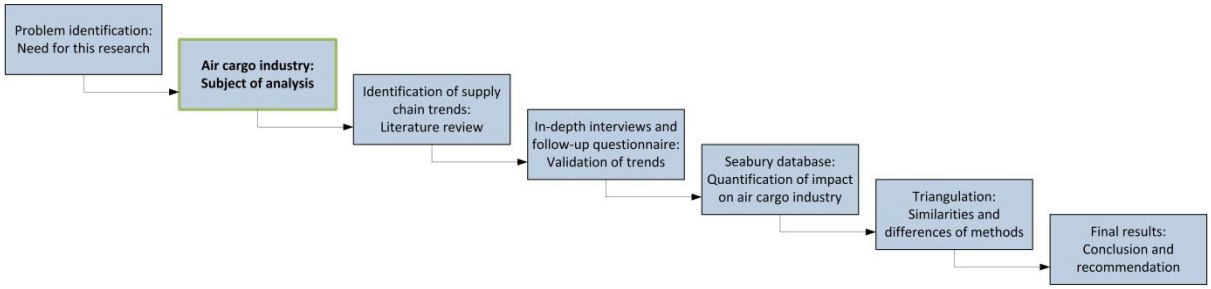
As already mentioned above, TIA is not used due to a lack in qualitative data. Scenario planning will also not be employed but deems to be a well suited methodology for trend research after consulting experts to draw up conclusions of the connection between the different supply chain trends.

3. Current State of the Air Cargo Industry

3.1 Introduction

The first air cargo shipment was most likely in 1910 when Glenn Curtiss flew a sack of mail from New York to Albany (Wensveen, 2011). Of course, today's air cargo industry cannot be compared to the pioneering-times more than a century ago. Within the last 100 years the air cargo industry became more complex and is imbedded in the logistics operations of shippers sending time-sensitive, valuable or perishable goods. This chapter aims to give a comprehensive introduction into the air cargo industry and consequently tries to answer the first sub-question: *What is the current state of the air cargo industry?* This is necessary since global supply chain trends impacting the air cargo industry is the focus of this master thesis. By identifying the population of this research it is tried to answer the second sub-research question. It is also tried to identify industries that are relevant for the air cargo industry. These industries represent the population of this master thesis.

The chapter will start with describing statistics of the air cargo industry in regard of growth, changes in regional share and major trade lanes of air cargo. After that, the key market players within the air cargo industry are defined and special emphasize is placed on their convergence in terms of geographical coverage and offered products within the last decades. This is followed by an analysis of typical pre-conditions of goods prone to be transported by air. An examination of the market environment in which the air cargo industry operates is conducted to understand what the current enablers and constraints of growth and decline in the industry are. This is complemented by addressing political milestones that lead to today's development of the air cargo industry. After that, relevant industries are examined which define the population of this master thesis. The chapter finishes by looking at current struggles within the cargo industry and describing the air cargo supply chain in detail.



3.2 Air Cargo Statistics

Over the last ten years, air cargo as well as passenger ton-kilometers, grew steadily with a compound annual growth rate of 3.4% and 5.7% respectively (IATA, 2012; 2013a). Even though, the time period from 2002 to 2011 included two major financial downturns one being at the beginning of the 2000s and the second being the financial crisis from 2008 to 2009. From Figure 8, which shows the ton-kilometers of passengers and cargo (scheduled freight including mail) as well as their annual growth rate among IATA member airlines, it can be seen that air cargo usually decreases before passengers but also recovers earlier. Furthermore, air cargo responds more volatile than passenger services. For instance, despite the beginning of the financial crisis in 2008, passenger ton-kilometers still grew by 1.0% whereas the amount of air cargo declined by 3.3%. The following year, air cargo deteriorated by 9.7% whereas passenger ton-kilometers only depreciated by 0.7%.

However, in 2010 air cargo retreated by a growth rate of more than 18.4% and the throughput of freight ton-kilometers was higher than before the financial crisis.

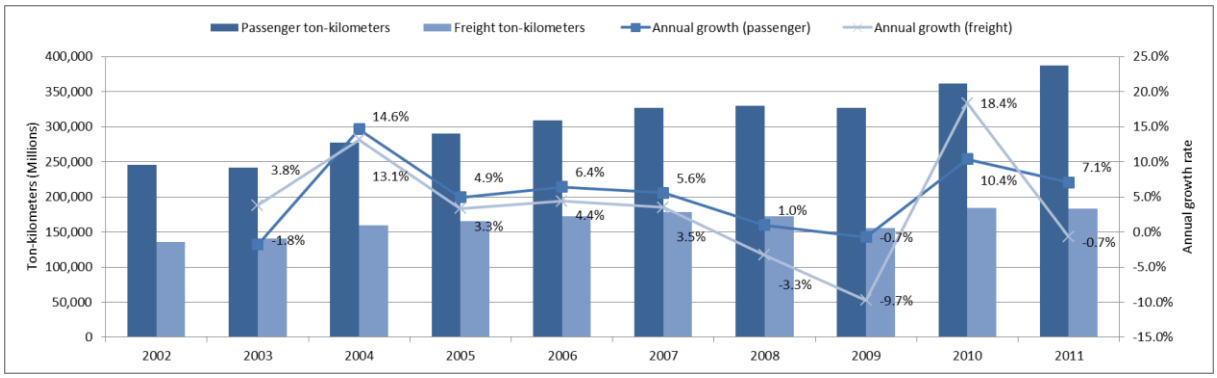


Figure 8: Total passenger and freight ton-kilometers from 2002-2011 (Source: IATA, 2012; IATA 2013a)

Until the 1970s airlines from North America and Europe were responsible for nearly 75% of all air cargo traffic (see Table 4). 30 years later this dominant position has vanished, especially since East Asian and South East Asian carriers increased their market share exceptionally. This rapid growth is connected to the increase in manufacturing capabilities and the export focus of emerging economies such as China, Taiwan, South Korea and Singapore. Therefore, the main air cargo markets have been shifted to Asia and their carriers are now responsible for the transportation of 43% of global freight. This dominance is also visible by the fact that in 2011, five of the top ten international freighter carriers, measured by revenue ton-kilometers, were located in Asia (see Table 7). Due to the perfect location in the world, carriers from the Middle East also increased their market share within the last 30 years. It has to be acknowledged that Table 4 only includes international freight and neglects especially the domestic freight within the United States of America which contributes to one tenth of global air traffic (see Table 5).

Table 4: Changing regional distribution of freight (Doganis, 2010; IATA, 2012)

Region of airline	*Regional share of international freight ton-kilometers*	
	1972	*2011*
Europe	44.8%	24.8%
North America	29.0%	15.9%
Asia and Pacific	12.3%	43.4%
Middle/South America	5.8%	3.0%
Middle East	5.0%	11.6%
Africa	3.1%	1.4%
World	100.0%	100.0%

In 2011, 85% of the world's total air cargo was transported on international routes. The remaining 15% were generated by domestic freight of which freight movements within North America especially within the United States accounted for two thirds (see Table 5). Furthermore, air freight is dominated by three major trade lanes accumulating more than 60% of international freight. This means that every fourth good travelling by air on an international route is sent from Europe to Asia or vice versa. The second strongest route is between North America and Asia. As already discussed earlier, the trade lane between Europe and North America has been losing its importance. Doganis (2010) argues that the largest international cargo airlines need to be involved in at least two of these routes to be a global market player.

Table 5: Major scheduled freight markets in 2011 (Source: IATA, 2012)

Route area	*Share of freight ton-kilometers*	
	% World total	*% International*
Europe Asia	20.9%	24.6%
Trans-Pacific	18.5%	21.8%
North and Mid Atlantic	13.5%	15.8%
Intra-Asia (International)	8.8%	10.4%
Europe-Middle East	4.1%	4.8%
Middle East-Asia	4.3%	5.1%
Other	15.0%	17.6%
Total International	85.2%	100.0%
North America Domestic	10.0%	
Asia domestic	3.9%	
Other domestic	0.9%	
World Total	100.0%	

Consequently, the largest cargo airports are located along or within these major trade lanes. In Table 6, the top 20 cargo airports are listed and the growth/decline is compared to 2010. The amount of cargo includes loaded and unloaded freight as well as mail. Most of the airports in this list also function as a hub for their home carriers. For instance, Hong Kong serves as the hub of Cathay Pacific while Dubai is mainly used by Emirates. Memphis and Louisville, both located in the United States of America are rather local passenger airports. Still, they serve as the hub for the two largest integrators FedEx and UPS respectively and hence have a high air cargo throughput. Anchorage in Alaska, also handling only a rather small amount of passengers per year is used by both integrators as a secondary hub especially for express cargo from Asia. Therefore, Anchorage serves as a critical consolidation and distribution point for air freight between Asia and North America where goods go through customs and are sent to their final destination. In 2011, most of the cargo throughput at Asian airports declined except for Beijing, which changed from an export airport towards an import airport. Furthermore, many secondary airports within China such as Guangzhou (ranked 21), Shenzhen (ranked 24) and Chengdu (ranked 44) increased the amount of cargo handling above average. The largest growth rates of cargo from 2010 to 2011 appeared at Frankfurt Hahn (33%), Cincinnati (29%) and Leipzig (16%) where DHL has its European freight hub. Furthermore, the amount of cargo handled at airports in the Middle East such as Jeddah, Riyadh and Doha increased remarkably.

Table 6: Largest freight airports in 2011 (Source: IATA, 2012)

	Airport (IATA Code)	*Cargo handled (tons)*	*Change*
1	HONG KONG, HK (HKG)	3,968,397	-4.7%
2	MEMPHIS TN, US (MEM)	3,916,535	0.0%
3	SHANGHAI, CN (PVG)	3,103,030	-4.3%
4	ANCHORAGE AK, US (ANC)	2,625,201	0.5%
5	INCHEON, KR (ICN)	2,539,222	-5.4%
6	DUBAI, AE (DXB)	2,269,768	0.0%
7	FRANKFURT, DE (FRA)	2,215,181	-2.6%
8	LOUISVILLE KY, US (SDF)	2,187,766	1.0%
9	PARIS, FR (CDG)	2,095,773	-4.0%
10	TOKYO, JP (NRT)	1,945,110	-10.3%
11	SINGAPORE, SG (SIN)	1,898,850	3.1%
12	MIAMI FL, US (MIA)	1,840,231	0.2%
13	LOS ANGELES CA, US (LAX)	1,688,351	-7.2%
14	BEIJING, CN (PEK)	1,668,751	7.7%

15	TAIPEI, TW (TPE)	1,627,461	-7.9%
16	LONDON, GB (LHR)	1,569,450	1.2%
17	AMSTERDAM, NL (AMS)	1,549,686	0.8%
18	CHICAGO IL, US (ORD)	1,506,117	1.0%
19	NEW YORK NY, US (JFK)	1,358,410	0.7%
20	BANGKOK, TH (BKK)	1,321,842	0.9%

3.3 Key Market Players of the Air Cargo Industry

The air cargo industry consists of three different services as depicted in Figure 9. Large freight services are usually shipped by airport-to-airport carriers such as *combination carriers* or *all-cargo carriers*. A rather new business model is the wet-lease provider that leases its aircrafts on an aircraft, crew, maintenance and insurance (ACMI) basis to airlines. This enables airlines to operate aircrafts under their name without having the financial burden of owning the aircraft and to respond more flexible to changes in demand. Freight forwarders are not necessarily flying goods from one point to another but they are largely involved in the complete value chain. The express market is dominated by integrators that offer door-to-door services of usually more time-definite and smaller shipments. The last service consists of the transportation of mail and documents which is usually carried by national postal authorities.

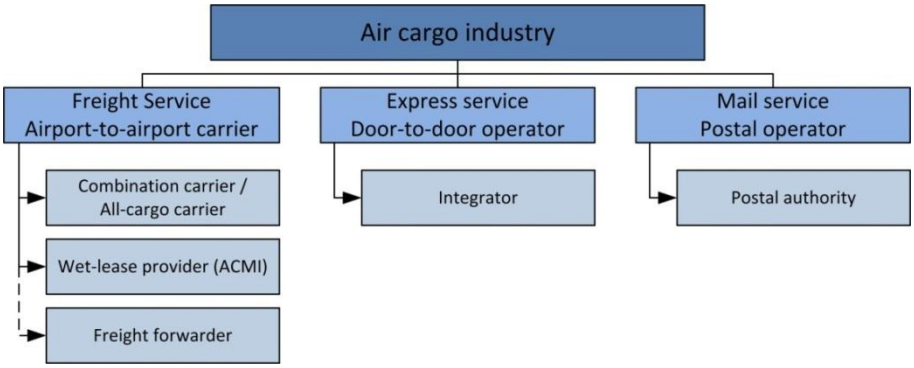


Figure 9: Key market players within the air cargo industry (Doganis, 2010; Scholz, 2011)

For the purpose of this master thesis, impacts of supply chain trends will only be investigated for airport-to-airport operators (combination/all-cargo carriers), integrators and freight forwarders. Postal authorities are neglected since for long international distances postal authorities often use combination carriers to transport their mail. Furthermore, due to liberalization of transport regulations a growing share of documents and mail is shifted from postal authorities to integrators (Doganis, 2010). Wet-lease providers usually lease their aircrafts to combination or all-cargo carriers which therefore can respond more flexible to seasonal or cyclical demand changes. The cargo capacity is not sold directly to end customers by the leaser but by the lessee. However, transports are operated on behalf of the combination carrier (Scholz, 2011). Since the flights operated by a wet-lease provider are fully integrated in the network of the lessee both business models are not necessarily competitors (Scholz, 2011). Therefore, the business model of ACMI will not be further analyzed in this master thesis.

For the remaining three business models a short analysis follows.

Airport-to-airport carrier

The biggest group of airport-to-airport carriers are *combination carriers* that transport passengers and cargo. Cargo is transported in freight holds (belly hold) of scheduled passenger flights. However, routes are determined by passenger demand and cargo is often seen as a by-product. Therefore, some combination carriers operate also all-cargo flights with dedicated freighter aircrafts. In addition to combination carriers, *all-cargo carriers* operate scheduled cargo services as well as ad hoc cargo charters. All-cargo flights can transport larger shipments on their main deck that do not fit in the 'belly' of an aircraft. Furthermore, these freighter aircrafts often have hinged tails or noses that allow for a straight loading of large shipments. Nevertheless, it becomes more difficult to distinguish between combination carriers and all-cargo carriers since some airlines demerge their cargo division as separate entities with their own staff, pilots and fleet. For instance Lufthansa Cargo operates scheduled cargo services on their own behalf. Still, it has to pay for belly-hold on the passenger flights of their parent airline Lufthansa. Airport-to-airport carriers usually transport larger shipments that do not necessarily require expedited transport. Yet, many airport-to-airport carriers extended their product portfolio with time-sensitive, cool-chained or other specialized services. Combination and all-cargo carriers usually operate on a global scale from its home base. Since air freight usually does not mind stopovers along the way, as opposed to passengers, complex rotations are flown to maximize yield and load factors of each aircraft. As a consequence, goods are also transported without originating or ending in the home country of the airline.

For the remainder of this master thesis, airport-to-airport operators are airlines (combination carriers and their affiliated cargo companies or all-cargo carriers) that transport cargo from airport to airport, while pre- and onward-carriage is contracted to another company.

Integrators

Integrators are the fastest-growing and most dynamic players in the air cargo industry. In comparison to airlines, integrators are vertically integrated transport providers that offer a door-to-door service with guaranteed delivery times (Doganis, 2010). Integrators can serve the entire logistics chain by using a large network of trucks for pre- and onward carriage as well as a pure cargo fleet with a network that is organized in a multiregional hub-and-spoke network employing a departure and arrival wave system (Scholz, 2011). Integrators use small, medium sized and large freighters to transport their cargo. From 1992 to 2011, the international express share of total world air cargo grew from 4.1% to 13.8% (Boeing, 2012). Whereas airport-to-airport carriers are largely fragmented and usually emerged from flag carriers of a certain country, there are only a few large integrators. For instance, the 20 largest cargo airlines transported 63% of all traffic in 2007 while the four big integrators FedEx, UPS, DHL and TNT together control about 80% of the express market (MergeGlobal, 2008a). Integrators are specialized in carrying express freight. However, within the last years they also expanded their services towards heavier consignments.

For the purpose of this master thesis, integrators are transport providers that offer door-to-door services from shipper to consignee, for express or time-sensitive shipments including documents, parcels or merchandise products by operating their own fleet of trucks for pre- and onward haulage and aircrafts for the main haulage.

Freight forwarders

A freight forwarder is an intermediary that connects a shipper with an airline, a shipping line or trucking firm and/or connects the consignee with one of these logistics services providers (Bowen & Leinbach, 2004). Usually freight forwarders are non-asset based which means that they do not own any aircrafts and therefore rely on airport-to-airport carriers for the physical movement of goods. Their role within the supply chain can also be compared to a travel agent for passenger flights (Doganis, 2010). Freight forwarders buy cargo capacity of airlines and sell it to shippers. Small shipments are consolidated by freight forwarders to bulk shipments which are transported by airlines. To further generate revenue, freight forwarders also offer value added services such as packaging, sorting, labeling, warehousing, inventory control, ground transportation and customs clearance. Large freight forwarders can also be integrated vertically to offer customers end-to-end solutions by planning and managing the supply chain of their customers. Some forwarders are even operating their own fleet of aircrafts to be able to generate higher yields but also to counteract to the growing dominance of integrators (Doganis, 2010). Still, the operation of own aircrafts is an exception. The importance of freight forwarders within the air cargo industry is reflected by the estimation that in 2007, 85% of all heavy air shipments (excluding mail and express services) were directly sold to shippers by freight forwarders leaving only 15% to airlines which actually offer most of the capacity in air freight (MergeGlobal, 2008b). Next to air freight, freight forwarders also sell capacity of ocean carriers and other transport modes to shippers. This enables a freight forwarder to offer a large variety of different transport possibilities to the same shipper.

For this master thesis, freight forwarders are defined as an intermediary between shipper/consignee and an airline by offering value added services such as the ground transportation between the customer's premises and the airport. Furthermore, they are responsible for the transportation of cargo from the point of receipt to the point of destination by contracting airlines or operating an own fleet of aircrafts for the main haulage of cargo.

Largest freight carriers

In Table 7, the top 20 IATA member airlines are ranked by international, domestic and total traffic measured in scheduled freight ton-kilometers. It is apparent that the largest carriers are the two major integrators FedEx and UPS. Both of these carriers generate more than half of their traffic on domestic routes within the United States of America. Another large integrator, DHL, is not listed within the top 20 since it ships some of its express freight on combination carriers such as Lufthansa or on its subsidiaries (Bowen, 2012). The large flag carriers such as Cathay Pacific, Korean Air, Emirates or Lufthansa follow in the list of the top cargo carriers since a large amount of cargo is shipped in the belly-hold of passenger flights and their cargo subsidiaries. The only all-cargo airline within the top 20 is Cargolux from Luxembourg. Within the domestic markets, cargo airlines of large territorial countries such as China, USA or Russia are represented. However, the amount of cargo shipped within a country is considerable low compared to international traffic besides the two integrators FedEx and UPS. Within the last years the cargo divisions of the Middle Eastern flag carriers such as Emirates SkyCargo (ranked 5) and Qatar Airways Cargo (ranked 14) grew above average triggered by their geographical centricity employing Sixth Freedom rights (see Chapter 3.5.2) between Europe, Asia, Africa and beyond (O'Connell, 2011). The large amount of wide-body jets which will be delivered in the upcoming years to Gulf carriers will further increase their importance within the air cargo industry (Vespermann et al., 2008).

Table 7: Top 20 IATA carriers ranked by traffic in 2011 (Source: IATA, 2012)

Scheduled freight ton-kilometers (Million)								
International			*Domestic*			*Total*		
#	Airline	t-km	#	Airline	t-km	#	Airline	t-km
1	Cathay Pacific (C)	9,109	1	FedEx (I)	8,335	1	FedEx (F)	15,939
2	Korean Air (C)	8,918	2	UPS Airlines (I)	5,036	2	UPS Airlines (F)	10,566
3	Emirates (C)	8,132	3	China Southern (C)	1,269	3	Cathay Pacific (C)	9,109
4	Lufthansa (C)	7,668	4	Air China (C)	934	4	Korean Air Lines (C)	8,974
5	FedEx (I)	7,603	5	China Eastern Airl. (C)	693	5	Emirates (C)	8,132
6	Singapore Airlines (C)	7,118	6	Hainan Airlines (C)	436	6	Lufthansa (C)	7,674
7	UPS Airlines (I)	5,530	7	All Nippon Airways (C)	428	7	Singapore Airlines (C)	7,118
8	China Airlines (C)	5,411	8	Shenzhen Airlines (C)	369	8	China Airlines (C)	5,411
9	EVA Air (C)	4,882	9	United Airlines (C)	341	9	EVA Air (C)	4,882
10	Air France (C)	4,700	10	Japan Airlines (C)	325	10	Air France (C)	4,702
11	British Airways (C)	4,677	11	Delta Air Lines(C)	308	11	British Airways (C)	4,681
12	Cargolux (F)	4,654	12	American Airlines (C)	302	12	Cargolux (F)	4,654
13	KLM (C)	3,699	13	TAM Airlines	213	13	Air China (C)	4,223
14	Qatar Airways (C)	3,641	14	Xiamen Airlines (C)	211	14	China Eastern Airl. (C)	3,935
15	Asiana Airlines(C)	3,577	15	Transaero Airlines (C)	209	15	KLM (C)	3,699
16	Air China (C)	3,289	16	Qantas Airways (C)	197	16	Qatar Airways (C)	3,641
17	China Eastern Airl. (C)	3,242	17	Aeroflot (C)	170	17	Asiana Airlines (C)	3,589
18	LAN Airlines (C)	3,139	18	Garuda Airlines (C)	157	18	China Southern Airl. (C)	3,459
19	Delta Air Lines (C)	2,929	19	Shanghai Airlines (C)	153	19	Delta Air Lines (C)	3,237
20	Thai Airways (C)	2,723	20	Continental Airlines (C)	132	20	LAN Airlines (C)	3,185

Development of market players

In Figure 10, the four main market players in the air cargo industry are compared on the products they transport and the geographical coverage in 1985 and 2010. In the 1980s, documents and mail were usually carried by the national postal authorities. On a global scale, integrators carried mostly documents and smaller parcels while larger consignments such as full pallets or less-than-truck loads (LTL) were carried by airlines on a global scale and by freight forwarders on a regional scale. Within the last 25 years, especially integrators and freight forwarders increased their market share by offering a wider range of services to shippers. Contrary, airlines and postal authorities only upgraded their product portfolio to a smaller extent. Integrators that usually carried smaller consignments now offer to ship larger consignments. Besides that, they are also covering the same activities as postal authorities. Freight forwarders on the other hand extended their market share by offering smaller shipments, international coverage and door-to-door services like integrators. Therefore, key market players converged towards each other which means that not only the same market players but also different business models compete for similar products on the same geographical scale. This convergence is also apparent by the fact that the same companies are functioning as an integrator and freight forwarder at the same time. For instance, Deutsche Post DHL has an express business unit (DHL Express) as well as a freight forwarding section (DHL Global Forwarding). In the future it can be expected that the convergence of freight forwarder and integrator will continue.

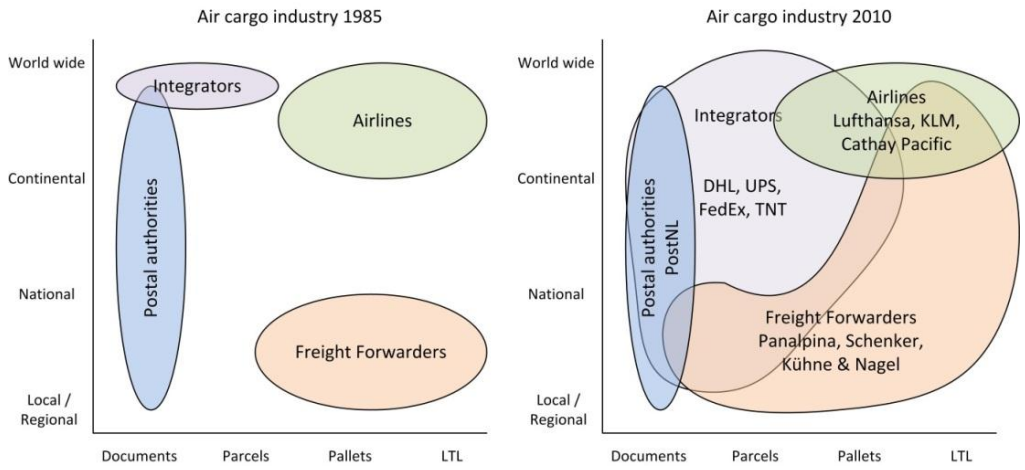


Figure 10: Air cargo industry 1985 and 2010 (Steer Davies Gleave, 2010)

3.4 What is Air Cargo?

According to Boeing (2003, p. 1), air cargo is considered to be "*any property (freight, mail, or express) carried or to be carried in an aircraft, other than the carry-on, checked or excess baggage, or property carried, which is incidental to the carriage of passengers (e.g., in-flight meals)*". Air cargo can be distinguished between air freight, mail and express. Air freight usually contains heavy/large shipments while express is considered to be time-sensitive freight which can be bound to certain dimensions and weight with a premium surcharge. The remainder, air mail, is considered to be the shipment of letters and documents.

Due to the fact that air transport is up to ten times more expensive than surface transport (Shaw, 2007, p. 41), one characteristic of air cargo is that it has a high value-to-weight ratio. Boeing estimates that products with a value-to-weight ratio of 16 $/kg are very likely to be transported by air (Boeing, 2012). In 2010, the average value for US freight by air was around 83 $/kg, while freight transported on water or road was considerably lower with 0.49 $/kg and 0.84 $/kg respectively (US Department of Transportation, 2011).

Another factor that influences goods transported by air is the perishability of products which benefit from fast transit times. Goods such as flowers, fruits and vegetables are encountered to physical perishability, while products such as newspapers or magazines as well as consumer goods such as high tech electronics but also fashion items are exposed to economic perishability since their life cycle in which these products remain saleable is relatively short (Morrell, 2011). Furthermore, the degree of emergency also plays an important role. Emergency situations occur when products have to be transported as fast as possible while costs play a minor role (Shaw, 2007). Apart from these features, air transportation is often chosen for products that require special handling such as theft endangered or dangerous goods as well as animals (Morrell, 2011). Table 8 summarizes characteristics that need to be present if transportation by air is favored (Wensveen, 2011).

Table 8: Air eligible characteristics of commodities

When the commodity is:	Perishable, Subject to quick obsolescence, Required on short notice, Valuable relative to weight, Expensive to handle or store
When the demand is :	Unpredictable, Infrequent, In excess of local supply, Seasonal
When distribution problems occur:	Risk of pilferage, breakage or deterioration, High insurance costs for long in-transit periods, Heavy or expensive packaging required for surface transportation, Need for special handling or care

Figure 11 shows the commodity breakdown of selected global air freight lanes in 2012. It also indicates the number of air weight per trade lane. It is apparent that on a global scale high tech goods such as laptops or smart phones were responsible for one fifth of total air weight in 2012 while one sixth of global air cargo was machinery parts, components and supplies as well as raw materials. About 13% of global air weight was represented by perishables and 7% by consumer fashion clothes. Of course, within certain trade lanes there are differences. While a large amount of machinery parts and capital equipment is shipped from Europe to North America and Asia, high tech products are returned from Asia to Europe. Another large discrepancy is the movement of perishable goods such as food. On average perishables are responsible for 13% of global air freight by weight. However, perishables account for more than 71% of air weight from Latin America to Northern America. Furthermore, trade lane imbalances are visible. For instance, 1.8 million tons of air freight were transported from Asia Pacific to North America while only 1.3 million tons went the opposite way. A further analysis on current trade lane imbalances follows in Chapter 3.6.1.

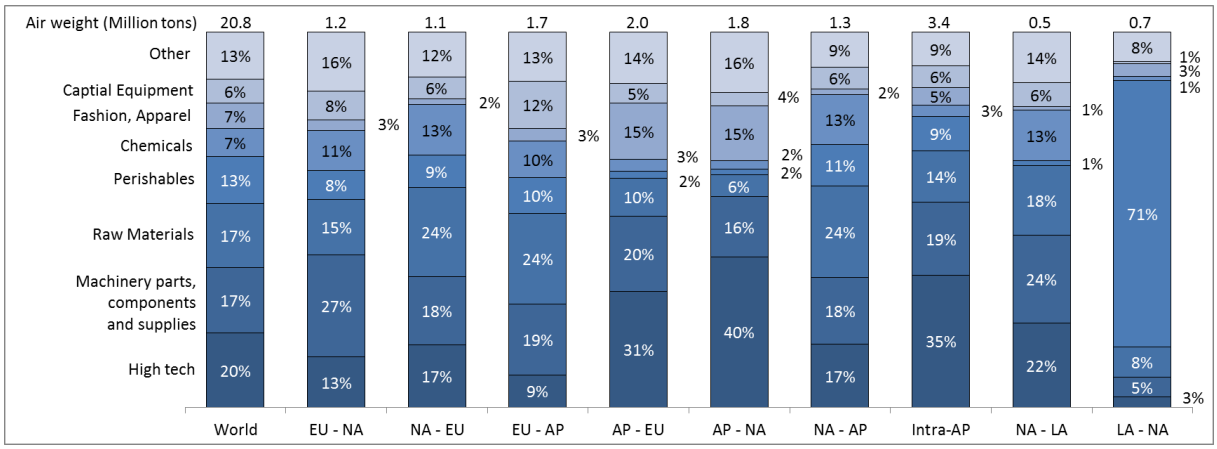


Figure 11: Commodity breakdown of global air freight markets (Source: Seabury, 2013a)

As mentioned earlier, air freight can be transported in the cargo holds ('belly') of a passenger aircraft as well as in the upper holds (main deck) of freighter air crafts. For belly hold, cargo can have a maximum height of around 1.6 m. The upper cargo holds of freighter aircrafts can accommodate freight with a height of approximately 3.00 m and a width of up to 3.4 m depending on the aircraft type. Currently, 54.3% of the global cargo capacity is represented by the lower cargo holds of passenger aircrafts while the remaining capacity (44.3%) is mostly in freighters and only 1.4% on combi aircrafts (Boeing, 2012). Boeing forecasts, that the capacity growth on freighters and passenger aircrafts will increase with a compound annual growth rate of 5.3% and 5.2% respectively. Hence, the growth will be balanced between these two types of aircrafts while by 2031 combi aircrafts are expected to be phased out.

3.5 Air Cargo Environment

3.5.1 Macroeconomic Environment

This part contains a basic analysis of macroeconomic issues that influence the air cargo industry. First drivers and constraints for the growth of air cargo are identified. This is followed by a thorough analysis of the relationship between annual air cargo growth, GDP and world trade. The chapter ends by taking a closer look at one of the main constraints of air cargo growth – the increase in fuel prices and its volatility.

Enablers and barriers of air cargo growth

Transportation of goods by air is to a large extent derived demand of global trade. Therefore, economic activity which can be measured in annual GDP growth is the main driver for world air cargo growth. However, numerous other enablers but also barriers of air cargo growth can be distinguished. A list of enablers and barriers of air cargo growth according to Boeing is illustrated in Figure 12. These factors are usually beyond the control of airlines. The most important enablers of air cargo growth besides GDP growth are: new air-eligible commodities, deregulation and open skies agreements as well as lean practices such as Just-in-time. Constraints of air cargo growth are increasing oil and fuel prices which make air transportation more expensive and consequently surface transportation by ocean or road more competitive. Furthermore, trade imbalances for instance between North America and Asia and trade restrictions play a major role for air cargo growth. A recent development which might have a huge impact on the air cargo industry is the federal sequestration in the US. The financial cuts could result in a decrease of cargo capacity of up to two billion pounds of cargo out of the US network (Econsult, 2012).

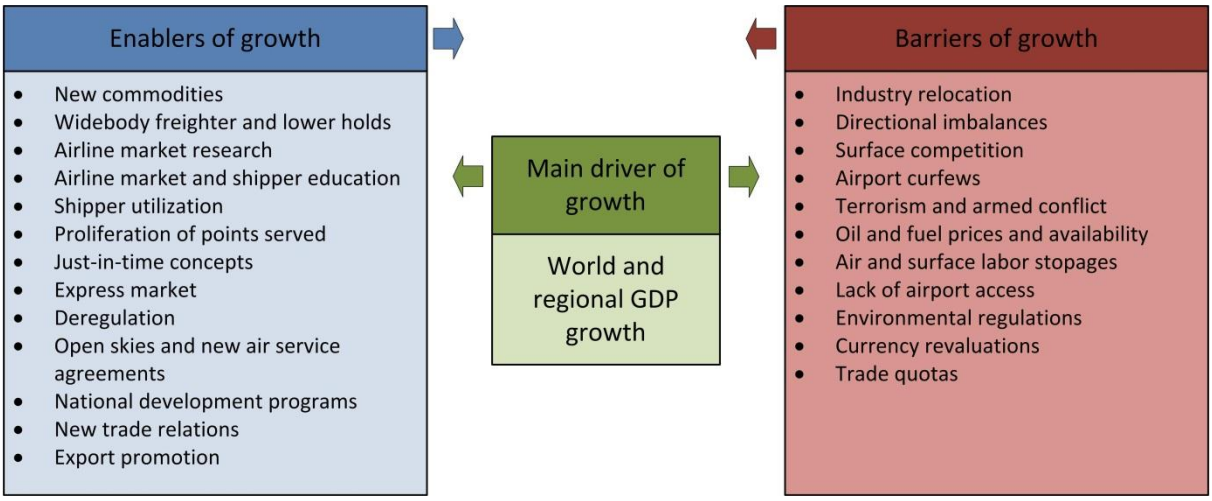


Figure 12: Enablers and drivers of air cargo growth (adapted from Boeing, 2012)

World GDP growth – facilitator of trade

There is a causal link between air cargo, world trade and GDP. The transportation of goods by air enables countries, irrespective of their geographic location, to connect with other countries and engaging them in trade with each other. Kasarda and Green (2004) found a statistical relationship between air cargo growth and the growth in GDP as well as GDP per capita between 1980 and 2000. With an r^2-coefficient of 0.982 and 0.981 for GDP and GDP per capita respectively, it was possible to predict air cargo growth with 98% accuracy.

In Figure 13, the annual growth rate of air cargo in revenue ton kilometers (RTK), GDP and world trade from 1995 to 2011 is illustrated. It can be seen that spikes and troughs are almost parallel with each other which means that there is an over-time correlation between the three measures. However, the magnitude of peaks and troughs is most pronounced for air cargo, followed by world trade. This means that air cargo is more prone to react to external shocks. The decline in 1998 can be explained by the financial crisis in Asia, whereas the decline in 2001 is followed by the 9/11 attacks. The consecutive decline of cargo growth in 2008 and 2009 is the result of the great recession. Nevertheless, the air cargo industry was able to rebound in a V-shape from the recession with almost 20% annual growth in 2010, reaching higher pre-recession levels.

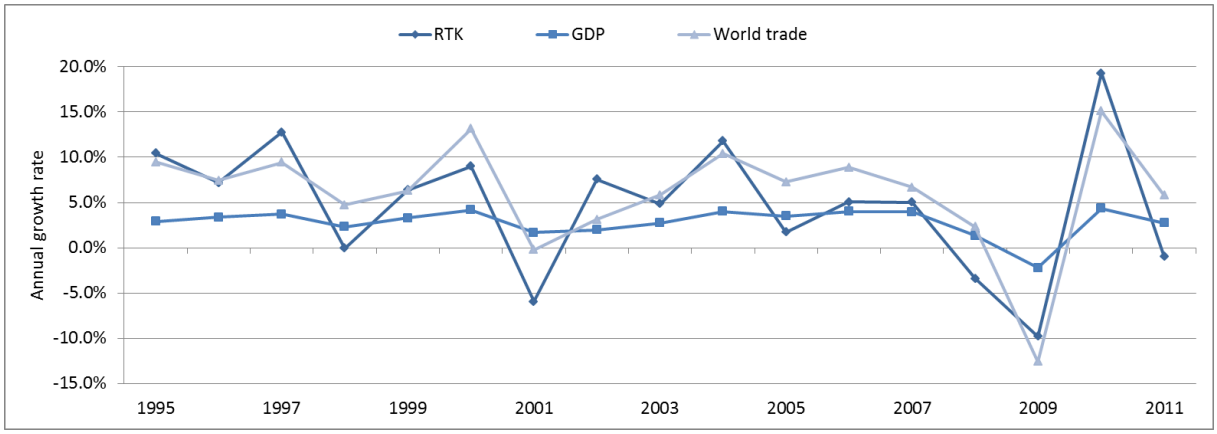


Figure 13: Annual change of RTK, GDP and world trade (Source: Boeing 2005, 2012; World Bank 2013; Netherlands Central Plan Bureau, 2013)

During the recession, the air cargo industry was first to rise from their low point in February 2009, four months earlier than world trade started to have positive growth rates (Pearce, 2012). The reason why air freight picked up quicker is based on the fact that shippers choose air transportation as their favorable mode of transport. Even though this required higher transport costs it enabled shippers to restock manufacturing sites with supplies and warehouses or retail outlets with finished products anticipating the recovery of the economy (Pearce, 2012).

Rising fuel costs

One of the largest constraints of air cargo growth is the sharp increase as well as the strong volatility of fuel prices of the last decade. In Figure 14, the costs per barrel of crude oil and kerosene-type Jet A is illustrated over a time span from 2000 to 2012 (US Energy Information Administration, 2013). Whereas crude oil prices and consequently kerosene prices remained stable between 2000 and 2003, prices increased from 2004 abruptly. In 2008, fuel prices reached its maximum by being more than four times more expensive than in the period between 2000 and 2003. During the financial crisis oil prices decreased to 60 US$/barrel kerosene. However, within the last years fuel prices increased to nearly pre-crisis levels.

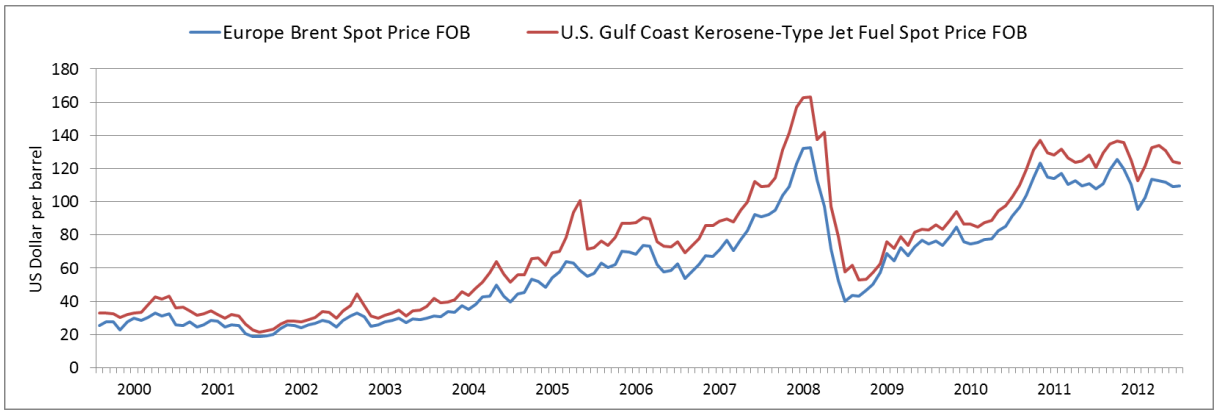


Figure 14: Crude oil and kerosene prices per barrel (Source: US Energy Information Administration, 2013)

For the aviation industry (passenger and cargo) the annual fuel bill is expected to increase in 2013 to US$216 billion compared to US$44 billion in 2003 meaning that the fuel bill nearly quintupled. Even though aircrafts are getting more fuel efficient, the fuel price increase over time represents nowadays 33% of operating expenses while in 2003 is was just 14% (IATA, 2013b). It has to be

acknowledged that the share of operating expenses of fuel for cargo operations are higher than 33% since other operating expenses such as crew or sales are not as high as for passenger operations.

3.5.2 Political Environment

It is favorable for market players within the air cargo industry to offer their transport services to shippers that demand air transportation. However, the air cargo industry is constrained by governmental regulations restricting carriers where to fly. This part aims to give a short introduction of the regulatory environment and its developments in which the air cargo industry operates. First, bilateral air service agreements (ASA) will be described, followed by an analysis of deregulation activities in different parts of the world.

Air Service Agreements (ASA)

Since the 1944 Chicago Convention, international air transportation has been regulated by bilateral air service agreements. The principle of these agreements is an equal and fair exchange of rights depending on the market size, geographical location and economic interests between two nations. ASAs regulate which carriers are allowed to fly on a certain route between two countries and determine the capacity each airline can offer (Zhang & Zhang, 2002). Based on that, the so-called '*Freedoms of the Air*' emerged, which are listed in Figure 15 accompanied by a figurative example (Morrell, 2011). The first two freedoms can be regarded as *transit* rights while the remaining freedoms are *traffic* rights.

The *'freedoms of the skies'* apply for both passenger and cargo operations. However some bilateral agreements between nations are designated for all-cargo carriers. From the 1970s on, a large amount of ASAs were signed mostly regarding passenger and belly hold freight liberalization. Only from 1995, a number of all-cargo clauses were added leading to a gradual liberalization of air cargo.

Deregulation

The rationale behind deregulation and liberalization is to increase competitiveness which should lead to higher productivity and lower prices for customers. The first steps towards deregulation in the aviation industry for passenger services and belly hold carriage were implemented by the United States Airline Deregulation Act in 1978 by intending to remove governmental control over fares, routes and market entry. The result of this deregulation in the USA was an average decline of air fares by 30% in real, inflation adjusted terms, resulting in a consumer surplus of $US5-10 billion per year between 1978 and 1990 (Kahn, 2002). The equivalent for freighter services was an amendment to the Federal Aviation Act in November 1997 to open domestic air cargo services in the USA (Zhang & Zhang, 2002).

After deregulating the domestic market, the USA promoted so-called 'open skies' agreements with individual countries. The first open skies agreement was signed between the USA and the Netherlands in 1992. By 1996, ten other European countries had successfully opened their 'skies' between Europe and the US. In the years that followed, several Asian countries such as Singapore signed 'open skies' agreements with the United States (Zhang & Zhang, 2002). Besides bilateral agreements, a tendency towards multilateral open skies agreements is visible. In 1998, Regulation 2407/97 was effective, replacing all ASAs between each EU member state (Morrell, 2011). A similar agreement was signed in 2001 between the United States of America and four other Pacific-rim

nations (Zhang & Zhang, 2002). In 2007, an open skies agreement between the United States and the EU was signed eliminating all restrictions on third, fourth and fifth freedom rights.

By 2012 more than 400 open skies agreements between 145 countries, representing 76% of the ICAO (International Civil Aviation Organization) memberships, were signed. However, the operations of carriers in other countries (Eighth and Ninth Freedoms) remain the exception and are only allowed within the EU and some other areas of the world. Apart from numerous small developing countries such as China, Mexico, Russia and Argentina still do not grant open access to its air space (ICAO, 2012).

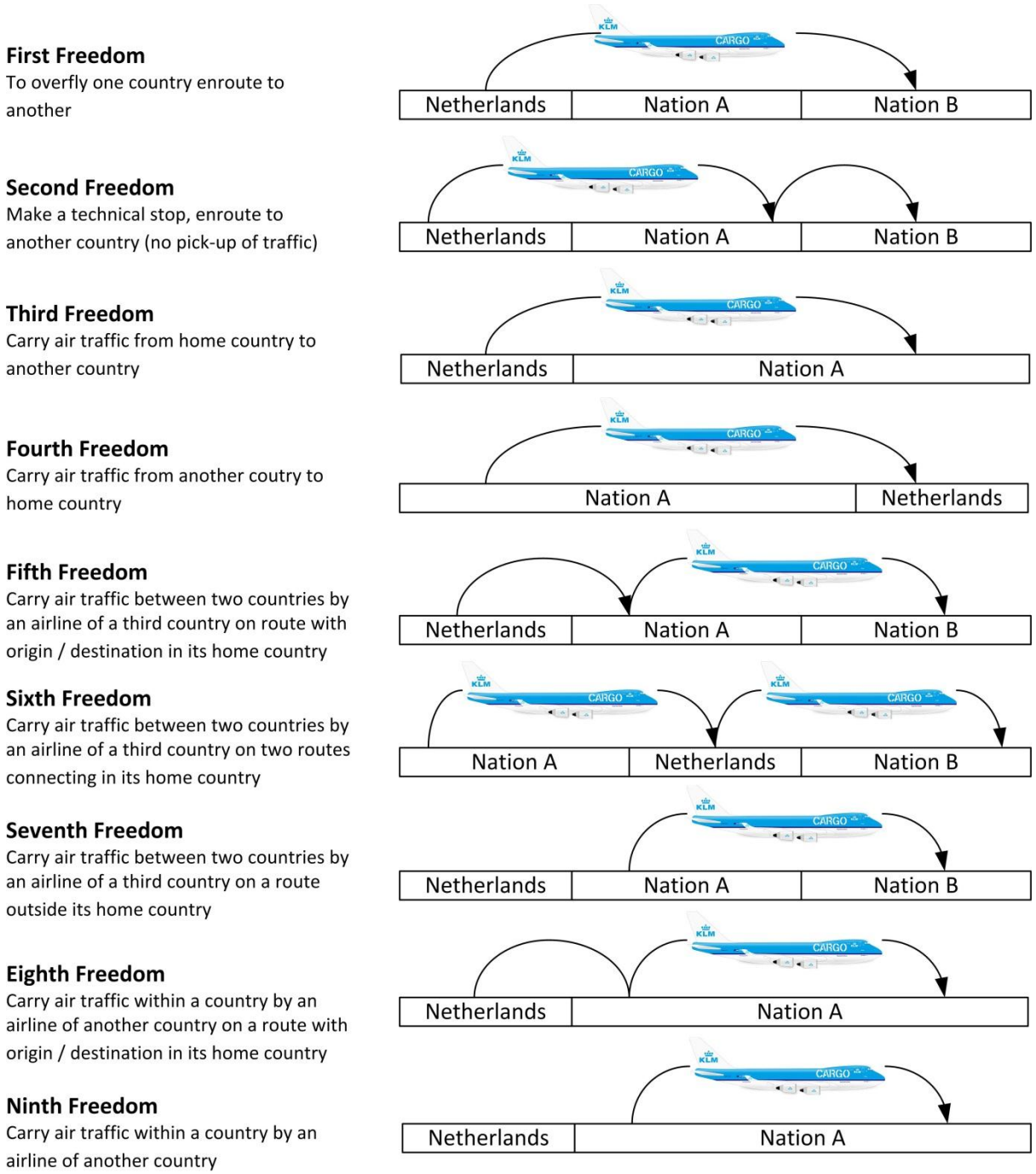


Figure 15: Freedoms of the skies

3.6 Current Struggles of the Air Cargo Industry

As mentioned before, the air cargo industry has been performing relatively poor within the last decade. This part aims to analyze current struggles of the air cargo industry that put more and more pressure on the operating performance of market players.

3.6.1 Slowdown of Air Cargo Growth

Even though on average the air cargo industry was growing throughout the last ten years with a compound annual growth rate of 3.4% the growth slowed down when comparing it over the last 30 years. According to Boeing (2012), the annual growth per year between 1981 and 1991 was 6.9%, while for the next ten years growth rates slightly diminished to 6.1%. The growth of FTK measured as the moving average over the last 30 years and external shocks are illustrated in Figure 16.

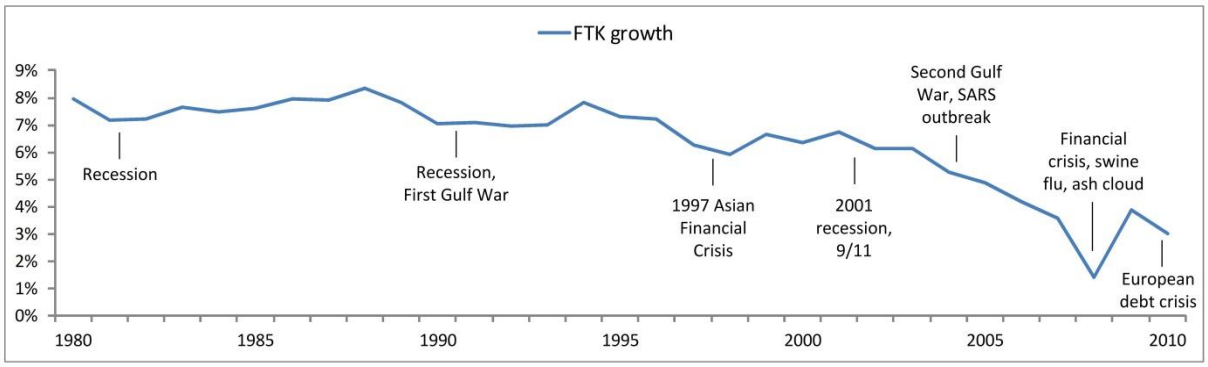


Figure 16: FTK growth 10-year moving average (Source: IATA, 2012)

The main reasons for the current slowdown are the financial crisis of 2008 and 2009, the current European debt crisis and the increase in fuel prices over the last decade. This slowdown is also apparent when examining the share of containerized international trade which decreased in terms of weight and value within the last decade. In 2000, about 2.9% of global weight was transported by air while in 2011 it was less than 1.7%. This represents a compound annual growth rate of -1.8%. For the value share, the decrease was even larger with a compound annual growth rate of -4.6% from 49.0% to 40.2% (Seabury, 2012a). Reasons for the decrease are:

- Trade lane effect: Trade lanes with a high degree of ocean transportation grew faster than lanes with a high air share
- Commodity effect: Trade of goods that are more prone to be transported by air grew at a lower rate than average global trade
- Mode shift: goods that were usually transported by air moved to ocean transportation

Besides the overall slow-down of growth of the air cargo industry, the air cargo market has seen a sizeable decrease in international air trade of 4% year-over-year from 2011 to 2012. Particularly, the main trade lanes connecting Europe, Asia and North America with each other decreased by up to 11% from 2011 to 2012. Intra-Asian trade stagnated while trade from Latin America to North America and Middle East and South Asia to the Asian Pacific Region increased (see Figure 17).

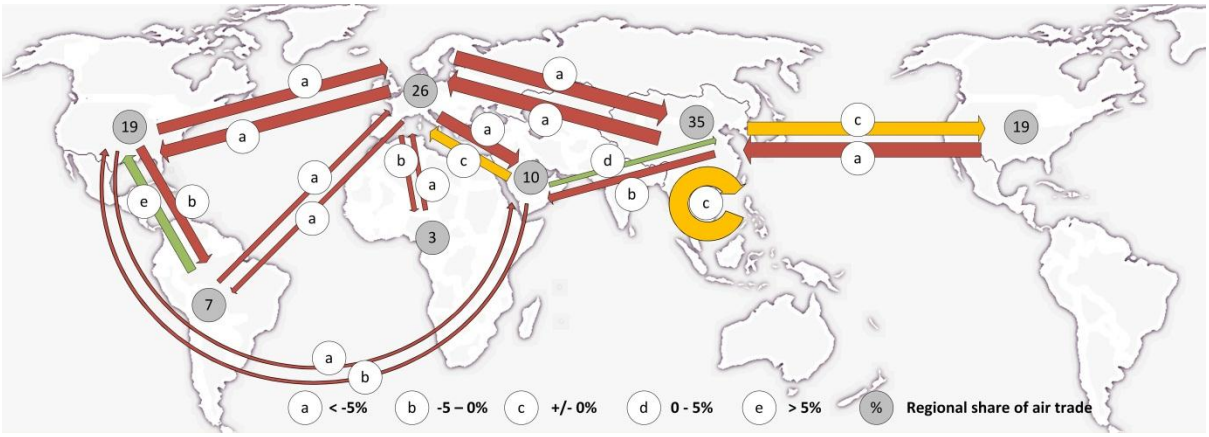


Figure 17: Trade lane growth/decline from 2011 to 2012 (Source: Seabury, 2013a)

3.6.2 Trade Lane Imbalance

The movement of freight, compared to passengers who usually return to their origin, is unidirectional. This means that goods travel in one direction where they will be processed or consumed. Based on different production and consumption patterns across the world trade lane imbalances occur.

In Figure 18, the total weight of air cargo between geographical regions in thousand tons is illustrated. The thickness of the arrow indicates the weight that has been transported while the color represents how balanced a trade lane is. A set of green arrows represent a balanced trade lane. This means that trade in one direction is not larger than 20% compared to the other direction. The light red arrows represent a medium trade imbalance between geographical areas. For these routes, trade in one direction is maximal 50% larger than in the other direction. A set of dark red arrows represent a large trade imbalance of more than 50% in one direction compared to the other. Two of the three largest trade lanes between Europe and East Asia as well as Europe and North America are mostly balanced. The same is true for the trade between North America and East Asia, where around 33% more goods are transported from East Asia to North America than the other way around. This is a recent development as in 2007 trade especially between North America and Asia as well as Europe and Asia was largely imbalanced towards an export surplus of Asia (MergeGlobal, 2008a). The most significant trade imbalance can be seen between East Asia and the Middle East/South Asia and Europe and Middle East/South Asia. The major impact of trade lane imbalances for freight carriers are excess capacity in one direction and shortages in the other direction. The excess capacity ultimately leads to lower overall load factors which influence total yields and profitability of a carrier. It is worth mentioning that trade lane imbalances between countries are usually more extreme on a country to country level and even worse on some city-pairs (Morrell, 2011). Therefore, carriers do not just fly from one point to another and return. Hence, carriers use flight rotations where every segment on the rotation should be maximized in terms of yield and load factor.

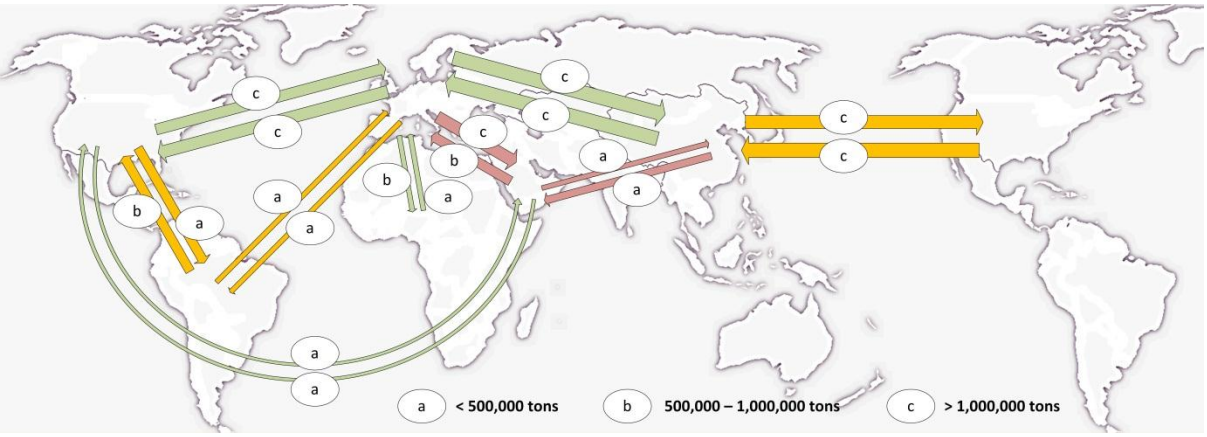


Figure 18: Trade lane imbalance in 2012 on selected routes (Source: Seabury, 2013a)

3.6.3 Demand and Supply Imbalance

Within the last decade growth of air cargo supply measured in available freight ton-kilometers (AFTK) mostly outnumbered the growth in air cargo demand (freight ton-kilometers). On average demand grew by just 2.5% while supply grew by 3.1%. Even though actual demand has been declining in 2011 and 2012, carriers offered more capacity having a direct impact on the load factors and yields and profitability.

Table 9: Annual growth rate of total FTK and AFTK (Source: IATA, 2013a)

Annual growth	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
FTK	-6.5%	8.9%	3.8%	13.1%	3.3%	4.4%	3.5%	-3.3%	-9.7%	18.4%	-0.7%	-1.5%
AFTK	4.8%	1.3%	4.3%	10.1%	6.7%	4.2%	4.0%	-1.1%	-7.5%	7.3%	4.1%	0.2%

By looking at Figure 19, the effect of demand and supply imbalance is visible. After a strong deterioration of load factors in 2008 and 2009 due to the financial crisis to nearly 46% on a twelve month moving average, load factors moved up again. However, since the supply is growing faster than supply average load factors start to deteriorate again. It is also apparent that load factors declined over the last twelve years from 55% to 50%.

Aircrafts represent capital intensive equipment and their acquisition demand strategic decision making. Due to the long lead time of production most new aircrafts are ordered many years in advance before they go into service. Therefore, it is not easy to just sell aircrafts to reduce excessive capacity. One short term practice carriers are doing when demand declines, is to ground aircrafts in the desert until demand picks up (Air Cargo News, 2011). Due to large deliveries[1] of new passenger aircrafts which are very cargo friendly as well as freighter aircrafts that were ordered before the financial crisis, when forecasts were much more optimistic about demand growth, load factors deem to be further declining in the future if older aircrafts will not be retired earlier as planned.

[1] Boeing (2012) predicts the number of freighter aircraft will grow by 80% until 2031

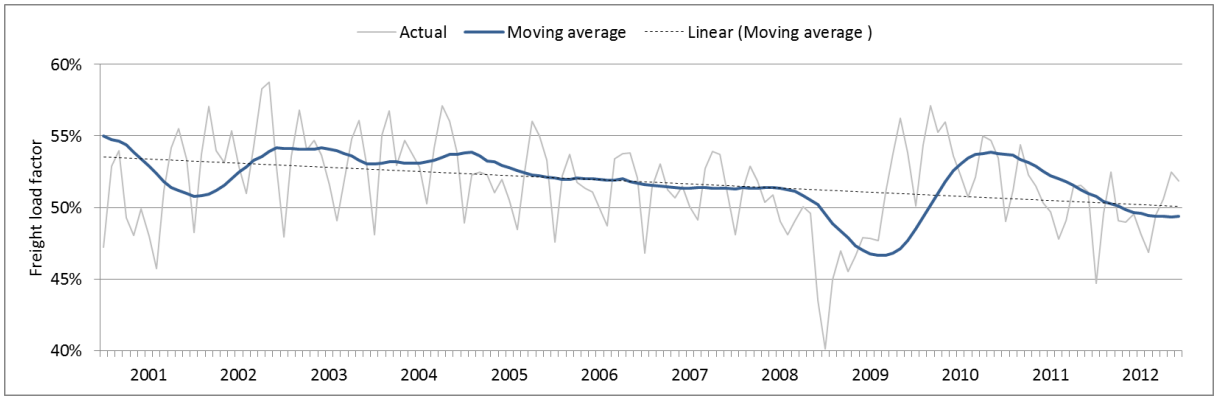


Figure 19: Demand and supply of air cargo carriers (Source: IATA, 2013a)

3.7 Relevant Industries for the Air Cargo Industry

This part aims to identify industries which are important for the air cargo industry and will therefore try to answer the second sub-question. Analyzing which industries are important for the air cargo industry, defines the population of this master thesis and justifies the selection of supply chain managers within a certain industry to research supply chain trends and their impacts by means of in-depth interviews and a follow-up questionnaire. The selection of the industries is based on the weight and value share as well as on the growth rate of each industry. Furthermore, a few of the largest companies of each industry should represent a high market share. Besides that, each selected industry should have a certain degree of communality since highly fragmented industries make it difficult to generalize findings.

The weight share represents the most important decision criteria since shippers are ultimately charged by the weight (for voluminous products by chargeable weight[2]) of their shipments. Therefore, it is important to focus on industries that have a comparable high weight share. The remaining three decision criteria (value share, growth rate and market share) are used to exclude or add certain industries in case industries score very high or low for the respective criteria.

While it would have seem logical to just select industries with a high weight share such as high tech or capital equipment, these commodity groups often comprise of many different industries and it is therefore difficult to use these generalized aggregates as a unit of analysis. Also, it is impossible to research supply chain trends impacting the air cargo industry within numerous industries due to the limitation of time.

The selection of the industries is mostly based on the Global Trade database of Seabury whereas industries will be chosen from the level-1 and level-2 commodities of this database. A more detailed description of the database is given in Appendix A and B.

3.7.1 Weight Share

In Figure 20, the weight share of level-1 commodities and selected level-2 commodities from 2000 to 2011 are illustrated. Firstly, level-1 commodities can be classified as aggregated product categories which are composed of different industries or more narrowed product categories. *High tech* products account for nearly 20% of the total air weight, followed by *machinery parts, manufacturing*

[2] Chargeable weight is based on dimensional weight which is usually at around 166kg/m^3 or actual weight, the shipper is charged what is higher

components & supplies as well as *raw materials, industrial consumables & foods* which are both responsible for 17% of the international air cargo weight in 2011. *Temperature or climate controlled* products (perishables) rank fourth with approximately 13%. The remaining eight level-1 commodities each have less than 10% of the total weight share.

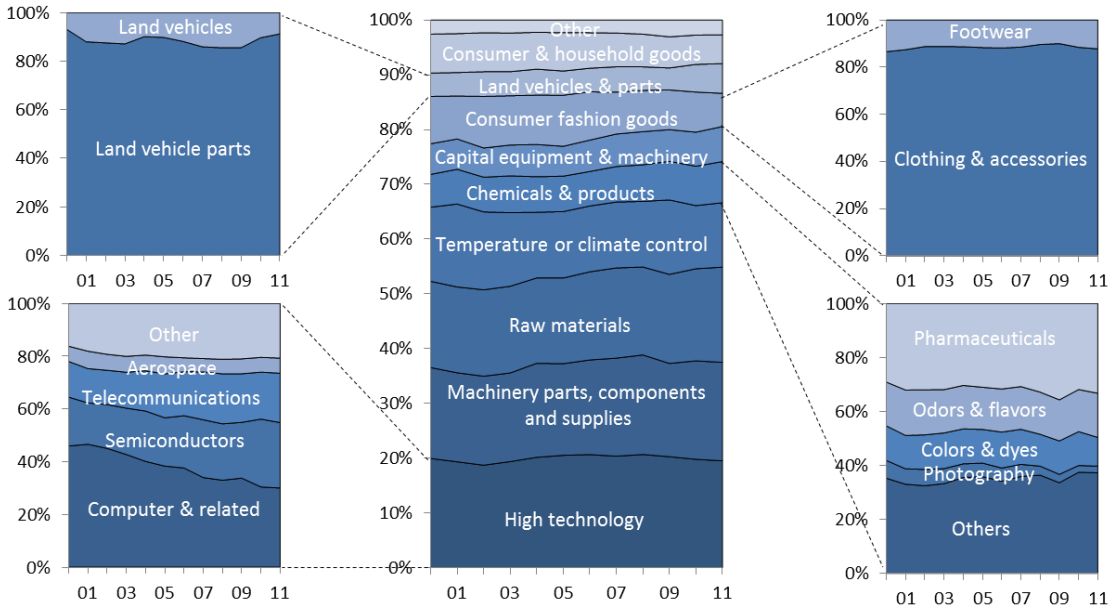


Figure 20: Weight share of international air trade (Source: Seabury, 2013a)

Due to the fact that this level of commodities is still very fragmented and the commodities do not necessarily represent complete industries it is necessary to drill one level down to have a better insight in the weight share distribution of certain industries. By ranking the top 10 level-2 commodities based on weight, it is apparent that there are still certain product categories which do not represent entire industries. However, the top six level-2 commodities (*Fresh foods*, *Computers & Related*, *Clothing & Accessories*, *Land Vehicle Parts*, *Semiconductors* and *Telecommunications*) represent to a certain extent industries with a high degree of communality in itself. Therefore, it seems reasonable to take these industries as a basis for a further assessment.

For the further analysis, industries can be added to the abovementioned industries in case they score high on the other decision criteria. The proposed industries can also be dropped if they score very low in the remaining categories.

Table 10: Weight share in 2012 (Source: Seabury, 2013a)

Level-2 commodity	*Level-1 commodity*	*Air Weight (tons)*	*% of total*
Fresh Food	Temperature or Climate control	1,858,902	8.93%
Clothing & Accessories	Consumer Fashion Goods	1,252,285	6.02%
Computers & Related	High Tech	1,222,062	5.87%
Land Vehicle Parts	Land Vehicles & Parts	931,936	4.48%
Semiconductors	High Tech	928,404	4.46%
Telecommunications	High Tech	815,584	3.92%
Machinery for general industrial uses	Capital Equipment & Machinery	726,734	3.49%
Electrical components	Machinery parts, manufacturing components & supplies	703,914	3.38%
Semi-manufactured industrial consumables	Raw Materials, Industrial consumables & Foods	685,505	3.29%
Parts & components of other machinery	Machinery parts, manufacturing components & supplies	671,650	3.23%

3.7.2 Value Share

For the value share, a similar analysis is conducted as for the weight share. First, the value share of level-1 commodities as well as selected level-2 commodities is illustrated in Figure 21. Remarkably, almost half of the value which is transported by air can be categorized as *high tech* products. Furthermore, *secure and special handling* represents nearly 15% of the total value while it only represents 1.1% of the total weight. Therefore, the value-to-weight ratio of these goods is extremely high. On the other hand, *consumer fashion goods* only accounts for 2.3% of the total value. Compared to its huge weight share, temperature or climate controlled goods have an even lower value share of just 0.6%.

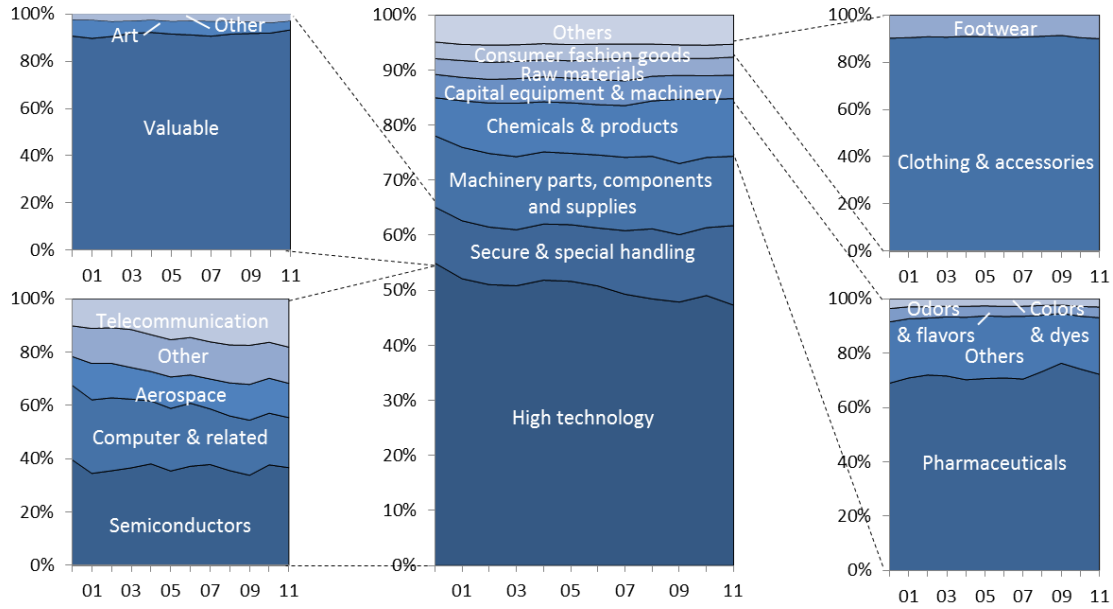


Figure 21: Value share of international air trade (Source: Seabury, 2013a)

In Table 11, the top 10 level-2 commodities by air value are listed. *Semiconductors* represent one six of the total value of all air transports. *Valuables* such as artworks or jewelry represent nearly 14%. This is followed by various industries that belong to high tech products and *pharmaceuticals* which represent 7.6% of the total value. Some of the remaining level-2 commodities represent rather broad industries, where it would be necessary to drill down another level (level-3 commodities), which consequently means that the value and weight will not exceed level-2 commodities.

Due to the fact that valuables only represent 0.8% of the total weight it seems not reasonable to consider this industry for a further analysis despite its exceptional value share. On the other side, *pharmaceuticals* have a value share of 7.6% and still represent 2.5% of the total weight. Therefore, it seems justifiable to take pharmaceuticals in consideration for further analysis. Due to the low value share of 0.4% for *fresh foods*, but also due to the wide ranging products within this industry and a lack of necessary manufacturing, fresh foods are not considered for further research.

Table 11: Value share in 2012 (Source: Seabury, 2013a)

Level-2 commodity	*Level-1 commodity*	*Air Value (million US$)*	*% of total*
Semiconductors	High Tech	467,300,605	16.33%
Valuables	Secure or Special Handling	399,037,714	13.94%
Telecommunications	High Tech	257,988,572	9.02%
Computers & Related	High Tech	254,914,865	8.91%
Pharmaceuticals	Chemicals & Products	217,076,767	7.59%

Aerospace	High Tech	194,485,050	6.80%
Machinery & apparatus for scientific, medical or technical purposes	High Tech	113,228,673	3.96%
Miscellaneous manufactures	Machinery parts, manufacturing components & supplies	80,854,066	2.83%
Electrical components	Machinery parts, manufacturing components & supplies	78,406,704	2.74%
Machinery for general industrial uses	Capital Equipment & Machinery	68,688,269	2.40%

3.7.3 Growth Rate

The growth rate of industries will be analyzed by comparing the weight of level-2 commodities of 2000 with 2012 in absolute terms. In 2000, the total weight of international air shipments was approximately 14.8 million tons. By 2011, the air cargo weight grew by 46% to 20.8 million tons. In Table 12, the top 10 level-2 commodities are ranked by absolute growth from 2000 to 2012.

From 2000 to 2012, *telecommunication* products such as smart phones had the highest growth in absolute weight. This is followed by *semiconductors* and *land vehicle parts*. *Perishables* on the other hand have a high absolute growth but are below the average growth (22.1%). Furthermore, many level-2 commodities represent again very fragmented industries with a low degree of communality such as *parts & components of other machinery*. *Pharmaceuticals* are again scoring relatively high in this category. *Clothing & accessories* grew only by 3.3% from 2000 to 2012 in terms of weight.

Table 12: Growth rate 2000 - 2012 (Source: Seabury, 2013a)

Level-2 commodity	*Absolute growth (tons)*	*Growth (%)*
Telecommunications	413,696	102.9%
Semiconductors	374,739	67.7%
Land Vehicle Parts	354,988	61.5%
Parts & components of other machinery	342,258	103.9%
Fresh Food	336,515	22.1%
Manufactured metal industrial consumables	319,755	141.0%
Foodstuffs & Beverages for human consumption	311,007	101.5%
Machinery for general industrial uses	300,582	70.5%
Machinery & apparatus for scientific, medical or technical purposes	261,786	92.1%
Pharmaceuticals	260,392	89.7%

3.7.4 Market Share

The aim of this decision criterion is that the leading companies within an industry have a high market share. Therefore it can be guaranteed that by conducting only a limited amount of interviews and gathering a few responses of shippers a large share of the market is covered. For instance within the semiconductor industry, the top ten companies represented a market share of 51% (Gartner, 2012). The same is true for telecommunications. The leading five smartphone manufacturers represented 61% of all deliveries in the third quarter of 2012 (Epstein, 2012). The automotive sector has a similar concentration. The top ten auto manufacturers together represent 68% of all cars (Oica, 2012) while part suppliers in the automotive industry are also highly concentrated. The pharmaceutical industry is also dominated by large corporations such as Pfizer, GlaxoSmithKline, Amgen, Merck, AstraZeneca or Abbott. The fashion industry, on the other hand is rather fragmented. Even though there are large fashion retailers such as Zara or H&M, these shippers are often not globally represented and only have a relatively small market share. Based on this fragmentation but also on the small growth rate and a rather low value share the fashion industry will be excluded from the further analysis.

This leaves three industries (high tech, automotive and pharmaceuticals) that comprise the population of this master thesis. These industries represent 27% of the total air weight share and around 56% of the value share of total international air trade. Furthermore, all industries have an above average growth rate. Lastly, the selected industries have a high degree of communality and the leading companies represent an accumulated high market share.

3.8 Air Cargo Supply Chain

The air cargo supply chain from origin to destination consists of the traditional air cargo (non-integrated) chain and the integrated express cargo chain, depicted in Figure 22. The most important actors within both sub systems are shipper, consignee, airline, freight forwarder and integrator. For the case of intra-enterprise transport the shipper and consignee can be represented by the same entity. Apart from these main stakeholders, ground handlers, airports, trucking companies, customs (for international shipments) and value added logistics service providers play an integral role in the supply chain of air cargo.

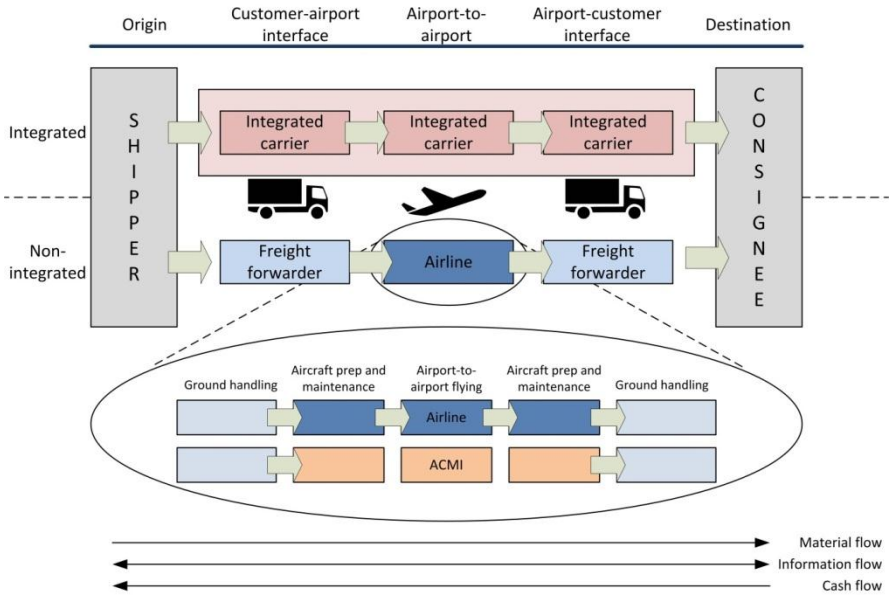


Figure 22: Air cargo supply chain (adapted from Leinbach and Bowen, 2004; MergeGlobal, 2008a)

The air cargo supply chain can be divided in three different steps:

- Pre-haulage (Customer-airport interface)
- Main-haulage (Airport-to-airport)
- Onward-haulage (Airport-customer interface)

The first step, pre-haulage, takes on average around 26% of the total delivery time, whereas the time a good is actual in the air is only 17%. The remaining 57% of transport time are needed for the final step (Scholz, 2011).

Pre-haulage

The supply chain starts with the shipper. A shipper usually contracts a freight forwarder or an integrator to arrange the entire transport from shipper to consignee. Consignments are collected from the shipper's premises by a freight forwarder/trucking company or an integrator's trucking fleet. Unless shipments are expedited, they are transported to a regional warehouse where they are

consolidated with other shipments, cross-docked and waiting for further transportation to the airport according to their priority. Forwarders must be in possession of the airway bill which is a legal document and acts as a contract between shipper and air carrier for the transportation of freight on a carrier's network.

Main-haulage

For international shipments goods need to be cleared by customs before they can be handled by a ground handler of the airport or the airline. Also, shipments are subject to a security check. The ground handler inspects and verifies the freight if it is ready for air carriage. Furthermore, a handling agent loads freight into special containers, called unit load devices (ULDs), or builds pallets by consolidating smaller shipments before pallets and containers are delivered to the aircraft and loaded into the cargo holds of an aircraft. Integrators usually have their own dedicated handling agents to load shipments into the aircraft. The shipment is then flown either to its final destination or an intermediate airport where the consignment is again consolidated, put on pallets or into containers and loaded to another aircraft. If a product is imported into a country it needs to be cleared again by customs before it is handled by an airport ground handler.

Onward-haulage

After the shipment is handled at the airport, freight forwarders collect the consignment and arrange the onward transportation to the final customer while integrators use their own network of trucks. Thereby, shipments can be first consolidated at cross-docking stations and transshipment points or delivered directly to the consignee. The supply chain process is finished once the shipment reaches the recipient.

3.9 Chapter Conclusion

This chapter offered an introduction into the global operations of the air cargo industry and identified three important industries that build the population of this master thesis. It can be concluded that the air cargo industry is a complex industry consisting of different market players but also depending on the global economic environment and governmental decision making to guarantee continuous growth. The main market players which represent the supply side of the air cargo industry are airport-to-airport carriers (combination carriers or all-cargo carriers), integrators and freight forwarders. Besides this, the shipper of consignments, representing the demand side of the cargo industry, plays an integral role. Other stakeholders such as ground handlers, customs or value added logistics providers can be regarded as supporting functions.

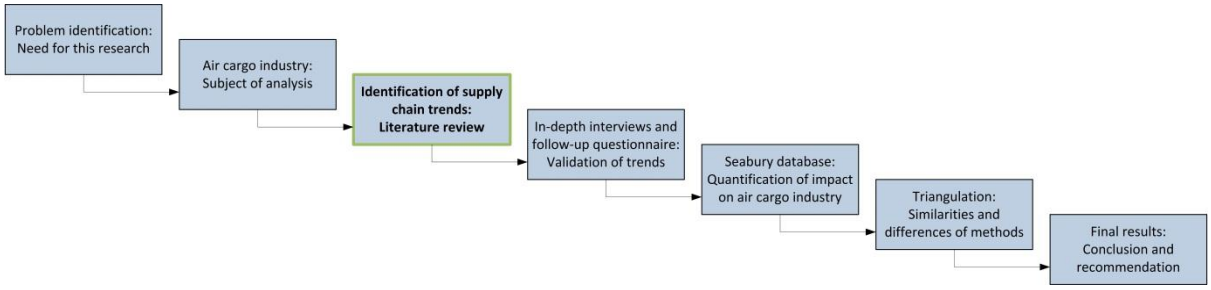
During this chapter it was apparent that the air cargo industry operates in a difficult market environment that is influenced by the economic cycle from which demand for air cargo derives. Furthermore, rising fuel costs and other current struggles such as a slowdown in air cargo growth as well as imbalances in regard of trade lanes or demand and supply further complicates the operations of cargo carriers.

The three industries that were identified as the population represent a weight share of 27% and value share of 56% respectively of total air transportation. Within these three industries supply chain trends which are gathered through an extensive literature in the following chapter will be researched by means of in-depth interviews and a follow-up questionnaire (see Chapter 5). After that, it is tried to quantify some of the trends and their impacts by using Seabury's databases.

4 Global Supply Chain Trends

4.1 Introduction

In Chapter 2, the term trend was discussed as well as different methods and techniques for trend assessment were identified. This chapter focuses on supply chain trends and tries to answer the remaining research sub-question based on an extensive literature review. Firstly, the concepts 'supply chain' and 'supply chain management' will be defined and a definition of the 'term' trend in respect to supply chain will follow after that. Then, the surrounding system in which trends evolve will be analyzed and grouped in social, technological, economic, environmental and political drivers. Various supply chain trends will be demarcated from their drivers and grouped into four different categories. This analysis consequently tries to answer the third research sub-question: *What are drivers influencing supply chain trends?,* as well as the fourth research sub-question: *What are global supply chain trends and which of them are relevant for the air cargo industry?* After that, the identified supply chain trends and their interrelations will be mapped and possible impact criteria on the air cargo industry will be outlined and thereby trying to answer the fifth sub-research question: *What are the impacts of the supply chain trends on the air cargo industry?* The chapter will end with selecting the supply chain trends that deem to have the biggest influence on the air cargo industry which will be the focus of the empirical assessment followed in Chapter 5.



4.2 The Term Trend in Relation to Supply Chain Management

So far, the term trend was examined in its most generic form. Since the focus of this master thesis is supply chain trends impacting the transportation of goods by air, it is necessary to define the term trend in the field of supply chain management. First, the concepts supply chain and supply chain management are defined. After that, a working definition for the term trend in respect to the supply chain follows.

4.2.1 Supply Chain Management and the Supply Chain

The term *'supply chain management'* was first introduced by Keith Oliver, as an idea to remove the functional silos within a company, during an interview with the Financial Times in 1982 (Heckmann et al., 2003). Since then, supply chain management became one of the buzzwords of the 1990s and the 21st century (La Londe, 1997; Mouritsen et al., 2003). While there is much clarity of what a supply chain is, the definition of supply chain management (SCM) differs among various authors (Mentzer et al., 2001).

A supply chain can be defined as a set of *"three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer*" (Mentzer et al., 2001, p.4). Mentzer et al. (2001) also

identified three degrees of supply chain complexity: a *'direct supply chain'* consisting of a focal company and its supplier and customer, an *'extended supply chain'* including the supplier's supplier and the customer's customer and an *'ultimate supply chain'* consisting of all organizations between an ultimate supplier and customer as well as financial providers, market research firms and third party logistics providers.

The concept *'supply chain management'* differs largely across various scholars. However, it can be classified in three categories (Mentzer et al., 2001): a *'management philosophy'*, an *'implementation of a management philosophy'* and a *'set of management processes'*. SCM as a management philosophy uses a systems approach viewing the supply chain as a whole to strategically position itself towards cooperation and customer focus. However, this concept only identifies the opportunity to strategically and tactically align activities to manage the flow of products, services, finances and information, while the implementation of a management philosophy recognizes activities such as integrated behavior, mutual information, risk and reward sharing, as well as cooperating to accomplish the same goal and focus and to integrate processes and build long-term relationships. SCM as a set of management processes can be defined as managing relationships as well as material and information flows throughout different entities to enhance customer service and economic value by synchronizing the flow of material and information from the source to the consumer (La Londe & Masters, 1994).

4.2.2 Framework to assess Supply Chain Trends

Zografos and Giannouli (2001) developed a framework to assess supply chain management trends. According to Zografos and Giannouli (2001, p. 154) a trend in the context of supply chain management can be defined as "the *collective manifestation of the influence of drivers and their factors on the configuration of the system*". They argue that at any point of time a trend becomes prevalent when a certain intensity of usage of system elements in their environment is reached. Following this definition of Zografos and Giannouli, trends can be defined as a shared appearance or generalized reactions at a micro economic level (corporations or individuals within the supply chain) which are influenced by the emergence or change of wider macroeconomic or external drivers.

Consequently, it is important to distinguish between drivers which are external forces and trends which are the response to the external forces. In the next part, the term driver will be defined in more detail and a classification of certain drivers impacting the emergence or continuance of supply chain trends will be given. This will be followed by an extensive literature review on current and near term supply chain trends. The causal scheme of drivers, trends and the air cargo industry as well as their influence on each other is illustrated in Figure 23. According to Figure 23, the transportation of goods by air is directly influenced by the environment of the supply chain (drivers) as well as supply chain trends. Certain drivers that have a direct impact on the air cargo industry were already discussed as enablers and barriers of the air cargo industry in Chapter 3.5.1. However, there are additional drivers that have a direct influence on supply chain trends which again influence the air cargo industry. On the other hand, the air cargo industry also has a certain degree of impact in form of a feedback loop. This means that the stakeholders of the air cargo industry can also influence the development of supply chain trends. Nevertheless, the aim of this master thesis is to examine the relationship between supply chain trends and their environment of external drivers as well as the impact of these trends on the air cargo industry. Therefore, the feedback loop between the air cargo

industry and supply chain trends as well as the relationship between external drivers and the air cargo industry will not be analyzed as part of this master thesis.

Figure 23: Causal scheme (adapted from Zografos and Giannouli, 2001)

4.3 Supply Chain Drivers

Drivers which are influencing the development of global supply chain trends derive from the environment in which the supply chain/logistic system is embedded. According to Zografos and Giannouli (2001, p.154), *"a driver is a force originating from the environment of a system which leads to changes in the system configuration"*. Drivers are thus seen as a macroeconomic external force that cause entities or actors within the supply chain to develop and implement new practices that will enable them to respond effectively to changes in the environment.

In literature, multiple frameworks are discussed to distinguish between different drivers (Mićić, 2006). The basic framework is the PEST analysis developed in the 1960s by Weiner and Brown which identifies political, economic, social and technological drivers. From this framework many derivatives have been formed which are listed beneath (Mićić, 2006):

- STEEP: Social, Technological, Economic, Environmental, Political
- PESTEL: Political, Economic, Social, Technological, Ecological, Legal
- DEGEST: Demography, Economy, Government, Environment, Society, Technology
- Customer, Competitor, Economy, Technology, Society, Politics, Legal, Geophysical

However, the classification of the environment in different groups of drivers is mostly done arbitrarily. Due to the complexity of the world we are living in, it is difficult to explicitly classify every driver into one group. For example, many drivers are interrelated to each other and the classification can be incomplete because there is an abundance of drivers that can be taken into account. Therefore, the identified drivers are considered to be the most important external forces which serve to ease the understanding of factors that trigger the emergence of current and near term supply chain trends.

The following section tries to classify drivers affecting the development of global supply chain trends using the STEEP (social, technological, economic, environmental and political) framework.

Social

Social drivers refer to consumer's preferences and are mostly reinforced and implemented by society. During the last decade the *increased usage of information and communication technology (ICT) in society* has been a widespread development, especially triggered by the large penetration of personal computers, laptops or smart phones. *Demand volatility* influenced by the changing consumer taste can permanently alter a manufacturer's market. Furthermore, customer's demand becomes more *fragmented* due to the need of customized products. Triggered by the population and economic growth of emerging countries, there is also a *demand shift* of goods to these markets visible (McKinsey, 2012). The demand shift can also be classified as a demographic driver. Another

driver is the *environmental awareness of society*. Within the last years, consumers and investors developed a favorable perception of sustainable products and practices (McKinsey, 2012).

Technological

Technological drivers refer to technological achievements that change economic activities which are influenced by innovation and research and development practices in different disciplines. Especially in the field of ICT tremendous progress has been made in the last decades. In regard to supply chain trends the following drivers can be identified (Sulogtra, 2002). The a*dvancement of ICT* enabled an increase in data storage and processing speed. Furthermore, ICT advancements allow information sharing in real-time. An *increased usage of ICT technologies in the industry* mostly through the emergence of the internet enabled manufacturers to extend the conventional channels of procurement, distribution and other fields. Furthermore, software packages such as Enterprise Resource Planning allow the *ICT integration for logistics decision making*. Further drivers are the *standardization of data interchange* and *identification systems* such as RFID.

Economic

Economic drivers refer to general economic as well as financial characteristics and represent the largest group of drivers which have a relation towards direct financial measures or indicators but also show changes within customer needs. The GDP is one of the most common economic indicators to measure the development of a nation's economy. Especially the *GDP share* of emerging and developing countries increased during the last years which results in a *market enlargement* of these areas (McKinsey, 2012). On the other hand, economic growth has slowed down in the developed countries because of the global financial crisis in 2008-2009 and the European debt crisis. Rubin & Tal (2008) extensively discuss the implication of *increasing oil prices* on transportation costs. While in 2005 oil prices represented around 30% of transport costs it now accounts for almost half of freight costs. MacCarthy & Atthirawong (2003) identified a comprehensive list of drivers that are potentially relevant for location decisions but also for other supply chain trends. Among these drivers are *costs for transportation, inventory, resources* and *energy* as well as cost of *wages* and *transaction*. They further identify *labor characteristics* such as the *availability* and *quality* of the *work force* as well as *infrastructure* characteristics such as the availability of sufficient transport nodes as important drivers. *Exchange rates*, *tax incentives*, *tax structure* and the *availability to capital* or *foreign direct investment* also play an important role for location decisions. Another location specific characteristic is the *structural climate* (MacCarthy & Atthirawong, 2003). The *proliferation of product types* is caused by the increased demand for customized products (McKinsey, 2012). Further economic drivers influencing the development of supply chain trends are a higher risk of *obsolescence*, *lost sales* or the importance of *time to market* (Wisner et al., 2011).

Environmental

The environmental element considers the current situation of the physical and biological setting in which the supply chain of companies operates. On the one hand, the *carbon footprint* and the *emission of greenhouse gases* play a bigger role for firms especially within the European Union after the introduction of the Emission Trading Scheme while on the other hand the *depletion of natural resources* might cause a scarcity of raw materials or energy resources in the future. Furthermore, *climate changes* associated with the global warming and the *increase of the number of natural disasters* have a huge impact on the supply chain. For instance, five of the ten largest and financially

most devastating natural disasters took place within the last five years and consequently had a huge impact on global supply chains (McKinsey, 2012).

Political

Political drivers refer to policy initiatives through the work of governmental bodies in a single country or the collaboration of various countries together that are subsequently translated into specific measures. Throughout the last decades, major political events such as the fall of the 'Iron Curtain' or the foundation of the WTO in 1994 have influenced the emergence of numerous supply chain trends. The *opening of national economies* or the *market liberalization* and the *establishment of free trade zones* can be identified as facilitators of trade between nations (Sulogtra, 2002). Furthermore, the *deregulation of the transport industry* which was already discussed in Chapter 3.5.1, can be seen as a political driver (Niepmann & Felbermayr, 2010). Finally, *national policies* such as the support for domestic manufacturing, current issues with *intellectual property rights* and *regional trade agreements* between various countries are triggering the emergence of certain supply chain trends as well (Wisner et al., 2011; Kulisch 2012; McKinsey, 2012).

The abovementioned drivers are summarized in Figure 24. This list of drivers serves as a basis to research continuing as well as emerging supply chain trends.

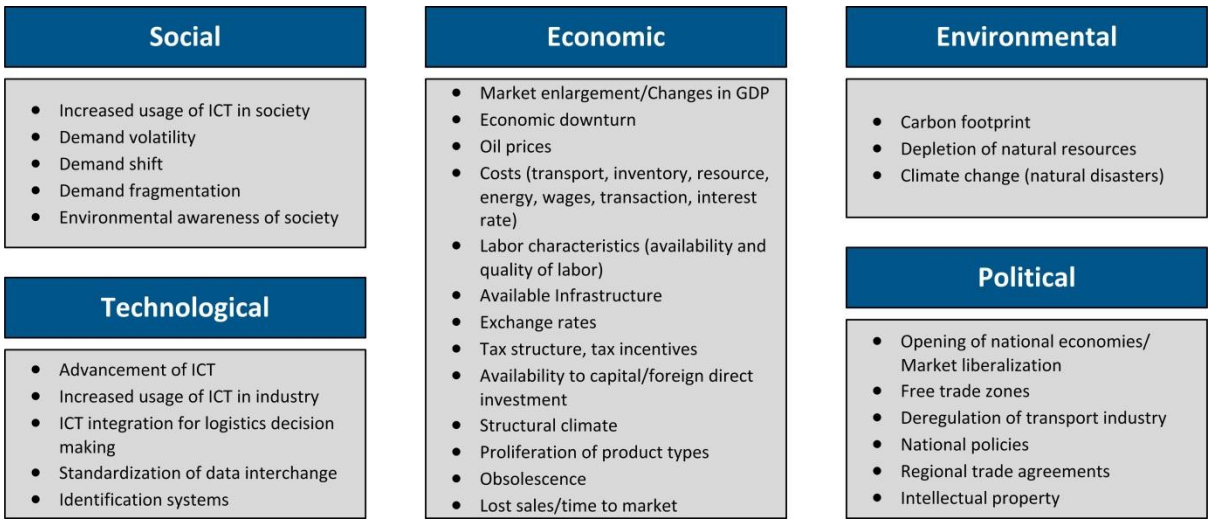


Figure 24: STEEP drivers

The trends which are affected by the abovementioned drivers will be discussed in the following chapter. These trends, gathered by an extensive literature review form the basis to examine global supply chain trends that have an impact on the air cargo industry by conducting in-depth interviews and a follow-up questionnaire with shippers of various industries.

4.4 Literature Review on Global Supply Chain Trends

This section identifies ongoing as well as developing supply chain trends based on an extensive literature review of academic articles, monographs, newspapers and industry magazines. SULOGTRA (2002), an European research project focusing on logistics and supply chain management trends and their impact on transportation discussed structural supply chain trends such as *wider geographical sourcing and distribution*, *vertical disintegration of production*, *rationalization of supply base,* a *spatial concentration of production and inventory* as well as the increasing development of *cross-docking/transshipments points.* Furthermore, this project which was done in collaboration with

various universities and research institutes in Europe mentioned the concept of *postponement* as a production trend as well as the trend of an *increase in direct deliveries* and a change in freight modal split towards road which results in a *mode shift* as product flow trends. Zhang et al. (2012) described emerging *shifts in production* either closer to the final place of consumption (*near-shoring*) or to *lower labor cost countries or areas* while PwC (2010) examined the trend of *shifting clusters*, especially to emerging markets. The shortening of the *product life cycle* and the factors enabling this development were indicated by Christopher (2011). The trend of *dematerialization of products* was first discussed by Schleicher-Tappeser et al. (1998). McKinnon (2010) described developments in *packaging* as a response to changing product characteristics. The widespread emergence of *3D printing* and its possible impacts on the logistics systems were examined in two white papers by Cottrill (2011) and Manners-Bell & Lyon (2012). Beesley (2010) provided an analysis on how manufacturing practices lead to the application of time compression principles which also influence the *speed of product flow* within the supply chain. Christopher (2011) further indicated a shift in size and frequency of shipments towards *smaller and more frequent shipments* as well as an increase of the *cost awareness* of corporations and its implications on logistics. Hesse (2002) examined the effects of *e-commerce* for logistics and freight transportation. An annual study on the third party logistics industry revealed the *increased outsourcing of logistics activities* (Capgemini, 2013). The increasing vulnerability of global supply chains to *risk* and the focus on an *resilient supply chain* were introduced by Jüttner et al. (2003) and Christopher and Peck (2004). The focus on *sustainability* within the supply chain is described in detail by Straube et al. (2010), Wu et al. (2012) and Ageron et al. (2012).

Table 13, represents a summary of the identified supply chain trends combined with the relevant literature sources.

Table 13: Reference list of supply chain trends

Trend	*References*
Wider geographical sourcing and distribution	Sulogtra, 2002; Trent & Monczka, 2003
Vertical disintegration of production	Sulogtra, 2002; Henstra et al., 2007
Rationalization of supply base	Sulogtra, 2002
Spatial concentration of production and inventory	Sulogtra, 2002; Christopher, 2011
Shifts in production (near-shoring, low labor cost area, industry clusters)	Zhang et al, 2012; Simchi-Levi 2011; Porter & Rivkin, 2012; PwC, 2010
Development of cross-docking	Sulogtra, 2002
Shorter product life cycle	Christopher, 2011; McKinsey, 2012
Changing value-to-weight ratio	Seabury, 2013a; US Bureau of Transportation Statistics, 2013
Changing packaging	McKinnon, 2010
Dematerialization of products	Schleicher-Tappeser et al., 1998; McKinnon, 2007
Postponement	Sulogtra, 2002; Zakery, 2011
3D printing	Cottrill, 2011; Manners-Bell & Lyon, 2012
Speed of product flow	McKinnon & Forrester, 2000; Beesley, 2010
Modal shift	Sulogtra, 2002
Increased direct deliveries and disintermediation	Sulogtra, 2002
Smaller and more frequent shipments	McKinnon and Forster 2000; Christopher, 2011
E-commerce	Hesse, 2002
Cost awareness	Christopher, 2011
Increased outsourcing of logistics activities	Capgemini, 2013
Increased supply chain risk and resiliency	Jüttner et al., 2003; Christopher and Peck, 2004
Sustainability	Straube et al., 2010; Wu et al., 2012; Ageron et al., 2012

The abovementioned trends can be classified in the following four groups: *structural supply chain trends, product characteristics and production trends, product flow trends and current supply chain focus trends*. The remainder of this chapter will briefly discuss each trend by looking at its drivers that lead to the development of the individual trend, the main characteristics of the trend as well as possible impacts on the air cargo industry. After that, all trends will be mapped by showing their interrelations towards each other. The chapter finishes by discussing the possible impacts on air cargo in more detail and identifying trends that deem to be most important for the air cargo industry.

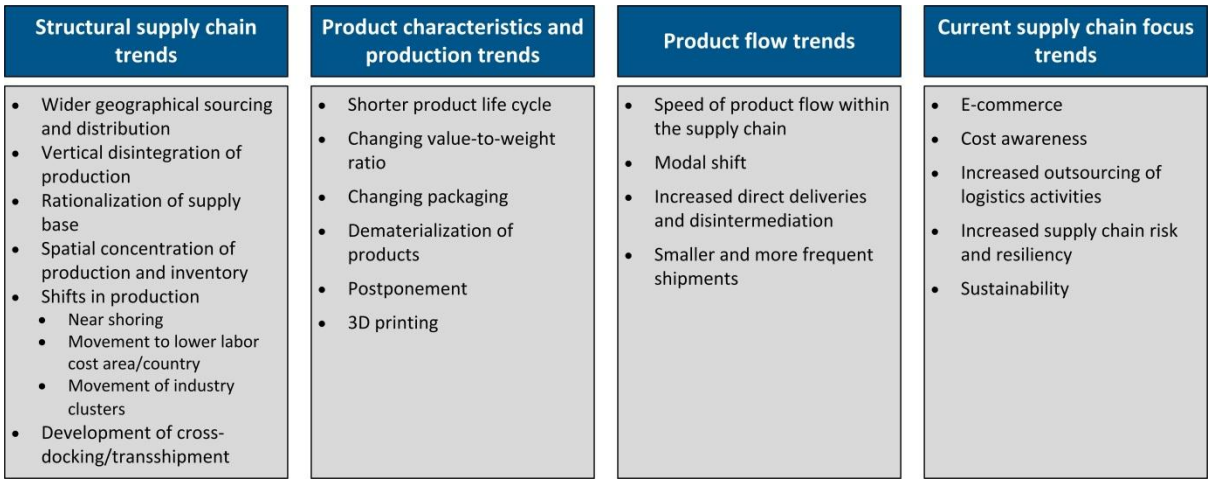


Figure 25: Categorized supply chain trends

4.4.1 Structural Supply Chain Trends

Structural supply chain trends relate to the physical structure of a supply chain. Hence, characteristics such as the number, location and capability of manufacturing plants and stockholding points as well as sourcing and distribution trends play an important role. Structural supply chain trends have primarily an impact on trading links dedicated to sourcing, manufacturing and distribution and impact air cargo volume and trade lanes.

4.4.1.1 Wider geographical Sourcing and Distribution

There is no doubt that in the past decades the world has moved closer together. As popular writers claim that 'the world is flat' (Friedman, 2005) or state 'the death of distance' (Cairngross, 1997) close proximity to suppliers and customers seems to be irrelevant. Due to the decline of transportation costs over the last five decades (Hummels, 2007), a trend towards wider geographical sourcing of supplies and distribution of finished products has emerged which extends the length of the supply chain in both directions, upstream and downstream. Global sourcing is mostly driven through the achievement of cost advantages i.e. cheaper labor, cheaper raw materials or beneficial exchange rates (Wisner et al., 2011). The trend is further encouraged by the deregulation of the transport industry as well as the opening of national economies or the establishment of free trade zones and regional trade agreements such as NAFTA, EU, COMESA or ASEAN (Wisner et al., 2011). Furthermore, the advancement in information and communication systems allows sharing of information between companies across the world.

Wider geographical sourcing can be described as procuring goods such as raw materials, semi-finished as well as finished products or services across national borders. Trent & Monczka (2003)

distinguish between international purchasing and global sourcing. While international purchasing is related to a commercial purchase transaction between a buyer and a seller which are located in different countries, global sourcing refers to the proactive "*integration and coordination of procurement requirements across worldwide business units, looking at common items, processes, technologies and suppliers*" (Monczka & Trent, 1991, p.2). A survey among 162 respondents revealed that global sourcing will become the dominant form of sourcing (Trent & Monczka, 2003). These findings are in line with a study conducted by PwC in 2008 where 46% of the respondents expected double digit growth rates for global sourcing (PwC, 2008). The same study revealed that around 85% of finished goods or retail products were sourced globally while raw materials and sub-assemblies represented 37% and 14% respectively.

However, various firms do begin to realize that besides the cost advantages made through global sourcing, many hidden costs appear such as transportation and logistics costs, customs and tariffs, currency risks, quality issues, a need for higher inventory levels as well as variable lead times (PwC, 2008; Wisner et al., 2011). Especially in short life cycle markets, there is the risk of obsolescence. This means that products become outdated and can only be sold with a rebate. Also, companies are more vulnerable of supply chain risks (Christopher et al, 2011). Therefore, companies might diversify their sourcing and distribution strategies based on an individual assessment for each product.

The trend towards a wider geographic sourcing of supplies and distribution of finished products increases the average length of haulage and the amount of freight ton kilometers which subsequently increases the transport intensity of the supply chain. For the air cargo industry this means that certain supplies or finished products that were formerly transported by truck are now switching to air and therefore could increase the volume of air cargo. This would be coupled with the emergence of new trade lanes.

4.4.1.2 Vertical Disintegration of Production

Since companies are focusing on their core competences to increase their competitiveness by specializing and gaining scale advantages, the number of production steps is increasing which leads to a vertical disintegration of production (Henstra et al., 2007). Thereby, manufacturing operations are decentralized which adds intermediate links in the transport chain and increases the transport intensity. The vertical integration is mostly driven by the globalization of the production process which is enabled by the access to cheap labor and the opening of national economies. Furthermore, it is linked to the trend of wider geographical sourcing of supplies and wider geographical distribution of finished products. Vertical disintegration increases the number of upstream and downstream tiers. Activities which are usually performed at the end of an assembly line such as product customization including re-labeling or re-packaging and configuration are outsourced to downstream tiers. The increase of upstream tiers in the supply chain can be illustrated with the example of the computer manufacturer Acer (see Figure 26). Components are sourced from many different component manufacturers which source parts from other suppliers while only a few contract manufacturers assemble products for Acer. The impact on the air cargo industry is rather limited and might lead to an increase in air cargo volume since extra transport links are added.

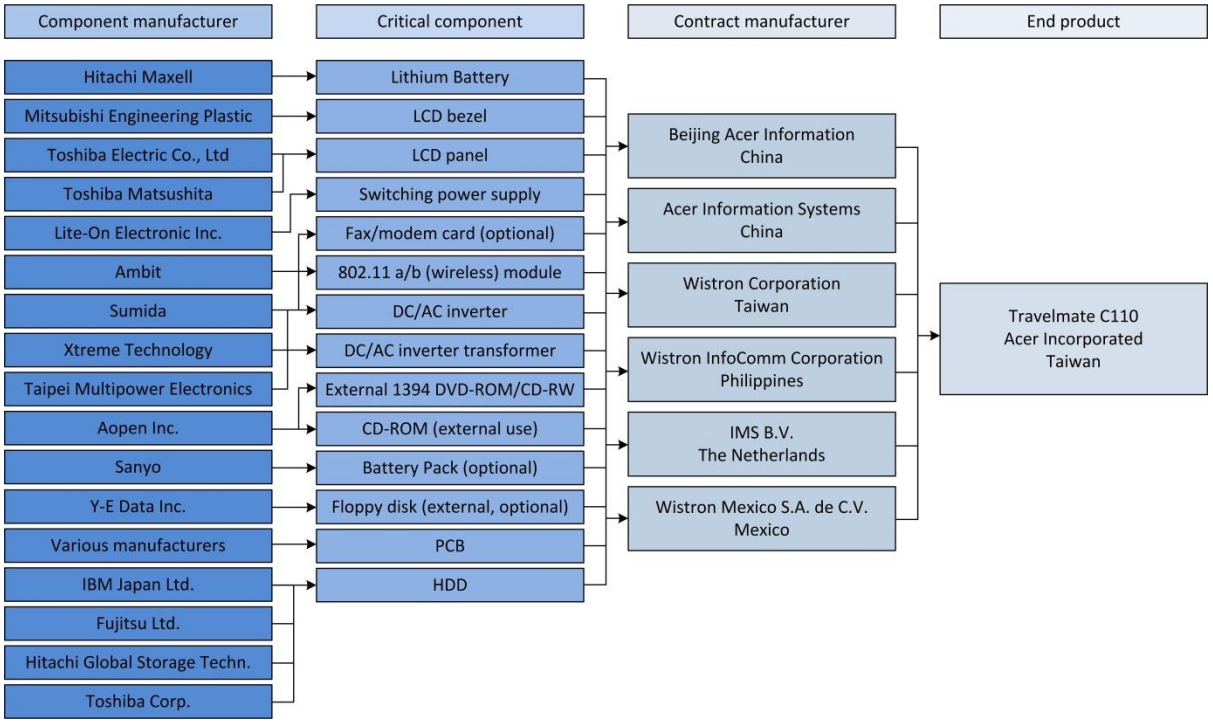


Figure 26: Upstream tiers of Acer's supply chain (adapted from Slob, 2005)

4.4.1.3 Rationalization of Supply Base

In many industries there is a trend of reducing the number of suppliers. The rationalization of the supply base is triggered by lower transaction costs as well as an increase in negotiation power towards the supplier. Furthermore, it reduces the complexity of the supply chain. Other advantages are that with fewer suppliers it is easier to establish a mutually beneficial long term relationship, quality variability can be reduced and transport economies can be achieved (Wisner et al., 2011). The extreme form of supply chain rationalization is a single sourcing approach where a company sources one item from a single supplier. This however leaves a company at greater vulnerability towards supply chain risk and increases the dependency on the single supplier.

Recent examples of supply base rationalization are shown by Moore et al (2002). For instance, Boeing tried to reduce the amount of suppliers from 31,000 to 18,000 within four years especially with smaller companies duplicating equipment while Nissan planned to cut its worldwide supplier base by 50% and then trying to reduce prices for the remaining suppliers by 20%. Due to a rationalization of the supply base, shipments are streamlined from fewer suppliers and can therefore be better consolidated. This results in a possible shift of trade lanes from many fragmented trade lanes to more condensed ones.

4.4.1.4 Spatial Concentration of Production and Inventory

Within the last years, there has been the tendency of manufacturers concentrating their production capabilities in fewer locations (see Figure 27) by reducing the number of factories and enhance greater plant specialization. This development is triggered by the emergence of free trade and the deregulation of the transportation industry (Niepmann & Felbermayr, 2010). Furthermore fewer factories and greater specialization allow for a more extensive usage of economies of scale. In practice this means that there is a shift from the traditional system of production for one nation or a local market towards so-called 'focused factories' where one plant produces a certain product for an

entire continent or even for the entire global demand. Such a configuration leads to a maximization of economies of scale and ultimately reduces the production costs while the supply chain becomes more transportation intensive and thus lead times increase. Another disadvantage of a focused factory is a loss of flexibility since it is designed to produce large batches and therefore cannot respond quickly to changes in customer demand (Christopher, 2011).

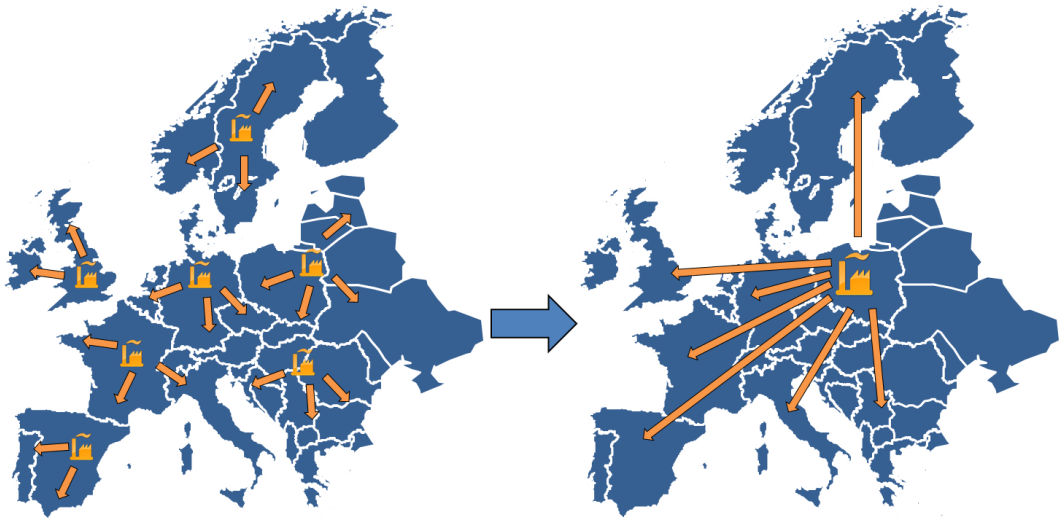


Figure 27: Spatial concentration of production

Examples of spatial concentration of production are the rationalization of production facilities within Unilever or Procter & Gamble (Christopher, 2011). While Unilever reduced its Western European plants within the business unit Lever from 16 to 11 plants, with each concentrating on a special product family, Procter & Gamble produces its potato chips Pringles in just two locations to satisfy global demand.

As for production, there is a similar trend in centralizing inventory in fewer stockholding points and therefore using mega warehouses or regional distribution centers. In 1998, the amount of planned large stockholding points (larger than 500,000 square feet) in the United States of America represented only 5%. By 2005, the share grew to 25% of all planned warehousing facilities (Andreoli, 2010). In Europe for instance, Philips reduced the number of warehouses for electronic consumer goods from 22 to 4 and Apple replaced 13 national warehouses with 2 regional distribution centers (Christopher, 2011).

This development is caused again by greater usage of economies of scale as well as free trade and the deregulation of the transport industry. Still, due to the advances in information and communication technologies, it is possible to centralize inventory without storing everything in a single warehouse. By controlling all inventories centrally and knowing the inventory of each stockholding point, the same safety levels can be achieved while having a higher flexibility by localizing inventory (Christopher, 2011). Due to the centralization of production and inventory trade flows are more streamlined and less fragmented. The impact on the air cargo industry is similar to the one of the supply base reduction.

4.4.1.5 Shifts in Production

Near-shoring

Within the last decade, many firms outsourced and offshored their production to low cost countries in Asia because of cheap labor, a stable global economy and rapidly growing local markets as well as decreasing transport costs (Goel et al. 2008; Zhang et al, 2012). Especially, the Pearl River Delta region in Southern China gained the nick name as the *'Factory of the World'*. However, within the last few years these beneficial conditions have fundamentally changed (Goel et al., 2008; Kulisch, 2012). Oil prices increased and became more volatile resulting in higher transportation costs. Currency valuations between importing and exporting countries put another strain on trade. Also, wages have increased in many former low-wage countries. AMR Research found that more than half of the companies who off-shored production encountered an increase in total landing costs opposing their wish for costs savings (Porter & Rivkin, 2012).

These changes might lead to a trend called near-shoring. This can be defined as shifting production of goods closer to the final consumption markets in order to minimize costs, reduce lead times and to maintain a more consistent time-to-market visibility and supply chain control (Bohn, 2012). One popular example examined in literature is the production shift from former off-shored production from China to the USA or its bordering countries such as Mexico. Apart from the abovementioned drivers, Kulisch (2012) mentions for this particular example a change in China's value added tax policy and intellectual property theft as a reason to near-shore. President Obama's industrial policy focusing on bringing manufacturing jobs back to the United States is an additional driver for the emergence of near-shoring. Furthermore, there is a growing demand in 'greener' products which suits a near-shoring approach (Burnson, 2011).

But which industries are most prone to switch to near-shoring? A study conducted by BCG (2008), identified seven industries to be at a 'tipping point', meaning that a considerable amount of goods produced for US consumption could move to the United States or nearby locations. Among these industries are computer and electronics, appliances as well as electrical equipment and machinery. Simchi-Levi (2011) developed a framework to match manufacturing decision with product and supply chain characteristics (see Figure 28). Goods such as TVs, refrigerators or car parts that are exposed to high transport costs compared to the value, irrespective of the cost of moving the infrastructure of manufacturing, are very likely to be near-shored. The same is true for goods which have a low impact on transportation as well as comparatively low costs of moving manufacturing infrastructure such as apparel and footwear. Industries for which the cost of moving the infrastructure is high and the transportation costs are low, e.g. PCs and mobile phones, are prone to stay off-shored. McKinsey tried to establish the optimal production location for five electronic products of different weight and manufacturing costs by developing a break even analysis (Goel et al. 2008). Surprisingly, by taking all costs into account, it was cheaper to assemble a TV or a midrange copier in the US, than producing a midrange server in Mexico and remaining production of a high-end server and an Ethernet switch in China. However, others see lower-tech, labor intensive industries such as fashion to move to the Western Hemisphere (Burnson, 2011). For the case of the US, most manufacturers prefer Mexico as the preferred location and describe it as the 'lowest-cost manufacturing locale' in the world (Burnson, 2011; Kulisch, 2012).

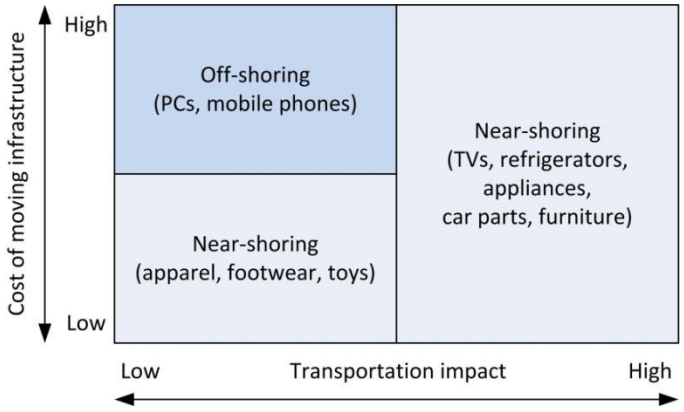


Figure 28: Taxonomy of shoring decision (adapted from Simchi-Levi, 2011)

A recent survey among 80 senior executives in manufacturing companies, conducted by AlixPartners (2011), revealed that 43% of the manufacturers are in the process of relocating or considering relocating within the next five years. However, near-shoring still has its limitations and needs to be kept in proportion. Most of the multinational companies are only re-shoring a small amount of their production for home consumption while the majority of off-shored production remains abroad (Economist, 2013a). Furthermore, the demand in emerging markets is growing faster than in developed countries which may lead to a shift or expansion of production to countries such as China, India or Brazil. A recent survey among Harvard Business School alumni responsible for location decisions in 2011, revealed that for location decisions at hand 57% of the decisions considered moving existing activities out of the US. 34% of the respondents considered locating new activities within the USA or elsewhere and only 9% reported the location decision was about moving existing production into the United States (Porter & Rivkin, 2012). Recent examples of production shifts towards the United States are the production of some of General Electrics' appliances to its formerly abandoned Appliance Park in Louisville, Kentucky (Fishman, 2012) or the announcement of Apple to produce Mac computers in the United States from 2013 (Satariano & Tyrangiel, 2012).

It is however important to understand that near-shoring does not just mean relocating the manufacturing plant closer to market demand. It requires a company to develop a network of local suppliers (Kulisch, 2012). It is also not realistic that all former off-shored production will move back to its originating area especially since demand in Asian economies is ever growing. For instance, around one third of the HBS alumni respondents said that proximity to customers and a faster-growing market lead to moving out of the USA (Porter & Rivkin, 2012). Therefore, it can be concluded that companies will utilize a strategy called 'right-shoring' which combines near-shore, far-shore and domestic opportunities providing the best combination of cost and efficiency (Burnson, 2011; Kulisch, 2012). A possible impact of near-shoring for the air cargo industry is a decrease in volume transported by air since finished products do not need to be shipped over long distances and can therefore be delivered by road. This is also connected to vanishing trade lanes.

Production movement to lower labor cost area or country

As mentioned before, the labor costs are increasing in Asia. Combined with higher logistics costs due to the rising oil prices, it might lead to manufacturing companies to move its production closer to demand. Not all manufacturers however consider moving away from low cost Asia, especially since labor costs are still lower than in developed countries and local demand is also increasing. It has to be mentioned that, the labor cost differences within Asia and China vary to a large extent. Especially in China's coastal areas such as the Pearl River Delta region, wages went up 70% from 2005 (Zhang

et al. 2012). Furthermore, there is a constant labor shortage within the coastal areas. To achieve further cost advantages, shippers can respond by moving their production to even cheaper low cost countries within Asia such as Vietnam, Thailand or Cambodia.

There is also a trend of moving to inland areas especially within China where labor costs are still considerable lower and an abundance of labor is available. The westward move within China is also triggered by the 'Go West' policy implemented in 2000 resulting in tax breaks for companies moving manufacturing facilities inland instead of moving out of China (Accenture, 2011). A survey conducted by the Chinese Manufacturers' Association in 2010 revealed that 31% of the surveyed manufacturing companies in the Pearl River Delta considered relocating their production facilities (Lam, 2012).

On the one hand, Zhang et al. (2012) conclude that the China-Inland option for labor-intensive industries seems reasonable if labor costs in China's coastal areas continue to rise. On the other hand, moving to other Asian low labor countries only makes sense if the Chinese currency continues to be devaluated. Current examples of the westward movement of multi-national companies are the movement of Foxconn, which is one of the original design manufacturers of Apple, to the Henan province and Intel and Hewlett Packard shifting production to Chengdu and Chongqing, located in the Sichuan province of China (Pomfret, 2010).

Whereas high tech production shifts towards the Chinese mainland, labor-intensive manufacturers are moving to other Asian countries. This is for instance reflected in the decrease of foreign direct investment in textile manufacturing in China by 18.9% while Indonesia and Thailand grew by 66% and 43% respectively within the first nine months of 2012 (HSBC, 2013). Another potential country for relocation is Vietnam where for instance Coach, a luxury brand for woman's handbags is shifting its production (Lam, 2012). However, it needs to be kept in mind that despite their low cost production capabilities, countries like Vietnam or Indonesia have a smaller workforce as well as an inferior infrastructure and transportation system which can create an obstacle to large scale production (Lam, 2012).

The relocation of production to low cost areas has the shift of trade lanes as a consequence. Furthermore, there might be an increase of air cargo volume since production is off-shored to low cost countries which require fast transportation.

Geographic shift of industry clusters

Within the last decades, location decisions have changed and it seems that due to the globalization of markets, the liberalization of trade and technological advancements of information and communication systems it is possible to source, produce and distribute goods globally. Hence, the role of location seems to be less important as a source of competitive advantage. However, there are certain industries that are clustered in a geographical area which show that location still plays a vital role. As defined by Porter (1998, p. 78) "*clusters are geographic concentrations of interconnected companies and institutions in a particular field*". In his seminal paper, Porter identifies clusters such as Silicon Valley in California or the leather fashion industry in Italy which gives individual members the benefits "*as if it had greater scale or as if it had joined with others formally – without requiring it to sacrifice its flexibility*" (Porter, 1998, p. 80).

Nowadays, industry clusters are being created globally by means of research parks as well as free trade and industrial zones (Wisner et al., 2011). Due to the shift of economic activities triggered by the increase in the share of world GDP from developed markets to emerging and developing countries, it is predicted that some of the world's largest clusters are also going to shift towards

emerging markets (PwC, 2010). The development of large clusters are for instance (Wisner et al., 2011; PwC, 2010):

- Singapore as the most attractive location for US high tech manufacturing firms
- Taiwan also nicknamed as 'Silicon Island' has the largest market share of motherboards, modems and scanners
- India emerged as a major player within the software industry
- The cities of Nanjing and Tianjin in China and Sao Paulo in Brazil developed as large clusters for the automotive industry

Furthermore, PwC expects Shanghai which attracted over US$ 1 billion in pharmaceutical foreign direct investment since 2005 to become one of the largest clusters within the pharmaceutical industry (PwC, 2010). Another example is the emergence of Thailand as a main manufacturer of cars also called the 'Detroit of the East'. But not only assembly takes place in Thailand. The rate of localization is, with more than 80%, extremely high (Economist, 2013b). However, not all clusters are successful and can therefore dissolve over time. For instance, Detroit, the automotive capital of the USA, experienced the closure of plants and employee layoffs since the major car companies relied on large gas consuming vehicles (Wisner et al., 2011).

The shift of new clusters has two impacts on air cargo. Firstly, there is a possibility of less air cargo volume since supplies and finished products are consumed locally. Secondly, if supplies are still sourced by air there is a possible shift in trade lanes.

4.4.1.6 Development of Cross-docking/Transshipment

The development of cross-docking or transshipment systems is strongly linked with the trend towards the geographic concentration of inventory in fewer stockholding points. While inventory holding becomes more centralized, cross-docking or transshipment systems remain geographically dispersed to maintain a close proximity between decentralized stockholding points and the end consumer.

Cross docking aims to reduce the stock along the downstream supply chain and enables a higher frequency and efficient replenishment of goods from manufacturer to customer (Christopher, 2011). It is enabled by the advancement of ICT systems such as point of sales which allows real time information sharing. Usually large quantities of goods arrive at the transshipment center where goods are mixed with other less-than-truckload shipments. Therefore, the cross-docking station serves as a distribution mixing facility where goods are not stored but immediately handled for new transportation (see Figure 29).

Cross-docking is especially becoming popular within the retailing industry of consumer products as it can save up to 10% of a shipper's logistics costs (Ernst, 2002). A survey of Saddle Creek (2011) among logistics managers revealed that 68.5% of the 219 respondents currently use cross-docking practices while in 2008 this was only 52%. Furthermore, 15% of the respondents are planning to implement cross-docking within the next 24 months. The most frequent factors for cross-docking were improving service levels, reduction of transport costs and consolidation of shipments to a destination (Saddle Creek, 2011).

The impact of an increase in cross-docking points on the air cargo industry is rather limited.

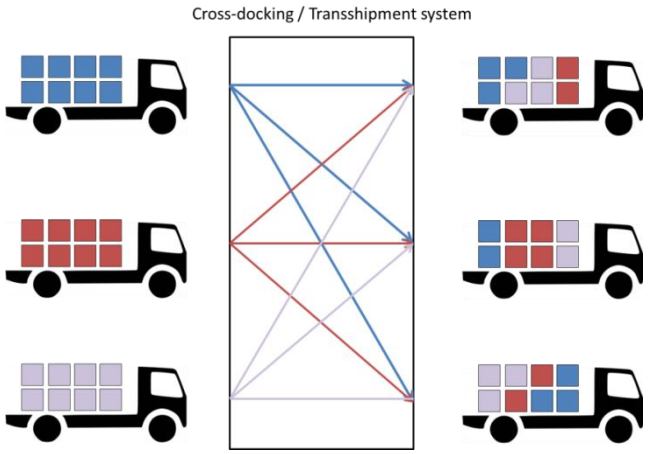


Figure 29: Cross-docking system

4.4.2 Product Characteristics and Production Trends

Product characteristics and production trends refer to changes in product design and length of product life cycle. Furthermore, it relates to developments on how goods are produced and manufactured.

4.4.2.1 Shorter Product Life Cycle

Due to the pressure of companies to develop innovative products responding to customer needs the life cycle of products has shortened. This is mostly the case, in sectors such as fashion, automotive, health care or high tech. For certain products, the life cycle is even shorter than the strategic lead time which includes design, procurement, manufacturing and distribution (Christopher et al, 2011). On the contrary, new products should not cannibalize the sales of existing products. Short life cycle products are goods that are produced and sold for a limited time, sometimes even less than twelve months or one season. After that period, products are usually replaced by a new version (Briano et al., 2010). Therefore, short life cycle products have a high potential of becoming obsolete. A study of McKinsey revealed that the average life cycle of different car manufacturers such as BMW, Audi, Honda, Mercedes Benz and Ford decreased between 5 to 19% from 2002 to 2011 (McKinsey, 2012). For instance the average life cycle of a BMW was 131 months. By 2011, the average life cycle declined to 106 months. Accompanied by a shorter product life cycle of products is the increased launch of new models or products. The number of new models of Audi or BMW for instance increased from 15 to 32 and 12 to 22 respectively within the last decade (McKinsey, 2012). The launch of new products is especially apparent in the high tech industry of consumable products such as smart phones, laptops or cameras.

Due to shorter product life cycles, fast and reliable transport becomes more important for shippers. Therefore, certain goods might become more eligible to be shipped by air which consequently increases the volume of air cargo.

4.4.2.2 Changing Value-to-weight Ratio

The value of a product is important for the planning of the logistics strategy. Since high-value products can easily absorb transportation costs, low-value products require an inexpensive transport system. As already mentioned in Chapter 3.4, a high value-to-weight ratio makes goods more prone to be shipped by air. Within the last decade, the value-to-weight ratio continuously increased as

depicted in Table 14. The average value-to-weight ratio of all commodities increased for global trade as well as for US imports from Canada and Mexico (NAFTA) between 2004 and 2011 with a compound annual growth rate of 6.5% and 6.3% respectively. One reason for a higher value of products is the increased product complexity and sophistication in production. Another reason for a higher value-to-weight ratio is inflation. However, in the same time period the global as well as US inflation was lower with a compound annual growth rate of 5.2% and 2.4% respectively (World Bank, 2013). Therefore, it can be conclude that the average value-to-weight ratio increased taking inflation into account.

Consequently, some commodities might switch from one mode of transportation to another, especially from sea to air, since the higher value of a product can easier absorb the high transportation costs which results again in an increase of air cargo volume.

Table 14: Value-to-weight ratio from 2004 - 2011 (Source: Seabury, 2013a; US Bureau of Transportation Statistics, 2013)

Year	*Value-to-weight ratio (US$/kg) Global trade*	*Annual growth*	*Value-to-weight ratio (US$/kg) Imports USA (NAFTA)*	*Annual growth*
2004	0.837	-	0.981	-
2005	0.917	9.56%	1.078	9.87%
2006	0.997	8.72%	1.164	7.98%
2007	1.088	9.13%	1.250	7.43%
2008	1.193	9.65%	1.408	12.62%
2009	0.996	-16.51%	1.195	-15.14%
2010	1.165	16.97%	1.376	15.14%
2011	1.299	11.50%	1.502	9.22%

4.4.2.3 Changing Packaging

Packaging is one of many logistics elements. On the one hand it protects goods from weather or shocks and enables a safe transport and better stowability. On the other hand it also enables labeling which helps to identify products. McKinnon (2010) argues that there is an increase in packaging because goods become more valuable and fragile and therefore need more packaging. Since packaging materials such as cardboard are relatively light, an increase in packaging will reduce the packaging volume to product volume ratio and ultimately decrease the average weight density of freight shipments.

However, due to the environmental impact of packaging and the possibility to reduce transport costs by decreasing packaging many companies redesign their packaging. For instance, Wal-Mart aims to reduce its packaging by 5% until 2013. This will reduce the emission of around 667 tons of carbon dioxide into the atmosphere and decreases shipping and fuel costs (Wisner et al., 2011). Procter and Gamble reduced the packaging for its detergents and dish soaps by two thirds which ultimately decreased total supply chain costs (Vitasek & Geary, 2003). For the packaging of Apples' iPhone, its package volume was reduced by 42% from 2007 to 2011. This enabled Apple to ship 80% more iPhones per flight saving one flight on a Boeing 747 every 371,250 shipped units (Stilwell, 2012).

The impact of packaging on the air cargo industry might be related to the air eligibility depending if packaging becomes more voluminous or not. Furthermore, if packaging becomes less voluminous, air cargo volume will be adversely affected.

4.4.2.4 Dematerialization of Products

Schleicher-Tappeser et al. (1998, p. 4) define dematerialization as the "*reduction of material resources required per unit of GDP*". The dematerialization of products relates to a reduction of the amount of components and material needed for a product or service or to increase the value of a product or service. Several processes such as the miniaturization of products, the replacement of heavier materials by lighter ones, the reduction of packaging and the digital distribution of information and entertainment based products that used to be transported in physical form, led to a dematerialization of products (McKinnon, 2007).

One example of dematerialization is the digitalization of products. Due to the improvements of information and communication technology, the electronic distribution of books, music or software by downloading via the internet is becoming a common practice (Vitasek & Geary, 2003). For instance, eBooks represented 22% of all book spending in the second quarter of 2012, an increase from 14% compared to the same period in 2011 (Milliot, 2012). However, dematerialization or the conversion of physical goods to digital goods is limited to a certain degree as there will always be a need for materialized goods and services.

Still, if products become smaller in size and/or lighter in weight, dematerialization can reduce the volume of air cargo and furthermore can have an impact on the required carriage such as switching from main deck to lower deck.

4.4.2.5 Postponement

Since product life cycles are shortening and customers are demanding individual products, it becomes more difficult to forecast future sales. One response to this, is a strategy called 'postponement' or 'delayed configuration' which refers to the process "*by which the commitment to a product to its final form and location is delayed for as long as possible*" (Christopher, 2011, p. 114). Postponement can be distinguished between geographical and product form postponement (Zakery, 2011). Geographical postponement suggests holding inventory centrally as long as possible and only commit it to a target market when customer orders are received or forecasts are more accurate. Product form postponement proposes to delay the final production steps as long as possible until the definite customer need is known. Therefore, inventory will be held in a more generic form which decreases inventory costs and enhances the flexibility of usage which ultimately leads to a higher forecasting accuracy (Christopher, 2011). Postponement also offers bigger product variability which allows a better match between customer needs and existing products which eventually increases sales. A famous example of postponement is Dell's built-to-order strategy allowing Dell to make approximately 100 million different computer configurations (Kumar & Craig, 2007).

Postponement can be achieved by using a 'design for localization' approach by which products and processes are designed in a way that semi-finished products can be assembled and configured based on the smallest number of modules and components (Christopher, 2011). An example of postponement within the aviation industry is the latest regional jet of Embraer. Currently, Embraer has two postponement points as illustrated in Figure 30. The first decision point is around one year before delivery when customers have to decide about a product family (Embraer 170 or 190). Half a year later a decision about configurations and engines has to be made which differentiates between an Embraer 170 or 175 as well as an Embraer 190 or 195. After that, seating arrangements, paint,

inflight system and interior design will be decided on. This strategy gives Embraer the required flexibility to respond to the changing environment in which their customers, mostly airlines operate.

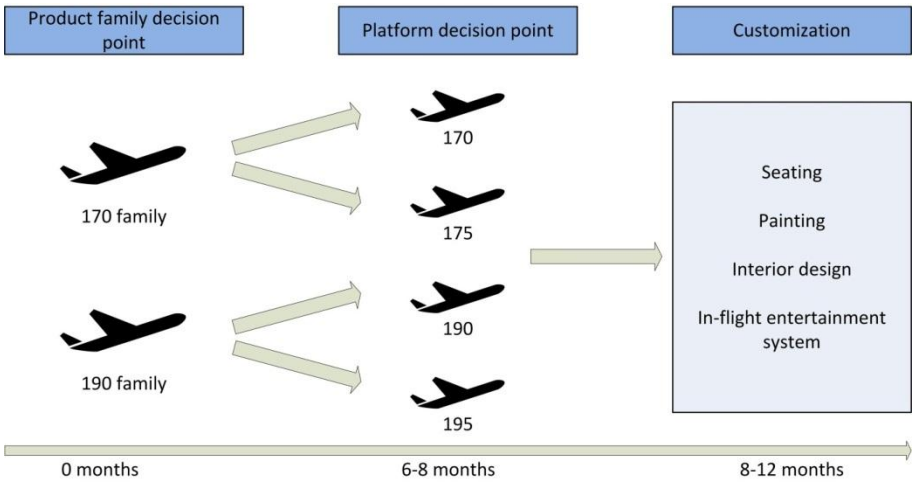


Figure 30: Postponement strategy of Embraer (adapted from Rietze, 2006)

The concept of postponement has an influence on the air eligibility of products. Finished products have a higher value than its supplies. This might result in a decrease of air cargo volume since formerly finished products shipped by air do not require air transportation because of the close proximity to end customers. On the other hand, the supplies might be shipped in bulk on a different mode of transport.

4.4.2.6 3D Printing

For more than a decade 3D printers have been used to mostly make quick prototypes before starting large scale production. As 3D printers have become more proficient and can use a wide range of different raw materials such as plastics or metal powder, 3D printing is increasingly being used for the manufacturing of final products. Currently, around 28% of printed goods are final products. This will most likely increase to 50% by 2016 and 80% by 2020 (Economist, 2012a). Even though, 3D printing is still in its early stages of development for large scale production, it has the potential to become one of the biggest disruptive phenomenon that can impact global manufacturing and lead to a reversal of global sourcing and distribution (Manners-Bell & Lyon, 2012).

3D printing also known as 'additive manufacturing' is the process of building up layers of material such as plastic, ceramic or metal powders by using a computer aided design. It is called an additive process since a thin layer of material is 'printed' until a three dimensional product is formed (Manners-Bell & Lyon, 2012).

The current development around 3D printing is triggered by the possibility to effectively respond to the demand fragmentation and demand volatility of consumers as well as the proliferation of product types which lead to shorter product life cycles. Furthermore, it eliminates the manufacturing process of goods which can achieve large costs savings in terms of labor, inventory, handling and distribution. Simple products can be produced at home while complicated goods will be produced by local fabshops (Hastings, 2012).

The product advantages of 3D printed goods are a reduction in weight as well as a reduced usage of material compared to conventional methods. Therefore, 3D printing is already applied within the aviation industry where weight and material savings result in huge cost advantages. For instance, GE

is planning to use 3D printing for the production of its LEAP jet engine while Airbus will use additive manufacturing to produce its wings (Economist, 2011; 2012b). The biggest effects of 3D printing will probably be visible in the service parts industry. With 3D printers at every spare part warehouse, service parts could be printed just-in-time and on demand which would reduce holding costs of expensive service parts (DHL, 2013).

The implications of 3D printing for the logistics industry are manifold. A large proportion of goods being globally sourced and manufactured in Asia could be near-shored to its consumption markets in North America or Europe leading to a decline in global transport especially for air freight (Hastings, 2012). Furthermore, due to the possibility of mass-customization by a make-to-order production process, inventory levels of semi-finished and finished products would decline while the storage and transportation of raw materials as feedstock for 3D printers becomes more important (Manners-Bell & Lyon, 2012). Lastly, integrators such as UPS or DHL could function as a new type of hub where products can be made, assembled and distributed (Cottrill, 2011).

By all that enthusiasm for 3D printing it has to be mentioned that mass manufacturing by producing millions of units is a distant goal especially since the production of an individual item still takes more time than conventional production (Cottrill, 2012). This enthusiasm or hype for 3D printing is also illustrated in Gartner's 2012 hype cycle for emerging technologies in which 3D printing is on top of the 'Peak of Inflated Expectations' (Forbes, 2012).

4.4.3 Product Flow Trends

Product flow trends are related to changes in the way products are transported. This includes the speed of product flow, the transport mode, the shipment size and frequency and the trend towards direct door-to-door deliveries.

4.4.3.1 Speed of Product Flow in the Supply Chain

As Benjamin Franklin stated over 200 years ago 'Time is Money', Stalk and Hout recapped this quote in 1990 by arguing that 'time is the last exploitable resource' (Beesley, 2010). During the 1990s and 2000s several supply chain principles such as JIT, efficient customer response, quick response, lean or agile logistics were introduced largely driven by the improvement of ICT systems and their integration in decision making, leading to a decrease in average order lead times by 25% from 1998 to 2003 (McKinnon & Forrester, 2000). However, with the ongoing trend of sourcing, producing and distributing goods globally, it seems quite contradictory to be able to shorten the lead times of products. Generally, by increasing the speed of product flow through the supply chain inventory levels can be reduced, a lower risk of product obsolescence is present and shippers can respond faster to demand volatilities. A reduction in transit time leads to a reduction in pipeline costs. Furthermore, the time to market of products becomes more important and has developed into a competitive advantage for companies. Hummels and Schaur (2012) calculated that every extra day in transit represents an ad-valorem tariff of 0.6-2.3%. Goods such as components or parts are most time-sensitive. Furthermore, Nordås (2010) found that an increase in shipping time of one day reduces the change that a shipper will export goods to the USA by 1.5%.

Of course the speed of delivery is largely influenced by the transport mode. While air transportation usually does not take longer than two to four days for the complete transportation, ocean shipping takes four to six weeks on most intercontinental routes.

However, within the different modes of transport different service levels exist. Some shippers especially in the high tech industry, require the fastest possible transportation within air transportation if for instance new products are launched. This means that first batches of goods are shipped by integrators with express services while later batches are shipped as economy air freight or even switch to ocean once the product is has matured. Furthermore, many high tech shippers such as Samsung or Apple use cargo charters to ship their products as fast as possible for product launches. For the launch of the iPhone 5, Apple chartered up to 70 aircrafts which resulted in a spike of rates (Neate, 2012).

Still, due to the increased transportation costs and the consequences of the financial crisis, many shippers also tend to go in the opposite direction and aim for 'despeeding' the flow of their products to save costs. Especially for commodity like products this is the case since one or two days of extra transit time do not matter as long as cost advantages in terms of rates can be achieved. This results in a shift from expedited to deferred shipments. Nevertheless, longer lead times need to be balanced with the requirements set by the individual shipper and its customer. However, Pearson and Semeijn (1999) show that reliability (transit time reliability and pick up service reliability) are most important for shippers before transit time and costs. The changing speed of product flow for certain goods can have an impact on the type of service level and the type of carrier being selected for the transportation of products by air.

4.4.3.2 Modal Shift

The transport of many commodities is determined by its product characteristics. While air transportation has a transit time of a few days, transportation by ocean takes around four weeks or more depending on the route. Perishable goods (economic and physical) as well as emergency shipments are most likely transported by air. Also, the value density and therefore the looked capital on inventory during transit needs to be taken into account. Another criterion is the demand volatility. The more volatile the demand of a good the more responsive a company's supply chain needs to be and hence either requires higher inventory levels at stockholding points close to end consumers or fast and reliable transport modes such as air transportation. Still, air transportation is up to 10 times more expensive than transportation by ocean (Shaw, 2007, p. 41). One way to determine the right mode of transport is to calculate the total logistics costs by taking transport costs and pipeline costs into account. A brief example examines the modal choice for the shipment of laptops from Asia to Europe (Tavasszy and Ruijgrok, 2013).

> What mode of transport should be used to transport 1.000 laptops with a total value of € 500.000 from Asia to Europe?
>
> Ocean: Transit time is five weeks (1/10 of a year) at an interest rate of 10% resulting in pipeline costs of € 5.000. Transport costs per container are around € 1.500. Total logistics costs: € 6.500
>
> Air: Transit time is 3 days (1/125 of a year) at an interest rate of 10% resulting in pipeline costs of € 400. Transport costs are around € 6.000 (2€/kg* 3kg/laptop *1.000 laptops). Total logistics costs: € 6.400

In this example, it can be seen that the total logistics costs for certain products are actually quite similar for ocean and air transportation. However, if the value density of a good is low, the pipeline

costs can be neglected and ocean transport will be favored. The same is true if transport costs are increasing, since the share for air transport is many times higher compared to ocean transport.

The high increase of oil prices from 40 US$/barrel to around 120 US$/barrel within the last decade and hence an increase in transport costs may result in a shift from air to ocean. This trend is further encouraged by higher arrival reliability of container ships at ports (Leach, 2012). Furthermore, customers continue to develop a greater environmental awareness and often demand shippers to decrease their emission of CO_2 and other greenhouse gases. A recent survey conducted by the investment firm Stifel, Nicolaus & Co. and the U.K. research firm Transport Intelligence Ltd, revealed that more than 80% of shippers operating between Asia, Europe and North America expect a continued shift from goods formerly transported by air to ocean (DC Velocity, 2012). Especially high tech products are expected to shift from air to ocean structurally mostly because of the higher weight compared to for instance pharmaceuticals (Lloyd's List, 2013). According to Seabury, nearly 2.6 million tons of air cargo shifted from air to ocean between 2000 and 2011 representing 30% of the decline in total air weight share from 2.9% to 1.7% while the lane and commodity effect[3] represents 60% and 10% respectively (Seabury, 2012a).

On the other hand, many shipping lines drastically decrease the speed of their vessels in response to higher oil prices and engage in a trend called 'slow steaming' which means that the vessel speed is reduced from around 24 knots to 18 knots. Since not every shipper can easily cope with a 40 day transit time instead of 25 days, slow steaming might encourage some shippers to actually shift from ocean to air or use a combination of sea/air transportation.

Another way how shippers can save costs is to seek cheaper transport by switching from time-definite to day-definite deliveries as well as from express air freight to standard air freight which is for instance done within the fashion industry (Cargonews Asia, 2011). A similar trend is also demanded by consumers as a BCG survey revealed. Out of 1.500 consumers only 9% preferred costly same day delivery while the majority regarded free delivery or lower prices as their choice even though delivery would take longer (BCG, 2013).

The implications of a modal shift from air to ocean on the air cargo industry is straightforward and poses one of the biggest impacts. Air cargo volume can either increase or decrease depending if certain products convert or vanish to be air eligible. Furthermore, there can be an increase or decrease of the type of service level that will be used by the shipper such as a switch from expedited to deferred shipments and vice versa as well as a change in carrier selection from the integrated carriers (integrator) to the non-integrated (airport-to-airport) carriers and vice versa. .

4.4.3.3 Increased Direct Delivery and Disintermediation

Due to the advancement and integration of information and communication technologies but also due to the emergence of logistics providers that offer door-to-door transport services there has been an increase of direct deliveries over time. The increase in direct delivery, especially in business to consumer markets, is a direct consequence of consumers wanting products delivered directly to their home. This trend is further triggered by the increase in e-commerce and also supported by the centralization of inventory. According to the Aberdeen Group (2012), products in the retail sector

[3] Lane effect is the change in air share due to uneven growth on trade lanes where air share deviates from global average. Commodity effect is the change in air share due to uneven growth of commodities where air share deviates from global average

are 2.26 times more likely to be delivered directly to the customer than in other industries. The same study revealed that 49% of companies in the retail and consumer sector are using direct delivery strategies. The benefits of such strategies are a faster and better response to volatile demand as well as a better inventory optimization and inventory placement (Aberdeen Group, 2012).

One result of direct deliveries is the process of disintermediation by which shippers can bypass the middle-men in the traditional supply chain such as wholesalers or retailers and distribute goods directly to consumers (Gunasekaran et al., 2002). In the conventional supply chain, for example a pharmaceutical manufacturer produces its prescription drugs and employs wholesalers and retailers (pharmacy) to distribute its products from the plant to the patient. Wholesalers deliver multiple times a day from their stockholding points to guarantee that particular medication is available at the pharmacy. Patients that have a prescription go to the pharmacy to receive the medication. By using a direct delivery strategy the physician can forward the prescription for a certain drug to the manufacturer who picks, packs and ships the drugs to the home of the patient and therefore neglecting intermediaries (see Figure 31).

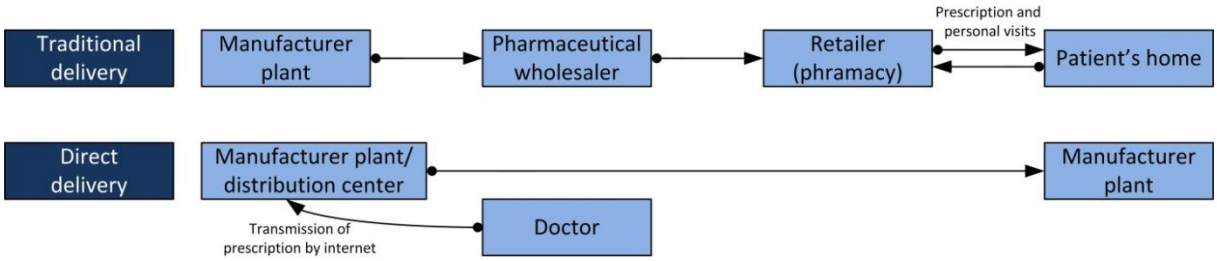


Figure 31: Conventional and direct distribution of pharmaceuticals (adapted from Duncan, 2010)

Due to direct deliveries, some of the traditionally intermediaries will be replaced in some way and certain business models might become outdated. Because of the emergence of the internet, a wide range of new business opportunities evolve leading to a process of re-intermediation such as the e-retailer Amazon (Gunasekaran et al., 2002; Duncan, 2010). An increase in direct deliveries would most certainly favor integrators since they can offer direct door-to-door transportation and hence impact the type of carrier being used.

4.4.3.4 Smaller and more frequent Shipments

Due to the increased customer demand in just-in-time (JIT) deliveries but also due to the move towards demand fragmentation and proliferation of product types, the shipment size has decreased whilst shipment frequency has increased over time (Christopher, 2011). JIT helps to lower inventory levels since material and components are only re-ordered and stored for current operations. Furthermore, storing less work in progress and finished goods reduces the necessary amount of warehousing space. Smaller and more frequent shipments are further triggered by e-commerce and the trend of direct deliveries. The disadvantage of smaller and more frequent shipments are declining load factors and higher transport costs. However, these trade-offs are offset by far greater cost reductions as mentioned above. McKinnon and Forster (2000) argue that within the retail sector, delivery frequency was expected to increase by 26% within the last ten years while average order size would decrease by 9%. Similarly, small freight shipments (less than 500 pounds) within the USA, increased by 56% from 1993 in value showing a trend towards smaller and more frequent shipments (US Department of Transportation, 2004).

Smaller and more frequent shipments also favor integrators since they are specialized in handling small and time-sensitive shipments and therefore again impacting the type of carrier being used.

4.4.4 Current Supply Chain Focus Trends

Current supply chain focus trends deal with a wide spectrum of changes in the supply chain. On the one hand, developments in ICT lead to an increased usage of e-commerce. On the other hand, due to the economic downturn, there is an increased awareness of cost reduction also resulting in the outsourcing of logistics activities to third party logistics providers. Furthermore, supply chains are exposed to mores risk and disruptions and therefore need greater resiliency. Lastly, supply chains deem to become more sustainable and green.

4.4.4.1 E-commerce

E-commerce can be regarded as the collective term of engaging in business transactions via an electronic platform. Hesse (2002, p. 216) refers to e-commerce as "*the exchange of information and to transactions between different commercial agents*". It can be distinguished between business to business (B2B) and business to costumer (B2C). Due to the interaction of technological innovation and their usage by corporations and households e-commerce has evolved over the last years leading to spatial consequences such as the flow of goods, transport operations, facilities and infrastructure (Hesse, 2002).

B2B e-commerce represents the majority of total e-commerce sales. For instance in 2003, sales in manufacturing and wholesale represented 21% and 14.6% respectively of total sales. Five years later the share has increase to 40% for manufacturing and 16.3% for wholesale (Christopher Jr. 2011). One reason why B2B e-commerce is so large in its scale, is because B2B transactions were deployed by electronic data exchange in the 1970s and 1980s. On the other hand, B2C e-commerce has been growing especially in retailing. In 1999, it just represented 1% of total retailing in the USA and increased to 3.6% in 2008. In 2012, US retail e-commerce represented 5.2% of total retail and increased by 15.8% from 2011 whereas total retail sales only grew by 5% (US Census Bureau News, 2013).

The advantages of e-commerce in a B2B market are that orders can be received with higher reliability and predictability, order and delivery times are decreased, changes can easily be processed and firms experience a higher market transparency (Hesse, 2002). B2C markets have a large effect on the buying behavior. Consumers can shop 24 hours and seven days a week online at home or with the help of portable devices and are therefore not restricted to opening hours or geographic locations. E-commerce further reduces the consumer search costs and the price dispersion for many goods (Christopher Jr., 2011).

The fast growth of B2C e-commerce in retail has also benefitted services offered by integrators since online purchases require the delivery of the product by a third party such as DHL, UPS or FedEx (Anderson et al., 2003; Christopher Jr., 2011). Integrators are able to consolidate the single shipments and deliver them economically through its large network. Therefore, e-commerce impacts the type of carrier selection.

With the emergence of e-commerce, other supply chain trends are influenced such as the tendency towards smaller and more frequent shipment as well as direct deliveries which might result in the

process of disintermediation where shipper might by-pass the middle men in conventional supply chains (see Chapter 4.4.3.3).

4.4.4.2 Cost Awareness

Triggered by the economic downturn as a result of the financial crisis from 2008-2009 and the European debt crisis, shippers in many industries need to look at cost reduction within their supply chains. Cost reduction is always a desirable goal but becomes especially apparent when the economy is in a recession. Still, cost reductions are only acceptable if it does not impact value creation negatively. Therefore, a low-cost approach might be efficient but not necessarily effective in terms of logistics (Christopher, 2011).

Predominant ways to reduce costs within the last decade were outsourcing and offshoring strategies as well as strict cost control and rationalization programs (PRTM, 2008). However, as discussed in Chapter 4.4.1.5, not all outsourcing or offshoring approaches have achieved the intended cost reductions since total landed costs were not taken into account. Other strategies to reduce costs are lean principles such as reducing wastes or lead time reduction and time compression by which non-value adding activities are reduced. Another strategy is to decrease inventory levels which are currently at a consecutive 45 month low measured by the Customers Inventory Index indicating that inventory levels of finished goods are very low (Solomon, 2013). The downside is, that low inventories make a company vulnerable against demand fluctuations that might require expensive expedited transportation. Cost reductions can also be achieved by switching to cheaper but most often slower modes of transport or switching from express to economic services within a transport mode. However, the aim is not just to look at the most apparent costs such as transportation or storage costs but to have a holistic approach that identifies cost by looking at the total pipeline and is based on true 'end-to-end' costs (Christopher, 2011). This means that costs within a supply chain need to be more visible to get a better view on how costs are incurred and allocated (Journal of Commerce, 2012). Among supply chain executives, reducing total supply chain costs scores highest in 2013 and is expected to further increase in importance in the upcoming two years (PwC, 2012). The impact of cost awareness for the air cargo industry might result in a decline of air cargo volume since former goods being transported by air are shifted towards ocean or other transport modes.

4.4.4.3 Increased Outsourcing of Logistics Activities

As already mentioned in the last chapter, shippers are forced to cut costs without compromising the quality of products and services. The need for cost reduction has become more prevalent since parts of the global economy are hit by the current economic downturn, especially in Europe. One fundamental way to reduce costs while increasing productivity and customer satisfaction is to outsource business functions that can be regarded as not core activities. The decision to outsource business functions goes back to transaction cost theory which decides if certain activities are internally done or secured from the market. Transportation, warehousing and other logistics activities are increasingly outsourced to third party logistic providers to realign the supply chain of a company and making it more agile, adaptable and efficient. The trend towards outsourcing of supply chain activities to third-party logistics providers (3PL) has been increasing during the past 15 years by 15% annually (Wisner et al., 2011). 3PLs can be defined as external companies that perform logistics functions which have traditionally been done within the company and can range from the entire logistics process to selected activities within that process (Skjoett-Larsen, 2000).

In 2009, four out of five US companies used 3PL for at least one logistics function. Nearly 47% of the total logistics in the US and 66% in Europe were spent on outsourced activities (Blanchard, 2009). In 2011, the amount of money spend on outsourced logistics activities accumulated to US$ 616 billion, an increase of 13.7% compared to the year before (Capgemini, 2013). A study of Georgia Institute of Technology found that using 3PL can realize cost savings for logistics of 13% (Wisner et al., 2011). Within the area of logistics outsourcing transportation (71%), warehousing (63%) and freight forwarding (53%) scored highest according to a survey among 2,342 industry executive in 2013 (Capgemini, 2013).

The impact of an increased usage of 3PL on the air cargo industry is rather limited since outsourcing of logistic activities does not influence air cargo volume, trade lanes and other impact criteria.

4.4.4.4 Supply Chain Risk and Resiliency

In 2000, a fire at a sub-supplier of Ericsson in Albuquerque, New Mexico caused a major loss of about US$ 400 million since the sole supplier was not able to supply microchips needed for the production of mobile phones. This resulted in the delay of the production and consequently caused Ericsson to stop in-house production of mobile phones (Norrman & Jansson, 2004). Another example the tsunami in Japan in 2011 where semiconductor manufacturer Renesas reported to have lost US$ 600 million while Toyota lost approximately US$ 1,300 million only topped by Toshiba suffering losses of US$ 2,900 million due to supply shortages (Brennan, 2011). These two examples show how vulnerable today's supply chains are and how supply chain risk is further driven by the following factors (Norrman & Jansson, 2004; Thun & Hoenig, 2011):

- Globalization of supply chains
- Demand variation of products
- Outsourcing and offshoring
- Reduction of suppliers
- Focus on efficiency by reducing buffers (lead time and inventory)
- Increased demand for on-time deliveries
- Shorter product life cycles and faster time-to-market
- Central distribution and production

Supply chains have become more connected on a global scale making them more complex. But also due to a continuous drive to improve efficiency and to cut costs supply chain risk exposure is increasing and hence the number of disruptions is growing as well. A survey conducted by the Business Continuity Institute in 2011, found that more than 80% of companies operating a global supply chain were exposed to at least one supply chain disruption within the last 12 months (Deloitte, 2013).

Jüttner et al. (2003, p. 200) define supply chain risk as *''the variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective values''*. Christopher and Peck (2004) distinguish between external and internal risks. While external risk can be considered as external events such as strikes, war, natural disasters or terrorist attacks, internal risk can be further divided in cross-company risk and internal company risk. Cross-company risk can either be based on downstream operations, related to quality issues or insolvency of suppliers as well as on upstream risks which are reflected by demand uncertainties. IT problems or machine failures are regarded as internal company risk. In Figure 32, external and internal risks are mapped according to their impact

and probability. It is apparent that internal risks have on average a higher probability and more severe impacts on the operations of a company.

A current study of Deloitte (2013) found that demand fluctuations, margin erosion such as cost increase or lost revenues and physical product flow disruptions, were the top three risks firms are exposed to. Another study of the World Economic Forum (2013) focusing more on system wide risks, revealed natural disasters, extreme weather, conflict and political unrest, terrorism and sudden demand shocks as the most prevailing risks. The growing importance of natural disaster and extreme weather is depicted by the fact that five of the ten most financially costly natural disasters took place within the last five years (McKinsey, 2012).

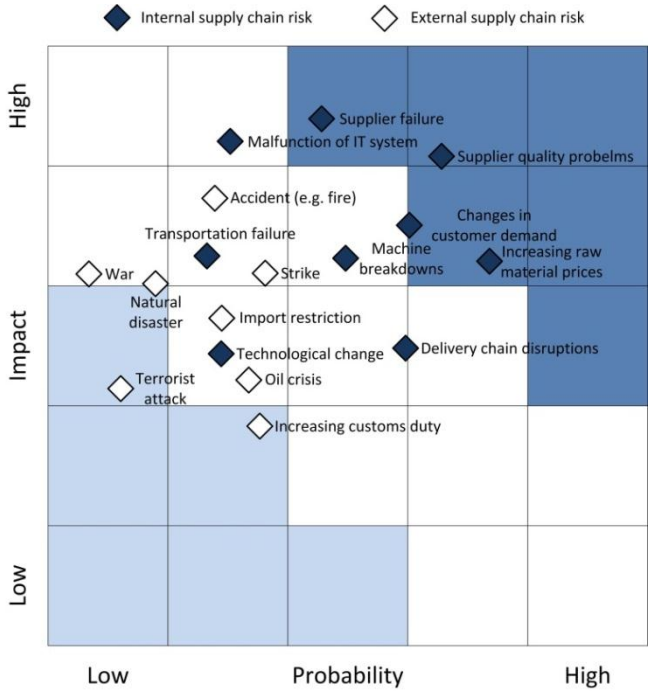


Figure 32: Probability-impact matrix of supply chain risks (adapted from Thun & Hoenig, 2011)

To act upon these supply chain risks, future supply chains need to become more resilient. Thun & Hoenig (2011) distinguish between preventive and reactive measures. Preventive measures are cause related and attempt to lower the probability of certain risks occurring. Reactive measures are related to the effect and try to mitigate the negative effect of a risk event. To make a supply chain more resilient shippers need to focus on visibility, flexibility, collaboration and control (Deloitte, 2013).

The volcanic ash cloud in 2010 showed that certain supply chains had an overreliance on air transportation which resulted in delivery delays for many goods due to a flight ban in Northern Europe and a shortage of air freight capacity leading to skyrocketing transport charges. However, the ash cloud also showed that the flexibility of a carrier is very important during such an incident. Integrators being able to divert shipments with their trucking fleet and then ship them by air from another airport were much more responsive than other carriers (O'Reilly & Trunick, 2010). Therefore, an increase of risk in the supply chain can affect the selection of carrier and the type of service levels of a carrier. Furthermore, supply chain disruptions for products being shipped by ocean might shift temporarily to air to be able to restock products and supplies in a short time.

4.4.4.5 Sustainability

Owing to government regulations such as the European Union Emission Trading Scheme introduced in 2005, the rising consumer awareness in more sustainable products as well as transport modes, companies start focusing to make their supply chains more sustainable or 'green'. Furthermore, the depletion of natural and non-renewable resources or climatic changes such as global warming and an increasing environmental destruction, further increases the need for more sustainability (Straube et al., 2010; Wu et al., 2012; Ageron et al., 2012). Carter & Rogers (2009, p. 368) define sustainable supply chain management as "*as the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains*". Therefore, a green supply chain focuses on the interplay of economic, social and environmental factors which are also represented in the 'triple bottom line' phrased by John Elkington in 1997.

In a recent study of PwC (2012), two third of the respondents indicated that sustainability will play an important role in future supply chains. At this moment, corporations are slowly investing in new technologies that for instance reduce CO_2 emission or they exclude supply chain partners that do not follow strict ethical standards. The same study revealed that the importance of sustainability within the supply chain is expected to increase by 34% between 2013 and 2015. PwC mentions four main reasons for corporations to engage in sustainability within its supply chain. Firstly, a greener supply chain enables a company to manage the risk of unintended environmental and social change. Secondly, greening your supply chain enhances a company's reputation and the expectations of its stakeholders. Thirdly, it enables to reduce costs and realize productivity improvements. The fourth and last advantage is to be able to create sustainable products and thereby increasing revenues and enhancing the corporate's brand.

Opportunities of greening a supply chain range from the selection of materials used in manufacturing to the location of vendors along the supply chain. Also the place of final consumption for a product can be an opportunity. Furthermore, improvements in packaging or the development of reverse logistics enhance the sustainability of the supply chain. To effectively create a sustainable supply chain, co-operation between all stakeholders within a supply chain is a prerequisite.

According to Straube et al. (2010), around 75% of a company's total carbon footprint is the result of emissions such as CO_2 caused by the transportation of goods. While within the manufacturing of goods certain limits are set for a reduction in carbon footprint, a switch to more environmental friendly transport modes such as rail or ship can help to decrease the carbon footprint drastically. In Table 15, the CO_2 emissions in grams per ton-kilometer are displayed for different types of transport mode.

Table 15: Emission per ton-km per transport mode (Source: Cristea et al., 2013)

Mode	*Type*	*CO_2 (g/ton-km)*
Maritime mode	Bulk	4.5
	Container	12.1
	Oil tanker	5.0
Land mode	Road	119.7
	Rail	22.7
Air mode	Boeing 747	552
	Average US Cargo Fleet	912

It is apparent that air transportation emits up to 100 times more CO_2 per ton-kilometer than ocean transportation and at least 5 times more in comparison to land transportation. However, air transportation is also by far the fastest mode of transport and irreplaceable for many time sensitive and high value goods. Still, shippers need to comply with the aforementioned drivers which might lead to a shift in transport mode wherever it is possible or an increase in multimodal shipments such as sea-air. Furthermore, shipper's individual carrier selection can also be influenced on sustainability practices within an airline. This means that shippers might select carriers that invest in modern fleets or new forms of fuel.

4.5 Mapping Supply Chain Trends

As mentioned in Chapter 2.2, trends should not be considered as standalone developments but should be seen as developments that are linked with each other and mutually impact one and another. Furthermore, one trend often engenders the emergence of a counter trend, which means that a trend can evolve in an opposite direction. In this subchapter, the aforementioned trends with their interrelations and connection towards each other are mapped.

Figure 33 maps the aforementioned trends with their relation towards each other. The relationship of each trend towards another one can be in both ways meaning that certain trends reinforce the emergence of a trend while others might weaken the development of other trends. It can be seen that there are a number of supply chain trends that only have an impact on other trends (arrows leaving a trend). Therefore, these trends can be regarded as independent. One example is for instance the growing importance of e-commerce which impacts the way products are distributed and may result in an increase in direct deliveries. On the other hand, some trends are truly dependent on other trends (arrows going inside a trend). The most visible example is the trend of a transport mode shift which is primarily influenced by changes in required speed of product flow, an increase in cost awareness, sustainability and so on. The remaining trends simultaneously impact other trends and are also influenced by certain trends.

As already mentioned, certain trends can evolve in different directions. For instance there is an ongoing trend of wider global sourcing of supplies and distribution of finished products. However, counteracting to this trend is also a development towards local or regional sourcing as well as producing closer to the end customer. The same is true for the speed of product flow in the supply chain. While for certain companies and industries the time to market is a competitive advantage and therefore this requires using the fastest possible service level of a transportation mode, there are industries that are less profound on the fastest transportation and therefore prefer deferred shipments where one or two additional days of transit time do not really matter.

Besides the mutual interaction of trends, it is important to understand that trends are not necessarily the trigger for the development of other trends. As shown in Chapter 4.3, most trends primarily derive from external drivers which represent the environment in which the supply chain/logistic system is embedded in. Since these drivers and their influence on the development of supply chain trends were already described in the analysis of the individual trends, they are not included in Figure 33.

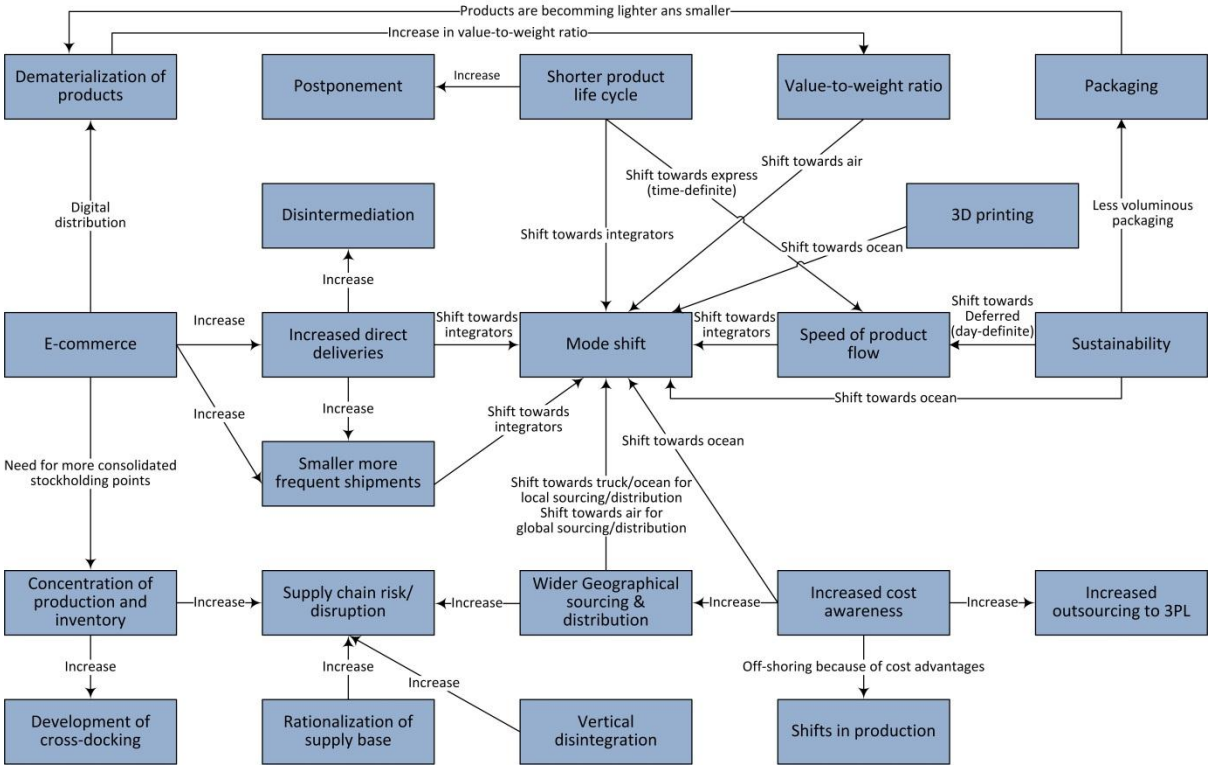


Figure 33: Interrelations of supply chain trends

All product flow trends, primarily triggered by social, technological and economic drivers, can be related to a shift of commodities being transported by air or ocean, a shift in carrier selection or service level. On the one side, the increase in direct deliveries and smaller more frequent shipments for instance favor integrators and could therefore cause a shift from non-integrated carriers to integrated carriers. On the other side, the need for a faster or slower product flow in the supply chain is related to a possible shift in service level from express services to deferred or economy services. The majority of the structural supply chain trends (all located in the bottom part of Figure 33) are caused by economic and political drivers. These supply chain trends mostly have an influence on the vulnerability of the supply chain and on the mode shift. Most of the supply chain trends dealing with product characteristics and changes in production practices (all located in the upper part of Figure 33) are triggered by social drivers such as demand fragmentation and demand volatility. These trends again influence the trend of a mode shift. Current supply chain focus trends are dispersed and are caused by the full spectrum of all STEEP drivers. While an increase in supply chain risk is mostly caused by the emergence of other supply chain trends, the increased cost awareness and the increased outsourcing to 3PL is prompted by economic drivers. The increase in e-commerce is determined by consumer behavior and technological developments and causes the emergence of other trends. The increased importance of a green supply chain is initiated by social, environmental and political drivers and again has an impact on the transportation mode.

4.6 Possible Impact Criteria for the Air Cargo Industry

As shown in the conceptual framework in Chapter 1.3, certain supply chain trends can have an impact on the air cargo industry. This subchapter tries to generate possible impact criteria which are the result of the aforementioned supply chain trends. The following six impact criteria have been identified through an internal discussion within Seabury and will be described shortly:

- Air cargo volume
- Commodities
- Trade lanes
- Type of carrier
- Type of service level
- Required carriage

It has to be acknowledged that this potential list of impacts is not exhaustive and can be completed by other impacts. Nevertheless, these criteria deem to be most impactful on the air cargo industry and represent a starting point to measure the degree of impact of various supply chain trends.

Air cargo volume

This impact criterion is industry wide and deals with the amount of cargo by weight being transported by air. It deems to be the most important criteria since it reflects the growth or decline of the air cargo industry. Primarily, the impact of certain supply chain trends can be twofold: air cargo volume can either increase or decrease. Air cargo growth is influenced by the vast majority of the aforementioned supply chain trends such as a mode shift, a wider geographical sourcing and distribution or an increased importance of sustainability in the supply chain. Additionally, the dematerialization of products and a less voluminous packaging can adversely impact the growth of the air cargo volume.

Commodities

This impact criterion can also be considered having an industry wide impact and deals with the air eligibility of certain commodities. Commodities can either shift to be transported from air to ocean and vice versa, depending on product trends such as a changing value-to-weight ratio or the importance of air transportation for product launches. The air eligibility of commodities directly influences the change in air cargo volume. For instance, if products become air eligible, air cargo volume is consequently expected to increase.

Trade lanes

A change in trade lanes is regarded as a shift in true origin and destination of air movements. Existing trade lanes can either shift which means that goods might have a different origin or destination due to structural trends such as production shifts. Furthermore, new trade lanes can emerge while other trade lanes might vanish. On a larger scale the shift as well as the emergence or disappearance of trade lanes can result in trade lane imbalances between different regions.

Type of carrier

As discussed in Chapter 3.8, there are two different supply streams in the air cargo supply chain: integrated and non-integrated. While integrators offer a vertical integrated supply chain, airport-to-airport carriers and freight forwarders usually comprise of the non-integrated stream. The increase of direct deliveries and the trend towards smaller and more frequent shipments favors the usage of integrators and consequently results in a shift from the non-integrated towards the integrated supply chain stream. This criterion primarily deals with the change of carrier types from integrated to non-integrated carriers and vice versa and therefore does not influence a change in air cargo volume.

Type of service level

Both integrated and non-integrated carriers offer different service levels. In terms of time, a differentiation can be made between time and day-definite or expedited and deferred shipments. While time-definite shipments require the fastest (expedited) and usually most expensive transportation, day-definite shipments can be regarded as deferred or economy shipments. Due to changes in the speed of the product flow in the supply chain, shippers might switch from expedited to deferred services and vice versa. This impact again does not influence the air cargo volume but rather deals with the type of service level of which goods are transported.

Required carriage

Due to changes in product characteristics such as dematerialization, changing packaging and a shift in the value-to-weight ratio, special attention needs to be paid on the way goods are required to be transported. For instance, very large goods might require 'main deck' transportation which means that it can only be transported in the main cargo hold of an all-cargo aircraft and not in the 'belly' cargo holds of a passenger aircraft. Furthermore, certain products such as pharmaceuticals require a constant cool chain which requires special equipment such as active or passive cool chain containers.

In Table 16, the individual supply chain trend is accompanied by one of the six impact criteria and an example. It has to be noted that this list of supply chain trends and impact criteria can be complemented by other trends and impacts which might evolve during the interviews with shippers.

Table 16: Supply chain trends and their impacts on air cargo

Supply chain trend	*Impact*	*Example*
Structural supply chain trends		
Wider geographical sourcing and distribution	Air cargo volume	The increase in average distance results in an increase in ton kilometers which results in a growth of the air cargo volume being transported
Vertical disintegration	Limited impact on air cargo volume	Adding extra transport links may result in an increase in ton kilometers which results in a growth of the air cargo volume
Rationalization of supply base	Limited impact on trade lanes	Consolidation and streamlining of transport flows might result in a shift of trade lanes
Concentration of Production and inventory	Limited impact on trade lanes	Consolidation and streamlining of transport flows might result in a shift of trade lanes
Production shifts (near shoring, low cost areas)	Air cargo volume, trade lanes	Near-shoring might decrease air cargo volume because finished products are transported by truck; Shift to low labor countries as well as new clusters largely impact a shift in trade lanes
Development of cross-docking	No impact on air cargo industry	-
Product Characteristics and Production Trends		
Shorter product life cycle	Commodities, Air cargo volume	Shorter product life cycles might require faster transportation and therefore commodities can become more air eligible which increases the air cargo volume
Value-to-weight ratio	Commodities, air cargo volume	A higher value-to-weight ratio of products justifies the transportation of goods by air instead of ocean and therefore might increase the air cargo volume
Packaging	Commodities, air cargo volume, required carriage	There might be a shift in air eligibility of goods depending if packaging becomes more voluminous or not
Dematerialization of products	Air cargo volume, required carriage	The dematerialization of products results in lighter products which consequently leads to a decrease in air cargo volume being transported

Postponement	Limited impact on commodities, air cargo volume	Supplies might be transported differently than finished products and therefore might impact the air eligibility of goods which leads to an increase or decrease in air cargo volume
3D printing	Air cargo volume	The local production decreases the need for air transportation of finished goods
Product flow trends		
Speed of product flow	Type of carrier, Type of service level	Goods that require a faster transportation might shift from non-integrated carriers to integrated carriers as well as within the carrier from deferred to express services
Mode shift	Commodities, Air cargo volume, type of service	Structural shift of transportation mode from air to ocean especially for high tech products resulting in a decrease of the air cargo volume
Increased direct delivery	Type of carrier	Direct deliveries favors integrators and therefore might shift goods being transported from non-integrated carriers to integrated carriers
Smaller and more frequent deliveries	Type of carrier	Smaller and more frequent deliveries favors integrators and therefore might shift goods being transported from non-integrated carriers to integrated carriers
Current supply chain focus trends		
E-commerce	Type of carrier	E-commerce favors integrators and therefore might shift goods being transported from non-integrated carriers to integrated carriers
Increasing cost awareness	Commodities, air cargo volume, type of service level	Due to an increase in cost awareness goods formerly transported by air might shift towards ocean transportation or goods are transported by an economy mode instead of express
Outsourcing of logistics activities	No impact on air cargo industry	-
Supply chain risk and resiliency	Type of carrier, type of service level	In case of supply chain disruptions shippers might rely on charters or fast express services
Sustainability	Commodities, air cargo volume	A shift to greener transport modes which means product formerly transported by air might shift towards ocean transport

4.7 Identification of relevant Supply Chain Trends impacting the Air Cargo Industry

From the analysis above, it can be seen that a number of supply chain trends only have a limited impact or do not impact the air cargo industry at all. Therefore, structural supply chain trends such as vertical disintegration, rationalization of the supply base, the concentration of production and inventory and the development of cross-docking will be discarded from the further analysis. The same is true for the production strategy of postponement which also has a limited impact on the movement of goods by air. The outsourcing of logistics activities to 3PL has also no visible impact on the air cargo industry and will therefore not be included in a further analysis. Even though, 3D printing deems to be a disruptive innovation that will have a major impact on the logistics of spare parts and other high valuable goods within the automotive and aerospace industry the emergence and large scale adoption seems to be highly unlikely to be within the next five years. Therefore, 3D printing is out of scope and will not be investigated further.

According to the literature analysis, that has been conducted, it can be concluded that a structural mode shift seems to be one of the supply chain trends that has a very high impact on the air cargo industry since it directly influences the growth or decline of the cargo industry. A change in production locations also seems to be quite important because it will influence the shift of current trade lanes. There are certain trends such as e-commerce, direct deliveries and smaller but more

frequent deliveries that clearly benefit the further growth of integrators which have been the fastest growing market player within the air cargo industry (Doganis, 2010). Furthermore, developments in product characteristics deem to have a crucial impact and will therefore be further researched by means of interviews and a follow-up questionnaire. The same is true of changes in the speed of product flow which results in shorter or longer transit time and consequently impacts the type of carrier selection as well service level within a mode of transportation. Lastly, the increasing awareness on cost reduction as well as the importance of greening the supply chain might reinforce modal shift from air to ocean transportation.

4.8 Chapter Conclusion

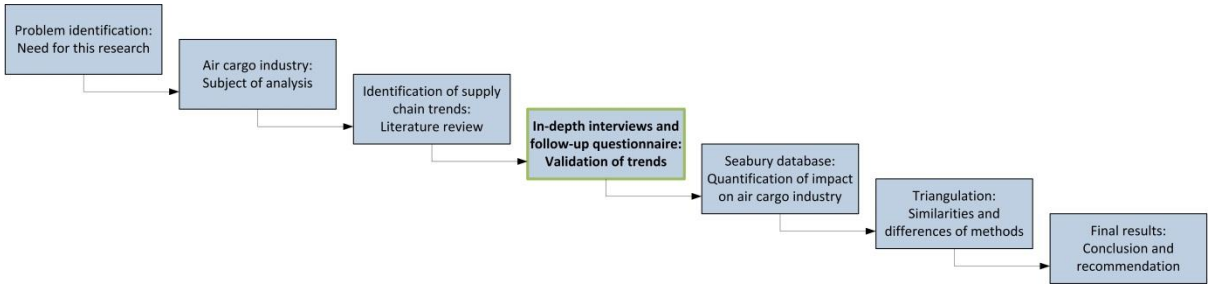
This chapter identified various global supply chain trends and their causing drivers. Drivers were identified by using the STEEP framework. The supply chain trends were gathered through an extensive literature review. All trends were classified in four different groups. Structural supply chain trends deal with the physical structure of a supply chain and relate for instance to geographical changes in sourcing, production and distribution. Product and production trends relate to developments in product design and the way goods are produced. Product flow trends refer to changes primarily in outbound transportation but also inbound transportation. The last group of trends deals with current and ongoing developments that could not fit to one of the aforementioned groups.

Besides gathering a number of different supply chain trends, it was also tied to map the trends and illustrate interrelations among each other. Hence, several trends are impacted by other trends while others only impact trends. From the analysis of supply chain trends it can be seen that all supply chain trends can have various impacts on the air cargo industry. A list of six major impact criteria was identified. Additionally, the degree of each impact caused by different trends can vary. Trends which only posed a minimal impact on the air cargo industry were discarded. The remaining trends will be tested in the next chapter, in form of in-depth interviews and a follow-up questionnaire with shippers of the three industries that were identified in Chapter 4.4.

5 Empirical Findings of 19 Interviews and a Follow-up Questionnaire with Supply Chain Experts

5.1 Introduction

This chapter describes the empirical findings of in-depth interviews and a follow-up questionnaire among shippers in three different industries which build upon the results of the literature review described in Chapter 4.4. The questions asked during the interviews mostly derived from the literature review. The questions asked in the follow-up questionnaire take the results of the interviews into consideration. First the data collection process of the interviews and follow-up questionnaire is described. After that the population as well as the resulting sample for both the interviews and follow-up questionnaire follows. Before the analysis of the primary data is described, measures to increase reliability and validity are explained. The main part of this chapter deals with the results of the 19 interviews which were conducted for this master thesis as well as the results from the follow-up questionnaire which aims to quantify the findings from the preceding interviews.



5.2 Data Collection Process

During an extensive literature review in Chapter 4.4 multiple supply chain trends were gathered. In order to collect the necessary data to test these trends and subsequently trying to answer which supply chain trends are actually taking place and what their magnitude is, the choice has been made to first conduct in-depth interviews with multiple shippers of three selected industries. After that, a follow-up questionnaire was distributed to the same shippers and an extended list of further shippers to quantify the findings of the interviews.

5.2.1 In-depth Interviews

A series of 19 semi-structured interviews with supply chain managers of different shippers in three industries were organized. Semi-structured interviews were chosen, to not be limited to a rigorous set of questions that do not leave room for new ideas and thoughts which might come up during the course of the interview. An interview guide was however prepared (see Appendix D) with themes and questions that are relevant. Many additional questions, not stated in the interview guide, were asked to respond and pick up on issues the interviewee mentioned. The interview guide was send to the interviewee in advance to familiarize the interviewee and prepare for the interview. Shortly before the interview, the latest annual report of each shipper was scanned to learn more about their products and operations, current developments in terms of sourcing, production and distribution as well as other possible issues relating to logistics and air freight. Of the 19 interviews, seven were conducted face to face by travelling to the site of the company. Face to face interviews were

conducted for most Dutch or international shippers that have an office, plant or distribution center within the Netherlands. The remaining ten interviews were conducted by telephone.

The interviews focused on current and ongoing supply chain developments of the individual shipper, the magnitude of each trend as well as the reasons for a certain development. To ensure a smooth process of the interview, the interview procedure as illustrated in Table 17 was followed. At the beginning of each interview, a short description of the study and its rationale was explained. It was guaranteed that all information will be treated confidential. As a thank you for participation, a conscience report in form of a presentation will be distributed to the respondents in August. Interviewees were asked about their position within the company and what kind of product flows they handle. After that, general questions were asked about the amount of annual air freight in metric tons, the number of TEU transported by ocean as well as the share of air transportation of total international transport. The remainder of the interview was organized around the following four themes:

- Developments in customer behavior
- Developments in product characteristics
- Changes in sourcing and production
- Changes in distribution patterns

Together with Seabury it was decided to have these four themes and this order to logical structure the interview and not move from one issue to another abruptly. To avoid leading questions, interviewees were not asked if a certain trend takes place or not. Rather it was tried to unravel the current developments and their preceding drivers within the company and allocate them to one of the many trends identified during the literature review. Additionally, in the course of interviews, a number of further trends and developments were gathered which were not identified during the literature review.

The theme of *developments in customer behavior* aimed to verify or falsify supply chain trends such as an increased usage of e-commerce which might result in more direct deliveries and hence a shift towards express services of integrators. Furthermore, issues around sustainability and its implication on transportation as well as changes in product life cycle which are triggered by customer demands were asked. The second theme, *product characteristics,* focused on changes in product design which might lead to the trend of dematerialization or an increase of the value-to-weight ratio. Additionally, it was aimed to learn more about the changes in packaging. Lastly, the consequences of product launches for the transportation system were investigated. *Changes in sourcing and production* dealt with structural supply chain trends such as wider geographical sourcing but also a shift in production closer to demand, to emerging clusters or to low cost labor countries. Furthermore, the impact of supply chain disruptions on the transportation of products but also the sourcing and production were investigated. The last theme, *changes in distribution patterns*, concentrated on the trend of transport mode shift from air to ocean and vice versa as well as a shift in carrier type and service level. Furthermore, it examined changes in shipment size and frequency as well as changes in transit time.

Table 17: Interview procedure

Interview step	*Content and comments*
Introduction	Introducing Seabury as well as the study to the interviewee,
Reason	Explaining the rational of the study

Enhancing trust	Explaining who is all involved in this study, support of the large network forwarders (CEVA, Kuehne & Nagel) and EVO (Eigen Vervoerders Organisatie); Explaining how information will be processed: confidential information will be discarded, summary of interview can be requested, final report will be anonymous (no shipper name and no tracing of companies involved)
Content	Shortly discussing the outline of the interview: duration and topics
Execution	Executing the interview: • General questions (Position within the company, air/ocean freight volume, air freight share of total international freight) • Developments in customer behavior (E-commerce, Direct deliveries, sustainability, product life cycle) • Developments in product characteristics (Dematerialization, packaging) • Changes in sourcing and production (Wider geographical sourcing and distribution, production shifts, supply chain risks) • Changes in distribution patterns (Mode shift, speed of transport flow, smaller and more frequent shipments)
Summary	Summarizing the content of the interview, asking if there are any developments not being asked that have an impact on air freight/express
Close	Informing on the further progress of the study: • Follow-up questionnaire in June • Final report will be distributed in August Informing interviewee on the plan to have continuous communication and knowledge sharing between shipper community and Seabury in the future Thanking for participation

Each interview lasted between 30 and 60 minutes. After every interview, a summary was composed by transcribing the most important answers of the interviewee. The transcripts, which are attached in Appendix E, are the basis for the analysis of the interviews which is described in Chapter 5.5.

5.2.2 Follow-up Questionnaire

The follow-up questionnaire was designed to quantify the findings from the in-depth interviews. A web questionnaire was conducted using the web interface surveymonkey.net. This online tool enables to create a questionnaire by choosing from 15 different types of questions which can be send out via weblink or email. Therefore, a large amount of respondents can be reached via email very fast which further increases the overall response rate (Griffis et al., 2003). Additionally, 'Surveymonkey' has built-in analyzing features such as text analysis or SPSS integration which simplifies the process of analysis.

To increase the response rate, the questionnaire was kept as short as possible. While only taking the most important findings from the interviews into account, it was decided together with Seabury to restructure the questionnaire from the preceding interviews. Hence, trends that were less apparent during the interviews were not asked again in the questionnaire. The complete questionnaire which was send to the shippers can be found in Appendix F.

In the beginning general questions such as company name, position within the company, air and ocean freight volume as well as air share of total international freight were asked. The remaining questionnaire focused on the following topics:

- Sourcing, production and distribution
- Transportation of products
- Product development

Even though the customer plays a vital role regarding to transportation of goods by air, during the interviews trends relating to the needs of customer such as of shorter product life cycles, sustainability and e-commerce infrequently evolved and had no major impact on the air cargo industry. Therefore, this theme was discarded from the questionnaire and issues of interest were partly combined in one of the other themes. The first set of questions of the survey focused on the current and future geographical location of *sourcing, production and distribution*. This set of questions aimed to gain insights in production and distribution shifts as well as the emergence of a wider geographical sourcing of supplies and distribution of finished products which influences the trade lanes as well as the air cargo volume. The theme of *transportation of products* concentrated on the trend of transport mode shift from air to ocean and vice versa as well as a change in the speed of product flow through the supply chain as well as an increase in the usage of larger airports. Furthermore, the main reasons for such a shift were asked. The last set of questions concerned changes in *product characteristics* which influence the required carriage but also the volume of air freight being shipped in the future.

5.3 Population and Sample

The population of this master thesis consists of multinational companies that ship a large amount of their freight by air. In Chapter 3.7, three different industries were identified based on the weight and value share of total air shipments as well as growth and market share. Therefore, the population comprises of shippers of the following industries:

- High tech
- Automotive
- Pharmaceuticals

Within high tech, special interest is placed on industries such as computing, semiconductor and telecommunication while for automotive mostly the transportation of parts is important. As those industries consist of countless shippers it is tried to build a sample that best represents each industry. Therefore, a judgmental sampling technique was used which led to 19 in-depth interviews with different shippers as well as 17 questionnaire respondents. The following part describes how the sample was gathered.

Step 1: Reducing shippers

To reduce the vast amount of possible shippers, a list of desired companies to have interviews with was created. Shippers in this list are companies that entirely or partly produce goods in one of the aforementioned industries. Furthermore, these companies represent large multinational companies that source, produce and distribute their products globally. Per industry, the largest 15-20 shippers were listed building the foundation of the sample size.

Step 2: Getting contact details of shippers

After an initial list of desired shippers was identified, shippers needed to be approached. Seabury had already performed interviews with a large amount of shippers in prior consulting projects. A list of past interviewees was created and compared with the desired shippers. Matching shippers were collected in a 'shipper list' database. Besides identifying former interviewees, the larger network forwarders such as DHL Global Forwarding, Ceva, Kuehne & Nagel, Agility and SDV were approached and asked if they could introduce this study to some of their key accounts to acquire new possible

contacts. The same approach was used with EVO. The potential shippers were also inserted in the shipper database. The next step was to contact the potential shippers and inquiring if they were willing to participate in an interview.

Step 3: Contacting shippers

Around forty shippers were approached by phone and were asked if they were willing to participate in the study. Shippers that have been contacted by Seabury in the past were usually easy to reach while others were less interested or lacking the time to be interviewed. After each initial call, a follow-up email with more background on the study and Seabury as well as a short presentation of Seabury's market dynamics were send. Especially, the presentation on current market developments within the air freight industry convinced many shippers to participate in this study. From the 19 interviews conducted for this master thesis, eight were done with shippers that have been approached by Seabury in the past while the majority of the remaining shippers' contacts were gathered through the large network forwarders or EVO.

Step 4: Profile of interviewee

The last step to gather the sample for the interviews was to find respondents which fulfill a set of characteristics. These requirements guarantee that the respondent is able to answer the questions to his/her best knowledge. All of the interviewees had the following characteristics:

- Supply chain or logistics function on a global or regional level (Transportation Manager, Global/Regional Logistics Manager)
- Familiarity with air freight/air express purchasing
- Middle or high managerial position

From the abovementioned sampling process the following 19 interviews have been conducted. The summary of each interview is depicted in Appendix E. Since most of the shippers demanded to treat all information confidentially, company names are only shown in this Green Light documents. In the final document, there will be no indication of a certain company shown.

Table 18: List of in-depth interviews

#	Date	Industry	Function	Type of interview
1	27.03.13	High tech	Transportation Manager, Global Cluster Manager	Face to face
2	08.04.13	Miscellaneous (partly high tech)	Purchasing Manager Director Airfreight/Parcel Express	Face to face
3	08.04.13	Pharmaceuticals	Global Transportation Specialist	Face to face
4	14.04.13	High tech	Operations Manager EMEA	Face to face
5	24.04.13	Miscellaneous (partly high tech)	Director Global Premium Freight Purchasing	Telephone
6	25.04.13	High tech	Strategic Sourcing Manager	Telephone
7	29.04.13	High tech	Logistics Manager Aftermarket EMEA	Telephone
8	02.05.13	High tech	Section Manager SCM & Logistics	Face to face
9	07.05.13	High tech	Director Global Logistics	Telephone
10	08.05.13	High tech	Manager European Supply Chain	Face to face
11	13.05.13	Pharmaceuticals	Strategy & Business Development Director	Telephone
12	13.05.13	Pharmaceuticals	Global Procurement, Freight & Logistics	Telephone
13	21.05.13	Pharmaceuticals	Regional Sourcing Analyst, EMEA	Face to face
14	23.05.13	Automotive	Corporate Supply Chain Manager	Telephone
15	24.05.13	Automotive	Logistics Manager EMEA	Telephone

16	27.05.13	Automotive	Global Carrier Manager	Telephone
17	28.05.13	High tech (computing)	Manager Global Logistics Operations	Telephone
18	20.06.13	High tech	Senior International Transport Manager	Telephone
19	18.07.13	High tech	Global Transport and Procurement Manager	Telephone

For the follow-up questionnaire, a similar sampling technique was used. Since the main interest of the questionnaire is to quantify the findings of the interviews, the sample size needed to be increased. On the one side, the same shippers of the interviews were asked to participate in the questionnaire. On the other side, a broader scope of further shippers was chosen. Again, a Seabury internal database of contact with shippers in the past was used to generate a shipper list of potential respondents. Furthermore, some of the shippers that have been approached for the interview declined the interview but were willing to fill in the questionnaire. Additionally, the larger network forwarders and EVO were asked to distribute the questionnaire to suitable clients and members.

The shippers that participated in the interviews were informed on a second round of a follow-up questionnaire. To increase the response rate of shippers that have not been approached before, most shippers were contacted by phone prior sending the questionnaire. The majority of the respondents were contacted on behalf of Seabury while some shippers were contacted through other channels such as EVO.

5.4 Reliability and Validity

It is very important that the conclusions, which are drawn from the primary data of in-depth interviews as well as a follow-up questionnaire, are verified in a structured way. This guarantees that the derived findings are reliable and valid.

Reliability refers to the ability to measure certain concepts over time without a bias and as a consequence to be able to replicate or reproduce the same results with a similar methodology. Therefore, reliability is an indicator of the stability and consistency of the measurement of a certain concept (Sekaran & Bougie, 2009). However, there is doubt that qualitative research can be replicated. Hence, the term ‘reliability’ is often avoided in qualitative research and is replaced by concepts such as ‘trustworthiness’, ‘confirmability’ and ‘consistency’ of findings which represent the concept of reliability in a certain way (Ritchie & Lewis, 2003).

The reliability of this study has been increased by taking the following issues into account:

- Extensive selection of interviewees and questionnaire respondents to ensure the quality of answers
- For every interview a separate summary with the main findings were transcribed (see Appendix E)
- Interviews were analyzed in a coherent and consistent way as described in Chapter 5.5
- Usage of triangulation to address certain concepts from different perspective (literature review, survey and database analysis)

The validity determines to which extent the in-depth interviews as well as the follow-up questionnaire measure the intended information in the right way. In general, validity can be distinguished in internal and external validity (Sekaran & Bougie, 2009). While internal validity refers to authenticity meaning that research results are correctly represent by the collected data, external

validity aims for generalizability meaning that the collected data can be generalized and conveyed to a different set of samples within the same population. To achieve a high degree of internal as well as external validity the following measures have been performed.

Internal validity was increased by:

- Letting professionals of Seabury review the structure as well as the questions of the interview guide
- Letting professionals of Seabury review the structure as well as the questions of the follow-up questionnaire in terms of comprehension
- Conducting the first interviews with the guidance of Marco Bloemen (Vice President Seabury Cargo Advisory) to ensure questions were asked in the correct manner
- Performing the analysis of the in-depth interviews as well as follow-up questionnaire in a coherent and consistent way (see Chapter 5.6)

External validity was increased by:

- Choosing experts for the interviews as well as the follow-up questionnaire on the basis of the managerial position they hold within supply chain management as well as taking into account the years of experience
- Choosing a selection of industries which are important to the air cargo industry based on the weight share, value share, growth rate and market share
- Selecting global shippers within an industry that have a high market share

However, due to the judgmental sampling and a rather small sample size of interviewees and questionnaire respondents the findings represent a snapshot of current supply chain trends within these companies.

5.5 Analysis of Interviews and Questionnaire

This part explains how the qualitative data of the in-depth interviews as well as the follow-up questionnaire is analyzed. While for the in-depth interviews a thematic analysis is used, a straight forward analysis of responses of the questionnaire is done by using Microsoft Excel.

5.5.1 In-depth Interviews

To analyze the 19 in-depth interviews, an approach similar to thematic analysis was chosen. This means that the analysis goes beyond counting explicit words and phrases as it is done in content analysis. Hence, it also tries to identify and describe explicit and implicit thoughts within the data (Guest et al., 2012). A content analysis is also not suitable since the interviews were not transcribed word by word but summarized with the most important statements of each respondent.

According to Braun and Clarke (2006), the general approach of a thematic analysis consists of six phases which are shown in Table 19. The analysis of the interviews differs in a way that most themes which are represented by the individual supply chain trend have already been found through an extensive literature review (see Chapter 4.4). However, during the course of the interviews and by analyzing the transcripts a number of new themes (trends) were found.

Table 19: Thematic analysis (Source: Braun and Clarke, 2006)

Phase	*Description*
1. Familiarizing yourself with data:	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes:	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes:	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. Reviewing themes:	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
5. Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6. Producing the report:	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

To conduct a thematic analysis of the primary data of 19 interviews, the notes of each interview were first transcribed into a two page summary. Each summary consists of the most important statements of the interviewees. The summaries have the same structure as the interviews and therefore consist out of five parts. The transcription of the interview notes is seen as the first phase of qualitative data analysis since at this early stage interpretations of the meanings of statements and thoughts of the respondents are put on paper.

The information of each summary was then coded in a excel file. The coding was done on various dimensions similar to the example underneath of which the coding is illustrated in Table 20.

> *"Policy from top management in 2010 to eliminate air freight completely but it is not possible, large mode shift towards ocean from all air for cameras to 26% of air transportation and 74% ocean transportation, only small adjustments towards ocean → mode shift has taken place"* (Appendix E, Interview 10)

The coding is organized in four parts:

- Coding of comments (A1)
- General coding (B1-B3)
- Coding of supply chain trends (C1-C3)
- Coding of impact on air cargo (D1-D3)

Coding of comments

By coding comments it is aimed to rephrase the rather long statements from the interview summaries to a short comment. This enables to rephrase the statements that consist of different wording to homogeneous comments with a consistent definition. For instance, many shippers referred to expedited services as express, expedited, fastest possible or next day out services.

General coding

The first dimension in this group is the company name. Due to the fact that many shippers requested confidentiality of their information, the company names are not mentioned. The second dimension is the industry. Each shipper is assigned to one of the focused industries. By assigning an industry to a shipper, it is possible to find out if certain trends are only industry specific or evolve in different

industries at the same time. The last dimension is related to the phase the comment evolved during the interview. This enables to analyze if a certain trend takes place at different parts of the entire supply chain. For instance, a mode shift was apparent during the sourcing of supplies but also during the distribution of finished products.

Coding of supply chain trends

For every comment, a certain trend is assigned from the list of trends that were gathered during the literature review on global supply chain trends. In the case that no trend from the literature review would match a comment, it was tried to find new themes (trends). However, most comments could be accompanied by one of the trends from the literature review. This indicates that the literature review captured a wide range of trends that describe developments within shippers. After that, the direction of each trend was indicated. For the given example in Table 20, two dimensions were possible: towards ocean or towards air. For other trends this dimension could be coded as bigger versus smaller, faster versus slower but also less voluminous versus more voluminous et cetera. The last dimension in this group relates to if the development has happened in the past, is ongoing or will happen in the future. This categorization allows an assessment if certain trends are currently developing, if they are ongoing or if their development is declining.

Coding of impact on air cargo

The last group of codes is related to the influence each trend has on the air cargo industry. The first category of these codes responds to the impact of each trend on the air cargo industry. The code for this dimension could be one of the six impact criteria which are described in Chapter 4.6. It could also be a new impact that was not found within the literature review. If a certain supply chain development of a shipper does not have an impact on the air cargo industry then this field is left blank. The dimension D2 deals with the direction of each impact. In the example of Table 20, the air cargo volume could either increase or decrease. Because of a modal shift towards ocean the air cargo volume would subsequently decrease. The last coding dimension is related to the extent of each impact. It can be distinguished between low, medium or high. This dimension requires the biggest interpretation of the data since it needs to be decided if for instance a mode shift from 100% air shipments to only 26% air shipments within three years has a minor, a moderate or a major impact on the air cargo volume.

Table 20: Coding of interviews

Dimension	*Characteristic*	*Example*
Dimension A	Comment	Mode shift from 100% air towards 26% air in 3 years
Dimension B1	Company	Company X
Dimension B2	Industry	High tech
Dimension B3	Interview part	Distribution
Dimension C1	Trend	Mode shift
Dimension C2	Direction	Towards Ocean
Dimension C4	Timing	Past
Dimension D1	Impact criterion	Air cargo volume
Dimension D2	Direction	Decrease
Dimension D3	Extent	High

Type of wording

During the analysis of interviews it is tried to count the appearance of certain trends. However, it is difficult to do that with explicit numbers since the majority of interviews were not recorded. The

same is true for interpreting the impact of certain trends. In Table 21, the wording that will be used to quantify the appearance of trends during the analysis is defined. Where it is applicable and possible actual numbers or percentages are used.

Table 21: Definition of wording for analyzing interviews and the questionnaire

Word	*Meaning*
Many …, most …, Nearly every …	More than 75% of all interviewees or subgroup
Majority …	More than 50% of all interviewees or subgroup
Few …, some …	Less than 25% of all interviewees or subgroup
Minor …, small …, Not major …	Negligible small change or impact (+/- 0%)
Moderate …, medium …, Sizeable …	Visible change with a medium impact (around +/- 5%)
Major …, Large …,	Significant large change or impact (>10%; <-10%)

Based on this coding process, 237 entries were made in the database. The database can be filtered on each dimension. It is also possible to filter two or more dimensions to be able to analyze the database in great detail. The results of the analysis are presented in Chapter 5.6.

5.5.2 Follow-up Questionnaire

Since the questionnaire was distributed by the online tool 'Surveymonkey', the software automatically collected the data. Hence, the data was downloaded and extracted in a spreadsheet program. 'Surveymonkey' also has an integrated SPSS analyzing function. However, due to the small sample size and the objective not to do any statistical tests such as normality or regression analysis the functionality of Microsoft Excel is sufficient for the purpose of this master thesis.

5.6 Results of Interviews and Questionnaire

This part identifies the results from the 19 in-depth interviews with shippers as well as the follow up questionnaire. The analysis is organized in the same way as the interviews and questionnaire were structured. Hence, the results of each section will be presented after each other.

5.6.1 In-depth Interviews

The database of comments and codes consists of 237 entries. Based on these entries, the interviews were analyzed and their results are presented in the following part. First general information of the companies that have participated are shown. After that, the results of the four remaining parts of the interview are presented. The results are illustrated with indirect quotes which derived from the interviews.

General information

From the sample of 19 interviews, eight shippers have their headquarters located in the USA, eight in Europe (United Kingdom, The Netherlands, Sweden, Finland and Switzerland) and three in Asia (Japan). However, interviewees were mostly contacted in the Netherlands (ten), while two interviewees were approached in the USA and Sweden. The remaining interviewees were contacted by phone in Germany, the United Kingdom, India, Hungary and Poland. The interviewed shipper represent global companies that employee a large number of employees and have many billions of revenues (see Figure 34). Of the eight shippers within the USA, seven were listed as Fortune 500 companies.

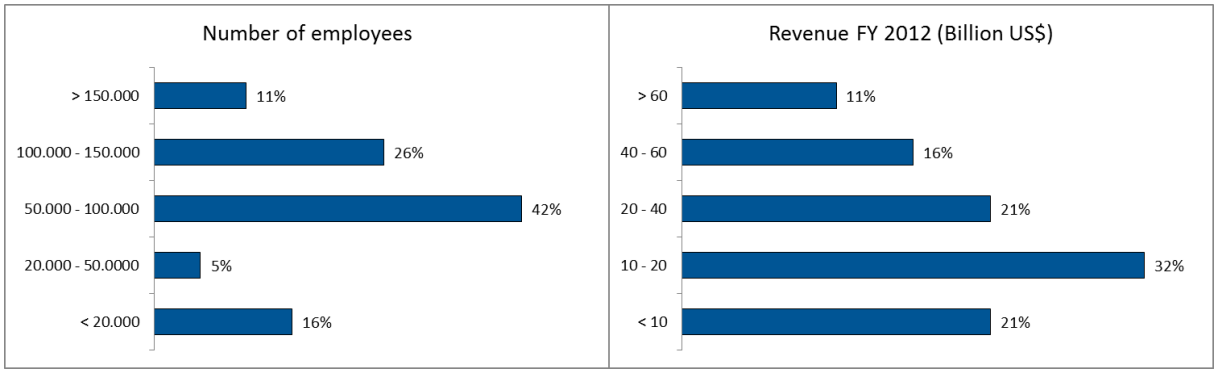


Figure 34: Number of employees and revenues in 2012 of interviewed shippers

The amount of air freight in metric tons per year ranged from 2,000 up to 100,000. The total tonnage of all shippers being interviewed cumulates around 410,000 tons representing around 1.9% of the global annual air freight. However, this amount is slightly influenced by the fact that two shippers were not willing to share and/or did not know respectively the annual amount of air freight. The air share of total international transport ranged per company from 5% to 100%. In Figure 35, the annual air freight distribution among the participating shippers as well as the air share of total international transportation is illustrated.

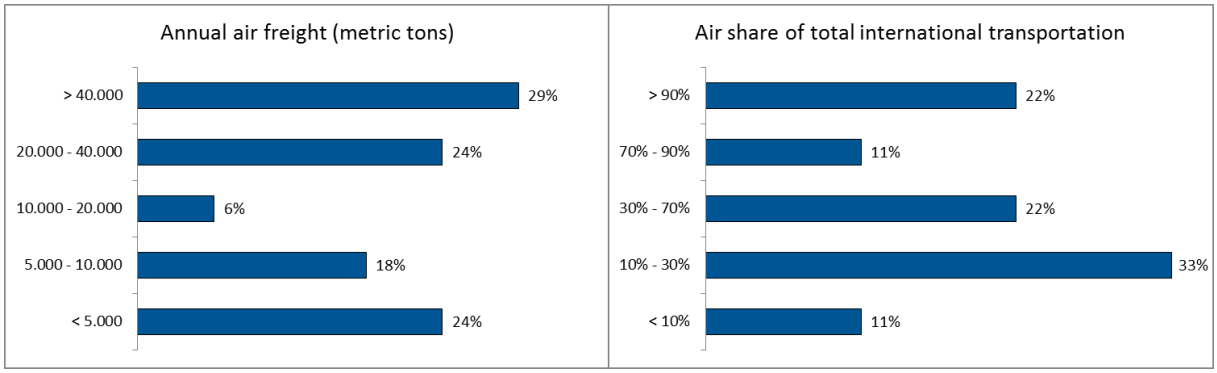


Figure 35: Annual air freight and air share of interviewed shippers

Sales

"Air freight will increase since our corporate strategy is to double our size and sales within the next four years"

At the beginning of each interview, respondents were asked about their expectations of the volume of sales in the next three to five years. The majority of all shippers expected to increase sales. Only two shippers (one automotive and one high tech) will expect decreasing sales due to the debt crisis in Europe. Besides that, shippers expected to sell more of their products and consequently ship also more by air. The increase in sales will be achieved by acquiring new business, developing new products or fulfilling products to emerging markets. However, this does not mean that a growth rate of for instance 15% a year will result in a proportional increase of air freight. Many of the subsequent supply chain trends such as the dematerialization of products or a mode shift from air to ocean will actually decrease the air cargo volume. Still, an increase in sales will reduce the impact of some of the supply chain trends. On the other hand, there are supply chain trends that positively impact the air cargo volume such as wider geographical sourcing or distribution. After describing

"Air cargo volume is expected to stay the same, sales are increasing but there is also a mode shift"

general information about the shippers that participated in the interviews and mentioning general expectations of future sales, the following part describes the findings from the 19 interviews.

Developments in customer behavior

E-commerce

"There is no e-commerce in a B2C sense; it does not fit our business model"

E-commerce in a B2C sense is for most of the interviewed shippers currently not an issue. This is related to the fact that most of the companies operate in a B2B market. Many shippers mentioned that they have a rather traditional supply chain and that e-commerce and delivering directly to end consumers (private users) does not fit to their business model. Furthermore, there are difficulties with last mile transportation to the customer's home for certain products such as pharmaceuticals. For other shippers, particularly when products are produced for the usage of private consumption, e-commerce was already fully integrated as a distribution channel and it was expected to grow within the next years by a small amount. Shippers that expect to offer an additional e-commerce channel stated that the amount in comparison to conventional channels will be rather small. One shipper that operated an e-commerce channel had no intention to promote it, since the transportation would be more costly and therefore the shipper prefers to distribute via retailers or wholesalers. Still, shippers that offer e-commerce expect to shift more of their transportation towards integrators. This will not mean that goods are shipped directly from the production facility to the end consumer, since the transportation is usually more expensive. Rather it will be delivered from a regional distribution center were goods are stored. In Europe, this means that goods are usually shipped by truck due to the close proximity while in the USA or Asia trucking might not always be an option and therefore goods might be shipped by air.

"We expect an increase in e-commerce and therefore a shift towards integrators, however the amount will be rather small"

It can be concluded that an increase in e-commerce is not a major trend and does not really influence the way goods are transported by air. However, the companies that participated in the interviews were to a large extent operating in a B2B market while in industries such as fashion or personal household goods, the degree of e-commerce might be higher and therefore influence the transportation to a far larger extent.

Direct deliveries and disintermediation

An increase in direct deliveries and the disintermediation is triggered by an increase in e-commerce. Since an increase in e-commerce was not a major development for the majority of shippers, direct deliveries did not increase as a consequence of e-commerce. If a change towards direct deliveries occurred, it was the consequence of increasing or decreasing sales over time.

"Order sizes are getting so small they need to be shipped by integrator"

One shipper mentioned that due to decreasing sales, for a small percentage of their shipments the order size has declined to such a small amount that this shipper was forced to switch towards direct deliveries and use integrators instead of forwarders. However, this decision was not favored by the shipper. On the other side, one company stated that sales especially in emerging markets increased

per country by a large extent which allowed for the direct transportation of their products to the market. Therefore, regional distribution centers could be bypassed. The remaining shippers stated that there was no real increase in direct shipments and that most of their deliveries are shipped via a regional distribution center. Shippers that produced customized, build-to-order products usually ship their products directly. However this is not a trend but a core necessity of their business model.

"More and more countries have large enough sales hence pharmaceuticals can be shipped directly to the designated country"

It can be concluded that there is no structural increase of direct deliveries due to an increase in e-commerce. Again, this might be caused by the fact that the investigated shippers are more prone to operate in a B2B than B2C market.

Product life cycle

Changes in product lifecycle were only reported by a few companies. These companies usually produce high tech products for private consumption. In general, a short product life cycle qualifies goods to be transported by air. However, there were no radical changes visible that the product life cycle is decreasing in time which might affect that products will be transported by air instead of ocean. Another finding from one interview is that shortening product life cycle do not influence the service level of a good being transported by air. Therefore, the product life cycle does not influence a shift in transportation mode or a shift in service level.

Sustainability

Nearly every shipper mentioned that within the last years an awareness of 'being green' and sustainable has started. This development is expected to become even more important in the future. Being sustainable is also often required by the shipper's customers. However, sustainability has a minor impact on the way goods are transported. Therefore, it is usually not a major trigger for a shift from air towards ocean. Being sustainable is practiced by optimizing packaging or better utilizing containers. One shipper reported as a consequence of being sustainable, it tries to source and distribute its goods more locally to prevent air and ocean transportation at all.

"We are trying to be as green as possible; however it should not affect the needs of our customers negatively"

"Being sustainable is very important for us and has consequences for transportation such as: the usage of slow steaming, reconsidering air freight in general, choosing deferred air shipments or selecting carriers that have sustainability programs in place"

For most shippers, a green supply chain comes as a pleasant side effect if for instance a shift towards ocean transport has been achieved. However, the main trigger for such a shift is cost efficiency and not the need to be more sustainable. Only one shipper actively took sustainability in consideration in the way they moved their products by air. As a result, this shipper reconsiders air transportation in general and tries to ship as much via ocean as possible. This shipper also tries to transport all their goods as deferred shipments and only selects carriers that have sustainability programs in place.

Based on the interviews, it can be concluded that sustainability is becoming more and more important for the operations but also for the transportation of shippers. However, it does not have a major effect on the way goods are transported. Therefore, an increased awareness of being green which is often demanded by customers does not result in a shift from air to ocean transportation.

Other developments in customer behavior

From the interviews, it is visible that demand is not necessarily becoming more volatile. Some shippers mentioned that towards quarter end demand usually picks up. Furthermore, it was stated that demand for aircraft charters is either flat or declining because there is enough capacity on commercial carriers. However, if there is an unexpected increase in customer demand and the demand cannot be supplied, for instance by standard ocean transportation, goods usually shift towards air transportation even if this means that all margins are gone. One shipper actually reported that around 50% of their air shipments are caused by unexpected planning or demand changes.

Summary

Even though the customer is one of the key reasons why products are shipped by air in the first place, there are no major trends among the interviewed shippers apparent that have an impact on the transportation of goods by air. E-commerce becomes more important, especially in a B2C market, but the shift towards integrators means that more small packages within Europe are send via truck. In Asia, where road transportation is not as efficient due to a lack in infrastructure, this could mean a shift towards air transportation by integrator. This was however not mentioned in any of the interviews because most of the shippers operate in a B2B environment. Being sustainable has also no major impact on the air cargo industry. The same is true for the trends of direct deliveries and shortening product life cycles. Due to the fact that these trends only have a limited impact on the air cargo industry and that the emergence was not apparent during the 19 interviews, it was decided to only partially investigate these trends further in the follow-up questionnaire.

Developments in product characteristics

Dematerialization

"Products are becoming lighter and smaller, for instance our new models will be 20% smaller than current size"

Dematerialization relates to the reduction of material usage per unit of GDP. Hence, it can be achieved by using less or lighter material, decreasing the size of a product, using less packaging or digitalizing a product. For the majority of shippers, products are decreasing in size and in weight. This has a direct impact on the air cargo volume that is transported. While for some shippers the size and/or weight was only decreasing by a small amount, a few shippers reported large reductions in size and weight. One shipper mentioned that the new version of one of their products will reduce its size by 20%. Another shipper stated that the weight of one product line was decreased from 0.7kg to 0.53kg representing a weight reduction of more around 25%. The weight and size reduction is especially visible for small and medium sized products in the high tech and automotive industry while pharmaceutical products seldom encounter a weight or size reduction.

"The total weight of one product decreased for instance from 0.7 kg to 0.53 kg"

"Our systems are getting bigger and we need more capacity on the B-747"

On the other hand, the two high tech shippers that manufacture mainly large systems, expect their products to increase in size and weight. These products often require the lift by main deck and therefore cannot be transported in a passenger aircraft. One shipper expressed its fear of not enough capacity on B-747 freighters in the future since their systems were getting too big and hence would not fit in a B-777 or MD-11.

It can be concluded that there will only be a minor decrease of the air cargo volume due to smaller and lighter products. This effect is also partly offset by the development towards bigger and heavier systems of other high tech shippers. The size and weight of pharmaceuticals is expected to remain constant over the next years.

Value-to-weight ratio

"If the value-to-weight ratio will be increasing, we expect to shift certain product types formerly transported by ocean to air however the switch will not be very significant"

Changes in the value-to-weight ratio are strongly related to the trend of dematerialization. If goods become lighter in weight while their value remains the same, this ratio increases. On the other side, the value might also decrease in the same proportion as the weight and thus resulting in a stable value-to-weight ratio. The majority of the shippers acknowledged that the value-to-weight ratio of their products was remaining stable or increasing slightly. However, a small increase of this ratio would hardly ever mean that shippers would switch the mode of transportation. For shippers that transport nearly all their products by air, an increase or decrease in the value-to-weight ratio would not have an impact at all. However, some shippers with a balanced share of air and ocean shipments revise their decision if a certain good is transported by air or ocean also based on the value-to-weight ratio. Even though it was shown that the value-to-weight ratio increased within the last years (see Chapter 4.4.2.2), it can be concluded that this trend has only a limited impact on the air cargo industry and might result in a minor increase of air eligible products and consequently in a minor increase of the air cargo volume.

Packaging

Packaging has changed in all three industries often as a way of being more sustainable. For automotive and high tech products, packaging has changed in a way that it is less voluminous while for pharmaceuticals, packaging helps to retain the temperature for cool chain controlled products.

"There is too much air in the packaging"

For the majority of automotive companies, the reduction of packaging has started in the past and continues to be an ongoing process. For one automotive shipper, optimizing the packaging resulted in a 35% increase of products being shipped per pallet. This also caused a shift of paying by chargeable weight instead of actual weight. On the other hand, one automotive part supplier reported that packaging is still rather voluminous and that there is a big opportunity in the upcoming years to optimize packaging. For high tech products, packaging has already become less voluminous and is tried to become even less voluminous in the future. Still, for most of the smaller high tech products, there is a limitation in the reduction of packaging because the instructions manual or the accompanied installation CD is not decreasing in size. On shipper of large appliances mentioned that it tried to decrease its packaging to a maximum height of 1.6m so it could fit in the 'belly' hold. This consequently reduced the need for freighters.

All pharmaceutical shippers reported that it is quite difficult to reduce package size and that the required package insert requires a lot of space. Since more and more pharmaceuticals require cool chain compliance, packaging changed in a way that it is passively trying to retain a certain temperature of the product.

"Redesign and optimization of packaging resulted in an increase of 35% more products shipped per pallet and a partial shift from paying chargeable weight to actual"

The trend towards less packaging is most likely to continue. However, there is a limitation of packaging becoming less voluminous. Packaging can only further decrease if product size also decreases. Nevertheless, some shippers still have a high potential in decreasing the size of their packaging. In total, the influence of changes in packaging on the air cargo volume is rather small.

Product launches

Due the course of the interviews, it became visible that product launches have an impact on the way goods are moved. In general, the amount of product launches is expected to remain stable for all industries. Only two pharmaceutical companies reported an exceptional increase in product launches for the next years. All shippers, for which product launches play an important role, stated that products that are usually transported by ocean will first be shipped by air and will then switch towards ocean. For some shippers this period can be as short as three to six months while for others it might be up to 18 months. For product launches, the type of service level is usually not changing. Only one shipper stated that it requires expedited services for product launches. However, this company hardly ever uses ocean transportation for this kind of products.

"Product launches are usually done expedited for the beginning and switch later to standard air or maybe ocean"

Other changes in product characteristics

Besides the abovementioned developments on product characteristics, there is one further change within pharmaceuticals. More and more pharmaceutical products, such as vaccines, require a cool chain. This means that from production to end consumption, a constant temperature between for instance 2 – 8 °C is required. If this regulation will not be followed, products might be damaged and are not allowed to be sold. Within the last years, the requirements and checks have become stricter. All pharmaceutical shippers indicated that the amount of cool chain products will be increasing in the upcoming years. These products can either be transported by active transportation (cooled containers such as Environtainers) or passive transportation with thermal blankets. Especially the active cooling is expected to increase since passive cooling is only valid for up to five days transit time. If these products are shipped by ocean they require transportation in a refer container.

"Many pharmaceuticals are time and temperature sensitive; now it is 35% but in 3 – 5 years it will be around 50%"

Summary

Product characteristics have a moderate impact on the air cargo industry in terms of air cargo volume and air eligibility of products. Furthermore, some products require special transportation such as main deck or cool chain. Most shippers reported a decrease in size and weight which consequently reduces the air cargo volume to a small extent. Packaging also become less

voluminous and hence decreases the amount of cargo volume. This decrease in air cargo volume is partly offset by the fact that some products will also increase in size. Due to product launches, goods that are usually shipped by ocean might shift to air for a certain amount of time. Therefore, some products become air eligible and consequently increase the amount of air cargo volume. However, this is only a temporary shift. Lastly, it can be concluded that especially pharmaceuticals will require more cool chain transportation to comply with regulations. Therefore, it becomes more important for carriers to offer such specialized products.

Changes in sourcing and production

Wider geographical sourcing of supplies

As already discussed in Chapter 4.4.1.1, the way supplies are sourced can differ. On the one hand, shippers try to source globally to benefit from cost advantages while on the other hand, a number of shippers try to source their supplies locally or regionally to achieve cost efficiencies in transportation and be more flexible. A similar situation was observable during the interviews. A number of interviewed shippers mentioned that they are planning to source more globally while other shippers also mentioned that they continue or plan to source locally.

"Most of our sourcing is currently done in Europe for European production, but we expect an increase in sourcing from Asia and North America"

"We shifted from global sourcing which was low-cost country driven to regional sourcing"

For most of the automotive companies, a shift towards local/regional sourcing was visible. This shift has often already taken place some years ago and is expected to continue. Among high tech shippers, sourcing trends were more diverse. Some shippers stated that they are expecting to source more supplies globally especially from Asia. While others, that already extensively source their material and supplies from Asia, stated that there will not be any change. One high tech shipper mentioned that it will source more locally from Asia, however the reason for this is that production actually moved closer to its suppliers but also to its customer base in Asia.

For pharmaceutical products, sourcing of raw materials is expected to remain in the current locations. However, it is also important to mention that the weight and volume of raw materials for most pharmaceuticals is comparable low and therefore has no real effect on global transportation.

"Air freight will be increasing, mainly driven by global sourcing and consolidating production to one or two facilities per product line"

It can be concluded that especially within the automotive industry, shippers opt to source supplies more locally. This would lead to a decline in the overall air cargo volume and to decreasing trade lanes. This effect is offset by a partial increase in global sourcing of high tech shippers, hence leading to an increase of the air cargo volume and the development of new trade lanes.

Production shift

The shift of production was identified as another structural supply chain trend. Three different developments (near-shoring, movement to low labor cost countries and industry clusters) were identified during the literature review. Near-

"We have moved all our production from Singapore to Suzhou, China"

shoring can be understood as shifting production closer to demand while a shift of production to low cost countries is driven by labor cost efficiencies. A movement of production to new clusters is caused by the shift of complete industries to a new location and the necessity to be in close proximity of other companies within an industry.

"We are planning new production sites in China and Brazil to be closer to the market but also to bypass high import tariffs in Brazil"

While near shoring was illustrated by the example of moving former off-shored production from Asia back to the USA or Mexico to be closer to its main consumption market, this particular case was only mentioned two times during the interviews; once by a pharmaceutical shipper and once by a high tech manufacturer. Therefore, a large scale of shoring back production to the United States is according to the 19 interviews only apparent to a small degree. Most often, production shifted or expanded closer to the consumer for high tech and automotive shippers in emerging markets such as Brazil, China or India. The predominant reasons for near shoring were lower transportation costs, higher flexibility, shorter lead times and a growing economy in the aforementioned regions. Besides that, near shoring is also done to gain market access in a particular country which is for some markets only possible if a production site inform of a joint venture was build. Furthermore, shippers try to bypass high import tariffs by moving or expanding production. Especially Brazil is one of the countries where shippers have set up or are planning to set up new production facilities for the Brazilian but also Latin American market since protectionism from foreign products requires extremely high import taxes.

"There will be a partial production shift to Puerto Rico for the North American market because of tax reasons"

The impact of near-shoring is a decline of the air cargo volume. However, only in a few cases production actually moved from one site closer to another. Most often new production facilities opened. Therefore, the air cargo volume is expected to stay constant in regard to the supply chain trend of near shoring.

"Movement of production from coastal China to inland China and to Vietnam, but it is not more than 5-10% of the total production"

A lot of shippers also reported that in the past they have moved already a fundamental amount of production facilities to low cost countries. This development caused the air cargo volume to increase substantially. Many shippers are continuing to relocate production facilities from developed countries such as the USA or countries in Western Europe to Asia or Eastern Europe. Therefore, air cargo volume is expected to increase and new trade lanes will emerge. Production facilities that have been moved to these areas years ago are most often staying there. Only a few shippers mentioned that they are planning to move to even cheaper countries such as Vietnam or cheap areas within China. The main reason for the hesitant move to these areas is the lack of developed infrastructure in terms of transportation, IT and security as well as high government corruption. For advanced high tech and pharmaceutical products, shippers mentioned that production will usually stay in developed countries in Europe, Northern America or Japan, while the production of mature products is very likely to be shifted to lower cost countries. Nevertheless, these mature products predominately are shipped by ocean.

Hence, it can be concluded that off-shoring of production to low cost labor countries is a continuing trend and therefore might increase the volume of air cargo to a small extent. The shift towards even lower labor cost areas as described in literature was however not visible to a large extent by analyzing the interviews. Hence, trade lanes will are expected to change only to a minor degree.

The movement to new industry clusters was only stated by one automotive shipper who successfully expanded its production to new automotive clusters in Brazil, China or Thailand. Another shipper of automotive parts mentioned that they usually follow their customers – the large automotive manufacturers. This is another sign that especially within the automotive industry clusters are highly important.

Supply chain risk

Nearly all shippers mentioned that they have witnessed an increase in supply chain disruptions due to strikes or natural disasters. For most of the shippers this development did not result in a proactive contingency planning or a fundamental change in their supply chain. Only a few shippers reported that dual sourcing would be an effective counter measure while for the majority this practice is too costly.

"We are looking for dual sourcing and production especially out of China because of 'China Risk'"

Political changes causing a disruption were mentioned twice. One Japanese shipper stated that for sourcing but also production they are actively looking outside of China because of the so-called China Risk[4]. Another shipper said to search for alternative sourcing locations outside of South Korea because of the possible military intervention on the Korean peninsula.

"In case of supply chain disruption we rely on more air freight"

In case of a supply chain disruption due to a natural disaster, shippers frequently mentioned that goods which are transported by ocean are often temporarily shifted towards air transportation. This was for instance the case in 2011 during the flooding in Thailand and the Tsunami in Japan. During the ash cloud, shippers tried to divert their air freight via Southern European gateways such as Rome or Milan and then truck it to its final destination.

Surprisingly, pharmaceutical shippers did not mention to suffer from supply chain disruptions that much. Their explanation was that usually inventory levels are quite high because the production costs of pharmaceuticals are much lower that its retail value and demand can therefore be served until the disruption is over.

It can be concluded that supply chain disruptions are increasing over time. However, it only has a minor impact on a reconfiguration of the total supply chain. Only a few shippers opt for new sourcing or production locations. Therefore, trade lanes will only change to a minor extent. Furthermore, there is only a temporary shift from ocean to air in case of a supply chain disturbance.

Other trends in terms of sourcing and production

One shipper that transports nearly all its goods by air mentioned that for the inbound transportation it achieved a small shift from air towards ocean since demand for parts can be scheduled better. For

[4] The so-called China risk derives from the political tension between China and Japan because of the claim of the Senkaku Islands

the remaining shippers a mode shift was most often achieved in the distribution of finished products (see next chapter).

Summary

Supply chain trend in regard to sourcing and production impact the air cargo volume as well as trade lanes. While automotive companies are trying to source supplies more locally, high tech shippers most often trend towards the opposite direction. Therefore, air cargo volume of automotive shippers should decrease by a small amount and some trade lanes could vanish or become less strong. On the other hand, high tech shippers are most often opting for global sourcing which results in an increase in air cargo volume. Production shifts in the future will also impact the air cargo volume as well as trade lanes. Due to near-shoring, the amount of air freight of finished products is very likely to decrease and will not be compensated by an increase of supplies being shipped by air. Near-shoring closer to developed countries and their consumption markets was the exception. Most of the shippers moved or expanded their production closer to new emerging markets. There is a continuation of production shifts to low cost countries which will enable the air cargo industry to grow to a certain extent. A shift from former off-shored production to even cheaper locations especially within Asia seemed to be uncommon for most of the shippers. Due to the increase of supply chain disruptions, many goods that are transported by air will continue to temporarily shift towards air transportation and thus increase the air cargo volume. However, this is not a structural change. Furthermore, short-term trade lane changes will appear in case of supply chain disruptions such as the ash cloud to divert air shipments.

Changes in distribution patterns

Wider geographical distribution of finished products

"We aim to achieve 50% of our sales in emerging countries by 2015"

The majority of shippers within the high tech and the pharmaceutical industry mentioned that the distribution of finished products will increase by a moderate amount. On the other hand, automotive shippers reported that they are trying to produce as close as possible to their customers and thus distribute from multiple geographic locations more locally/regionally. Especially the emerging markets such as the BRIC countries but also markets in South East Asia and Africa are expected to increase while production will not necessarily move towards all of these places. Additionally, shippers mentioned that the Middle East will grow faster in proportion to its market size.

The increase in global distribution is further triggered by companies supplying goods from one or two global manufacturing sites per product line to serve the entire global demand. The need for shippers to achieve economies of scale in terms of production was especially visible for high tech shippers manufacturing large systems on a build to order production approach. Hence, the cost achievements in production outplay the higher transportation costs even if goods are shipped by air.

It can be concluded that especially shippers of high tech products and pharmaceuticals will continue to distribute their products more global. Of course, for certain countries it is sensible to move production (see Chapter 4.4.1.5). This however has not necessarily an impact on the way goods are moved since it does not explain a shift from one mode to another. On the other side, a shift towards local/regional distribution as it can be witnessed especially for automotive part producers would definitely impact the air cargo volume since it is not practical to air freight goods over short distances.

Mode shift

One of the major trends that became visible during the interviews was a shift in transport mode selection. Nearly 75% of all respondents reported a shift from air towards ocean transportation. The remaining quarter of interviewees mentioned no mode shift. However, these companies ship nearly all their products by air and due to product characteristics such as value or size and customer needs it is also impractical and nearly impossible to shift towards ocean. One other shipper mentioned that air freight rates are relatively low and hence there is no need to shift towards ocean.

"The reasons for a mode shift to ocean are cost advantages and knowing which products are less time sensitive"

Of the shippers that identified a mode shift towards ocean, the predominant reasons were cost efficiencies since ocean transport is up to ten times cheaper and a better understanding of which products can have longer lead times. Hence shippers reported that they are managing their supply chain more efficient. Furthermore, due to the current economic downturn, many shippers implemented the policy to use air freight only by exception which requires approval of higher management in cases such as critical due dates, sudden demand increase or supply chain disruptions. For pharmaceuticals, one shipper reported that nearly 1% of their temperature controlled shipments are damaged upon arrival since vaccines and medications are for instance left hours on the tarmac, being exposed to high temperatures. This also caused the shipper to move a significant amount towards ocean. On the other hand, being sustainable was often seen as a nice side effect but did not actively trigger a shift from air to ocean.

"In three years we have moved from 50% air share to 25%, we only expect a slight shift towards ocean because we nearly reached the optimum"

Throughout the interviews, shippers reported that a huge mode shift has taken place in the past. For instance, one high tech shipper mentioned that they have shifted from 100% air shipments in 2010 to 26% air transportation in 2013. The shipper's top management is actually aiming to decrease the share of air movements close to zero. Many other shippers also reported a sizeable decrease in the share of air transportation. For the future, most shippers mentioned to continue with shifting from air to ocean. However, the possible shift towards ocean will become smaller. Therefore it can be concluded that a major mode shift has taken place in the past and hence in the future only a small move towards ocean can be expected.

"Everyone is talking about model shift, but we are not doing it"

"Once goods have changed from air to ocean no one will move it back to air"

The shift towards ocean is visible in all three industries and usually also among companies manufacturing the same kind of products. Surprisingly, one shipper mentioned that all their direct competitors are moving from air transportation to ocean while their products are still all being transported by air. Many shippers also mentioned that once goods have been shifted towards ocean transportation, products are expected to stay with this mode even if the economy situation would improve. This emphasizes that the shift is structural and not temporary because of economic reasons.

The only mode shift towards air was triggered by product launches since new products are more air eligible. Nevertheless, this represents a temporary and not a structural shift which might reverse towards ocean after demand is more mature. As already mentioned earlier, due to supply chain disruptions, there is most often a temporary shift towards air.

Only a few high tech shippers mentioned a change in the carrier type. As discussed in Chapter 3.8, there are two different carrier types: integrated and non-integrated carriers. From interviewing these shippers, especially a shift towards integrators can be seen. One shipper mentioned that the threshold in kg, that determines if a good is transported by an air cargo carrier or an integrator, has changed. For this particular example the shipper's threshold was increased from 100kg to 1,000kg resulting in an increase in the usage of integrators. Another shipper reported an increased usage of integrators especially in Northern America, because of capacity constraints. This was especially the case on wide body passenger air crafts. They furthermore reported that integrators are more reliable, have a better network and offer fast door-to-door transportation. On the other hand, some high tech shippers mentioned that products are getting larger and heavier which might shift a small amount of their shipments from integrators to non-integrated carriers.

It can be concluded that a mode shift from air to ocean is one of the most prevalent supply chain trends impacting the air cargo industry. However, according to most interviewees this structural shift has already taken place in the last couple of years. Shippers are still expecting and trying to shift a sizeable amount from air to ocean, however it can be anticipated that the magnitude will not be as high as in the past. A reversal of products that have been shifted from air to ocean back to air is also not likely to take place even if economic conditions would suddenly improve. The only shift towards air transportation is temporarily and triggered by product launches. A mode shift from non-integrated carriers to integrators is expected to be very small in size and only due to company specific reasons.

Speed of product flow

Besides shifting from one transport mode to another, shippers also change the service level of their consignments. In general it can be differentiated between expedited or deferred shipments. A similar classification can be made between time-definite and day-definite shipments. However, between both service levels huge cost differences appear. The change in service level is a direct response to the required speed of product flow within the supply chain.

"We are trying to reduce next day deliveries from 10% to 5%"

Most of the shippers that were interviewed mentioned that in terms of air freight, deferred shipments are most commonplace when selecting a service level and express solutions are usually used for emergency shipments and sometimes require the permission of higher management. In the course of the interviews, it became apparent that many shippers are able to cope with longer transit times and therefore try to reduce the usage of express or expedited services. Often it is tried to consolidate shipments and for instance only ship once a week instead of every day. The larger volume, consequently allows the shipper to pay less in total as opposed to ship smaller quantities in higher frequencies. For most shippers this trend of coping with slower product flows and consequently reducing the amount of express shipments started already some years ago and is expected to continue in the future.

"Our aim is to have consolidated deferred shipments instead of expedited ones"

Shippers also stated that they shift strongly to consolidated deferred shipments as it does not matter if products arrive on the first or the fifth day as long as the due date is met. Two high tech shippers actually mentioned that they would prefer a service that is in between the transit time of air and ocean freight, if considerable cost advantages could be achieved. For automotive shippers, just in time deliveries are still very important, however it is also tried to consolidate shipments and whenever possible shipping products less frequently but in larger batches.

"We are trending to switch from express services to economy mode, but only a few goods are shipped by express anyways"

Only two shippers stated that the speed of product flow was actually increasing in a sporadic matter. One pharmaceutical shipper mentioned that they unwillingly had to shift more often to express services because freight forwarders only offered express solutions due to alleged capacity constraints. On the other hand, a high tech shipper mentioned that shipments have seen a strong increase in expedited services to meet the business partners' sales out process.

It can be concluded that there is a structural shift from express to deferred shipments. This holds for all industries as well as both carrier types. Most shippers also stated that the amount of express services is usually quite small and therefore even a big shift to economy air freight services will not be too drastic.

Smaller and more frequent shipments

"Frequency and shipment size has not changed"

The trend of smaller and more frequent shipments was only prevalent for a few shippers. For the majority of shippers, the shipping size and frequency did not change and is also not expected to change considerably in the future. Due to cost efficiencies by consolidating shipments to large batches, shipping frequency actually became less while the number of products that are transported in one shipment increased. This development is strongly related to the trend of slower product flow. Since some shippers and their customers can cope with a longer transit time, as long as due dates are complied with, shippers can combine consignments and ship them less often in a time period. Therefore, one shipper expects to shift some of their products which are currently transported by integrator towards air cargo carrier in the future. For the remaining shippers, this development did not impact any shift in carrier selection.

"We try to consolidate smaller shipments to larger batches"

Only one shipper explicitly mentioned that batch size and frequency became smaller and more frequent. The reason for this trend is that customers require tailor made products and therefore smaller batches are sent more frequently. However, this development did not impact any carrier selection. As already mentioned earlier, one shipper experienced declining sales and consequently reductions in shipment size. Because of this small shipment size it was sometime required to ship products by integrator instead of air cargo carrier.

It can be concluded that the trend of smaller and more frequent shipments was a rather uncommon development for the interviewed shippers. Often, this trend actually moved in the opposite direction

towards less frequency and larger batch sizes. Still, the impact on the type of carrier selection is marginally small.

Increased usage of larger gateways

One trend that was found during the interviews was a shift towards consolidated trunk routes. Many shippers, especially in the high tech and pharma industry, mentioned that they are trying to ship their products on main routes and from one large gateway to another due to cost advantages. One shipper mentioned, it was more cost efficient and less capacity constrained to first truck a product to one of the larger gateways in Europe such as Frankfurt, London Heathrow or Paris Charles de Gaulle and air freight it directly from there instead of shipping it from a smaller airport via one of the large gateways to its final destination. This trend is also driven by a consolidation of production facilities to so-called 'focus factories' and a consolidation of inventory in multimarket warehouses or regional distribution centers. Due to this trend, many trade lanes of an individual shipper will shift to a few large streamlined trade lanes instead of many small dispersed ones.

"We would like to shift from many dispersed gateways (e.g. 20 airports in EU) to more consolidated pipelines (e.g. 5 airports in EU)"

Summary

From the interviews, it can be concluded that changes in distribution have the biggest impact on the air cargo industry in terms of air cargo volume, carrier selection, service level and trade lanes. On the one hand shippers will continue to distribute a large extent of their products globally especially in emerging countries. Therefore, global air freight will increase and new trade lanes will be established. On the other hand, a large shift from air towards ocean transportation has taken place in the past, reducing the amount of air freight for individual shippers by more than 50% in the last three years. However, this drastic shift is expected to slow done in the next years. Besides a mode shift, only sporadic changes in the usage of carriers can be seen.

The trend of an increase in transit time for certain products, results in the fact that shippers use less express services and increase the share of deferred shipments. Therefore, high-yielding services such as next day deliveries will decrease. Besides that, it is expected that many shippers will try to ship their products from large gateways instead of smaller dispersed cargo airports. This might strengthen the dominance of airports in Europe such as Frankfurt, London Heathrow or Amsterdam Schiphol. As a consequence, certain trade lanes between large gateways will become more consolidated and become bigger in size.

Summary

From the analysis of the interviews it can be seen that certain trends which were found during the literature review are more prevalent in this three industries than other trends. Furthermore, a number of additional trends could be found during the interviews. In Table 22, the results of the interviews are summarized taking the impact and the extent of each trend into account.

Table 22: Summary of the interviews

Trend	*Impact*
E-commerce	Minor change in carrier type: Minor increase in the usage of integrators, however increase is very small because interviewed shippers operate in a B2B market
Direct deliveries	Minor change in carrier type:

	Minor increase in the usage of integrators, however not caused by an increase in e-commerce but company specific reason
Product life cycle	No impact on air cargo volume: No visible change of the air cargo volume
Sustainability	No impact on air cargo volume: No visible change of the air cargo volume
Dematerialization	Minor impact on the air cargo volume: Minor decrease of air cargo volume because majority of high tech and automotive products are getting smaller, however this decrease is partly offset by an increase of product size for high tech shippers producing large systems
Value-to-weight ratio	Minor impact on commodities: Minor increase in commodities becoming more air eligible, which could result in a minor increase of the air cargo volume
Packaging	Moderate impact on air cargo volume: Moderate decrease of air cargo volume because shippers try to use less voluminous packaging
Product launches	Minor impact on air cargo volume: Minor increase of air cargo volume, however this increase is temporary and might shift back to ocean once sales are more mature
Increase in cool chain products	Moderate impact on the required carriage: Moderate increase of the need for cool chain transportation of pharmaceuticals
Wider geographical sourcing of supplies	Minor impact on the air cargo volume: No major shift in air cargo volume since automotive shippers try to source more locally while high tech shippers are expected to increase global sourcing. Moderate impact on trade lanes: Moderate shift in trade lanes especially out of China and emerging Asia
Production shift	Moderate impact on air cargo volume: Moderate shift in air cargo volume because some shippers tend to move production closer to end consumers while others off shore their production to low cost areas in emerging countries. Moderate impact on trade lanes: Moderate shift of trade lanes especially for high tech and automotive companies to China and other Asian countries as well as Brazil
Supply chain risk	Minor impact on air cargo volume and trade lanes: No major impact on the air cargo volume or trade lanes, due to supply chain disruptions air cargo volume will temporary increase and trade lanes can temporary shift but the impact is not permanent
Wider geographical distribution of finished products	Moderate impact on air cargo volume: Minor increase in the air cargo volume because high tech and pharmaceutical shippers are expected to distribute goods more globally from limited location. This increase is partly offset by automotive shippers who try to distribute goods more locally.
Mode shift	Major impact on air cargo volume: Major decrease of the air cargo volume because many shippers have and are expected to continue shifting from air to ocean transportation. Minor impact on carrier type: Minor increase in the usage of integrators, however this is mainly caused due to company internal decision.
Speed of product flow	Moderate impact on service level: Moderate shift from express to deferred shipments since most shippers can cope with a longer transit time
Smaller more frequent shipments	Minor impact on carrier type: No major impact on the carrier selection
Increased usage of larger gateways	Moderate impact on trade lanes: Minor shift from fragmented trade lanes to large consolidated trunk routes

Based on these results of the in-depth interviews, a follow-up questionnaire was distributed to the same shippers as well as an extended list of additional shippers. In this follow-up questionnaire only the trends that were most apparent during the interviews will be taken into account.

5.6.2 Follow-up Questionnaire

In this part, the results of the follow-up questionnaire are presented. In total 17 respondents filled in the online questionnaire. One respondent only partly answered all questions. First general information about the respondents is given by presenting their annual freight amount as well as growth expectations. After that the results of each part of the questionnaire will be shown.

General information

The respondents of the questionnaire were supply chain managers of shippers that operate mostly in the high tech industry. Only a few respondents reported that they mainly operate in other industries such as consumer electronics or household appliances. Additionally, two automotive shippers participated. In Figure 36, the distribution of shippers and their industries are illustrated. Similar to the interviews, most respondents were high tech shippers followed by automotive parts producers. Pharmaceutical manufacturers did not participate in the questionnaire.

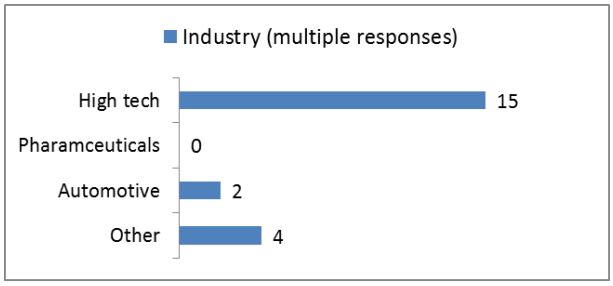


Figure 36: Respondents per industry

In Figure 37, the annual amount of freight for three different transport modes (air freight, air express and ocean) is shown. The questionnaire was filled in by a diverse group of shippers. On the one hand, large air freight shippers reported to have more than 40,000 tons per year while on the other hand, the majority of shippers carried less than 20,000 tons. The annual amount of air express, which can be regarded as smaller sized shipments usually up to 75kg transported by integrators, is given in number of shipments. Furthermore, the number of TEU for ocean transport is given. Most of the shippers transport less than 5,000 TEUs per year.

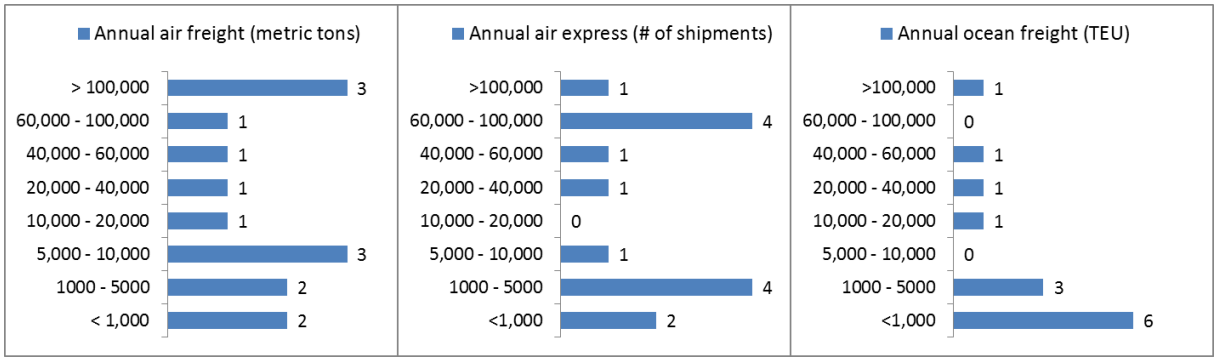


Figure 37: Annual freight per transport mode

The majority of respondents expect to increase its amount of annual freight in all three transport modes. However, between each mode there are significant differences. Air freight is quite variable.

More than half of the shippers expect their annual air freight to grow. At the same time, a number of shippers anticipate that air cargo volume will decline in the future. Two shippers even mentioned a drastic decline of more than 5% per year. The amount of air express is expected to outpace the growth of air freight. All shippers besides two mentioned that ocean freight will increase. It can be concluded that on average all modes of transport should grow. However, ocean freight is expected to grow the most followed by air express and air freight.

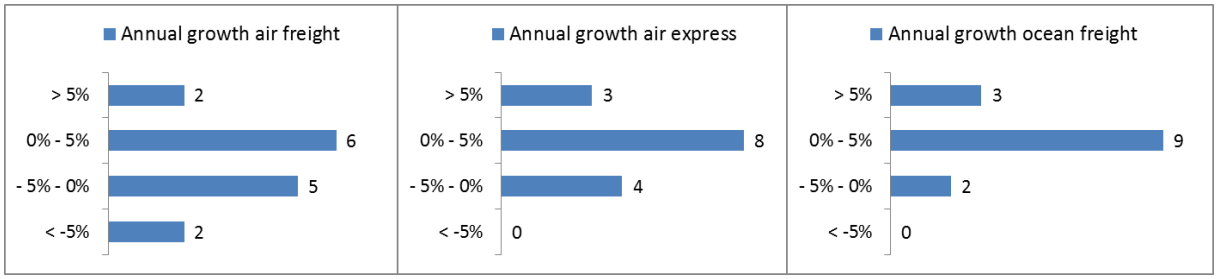


Figure 38: Annual freight growth per transport mode

Sourcing, production and distribution

The response of shippers to sourcing locations was evenly distributed. A number of respondents stated that there will be no significant change in the way supplies are sourced. A few shippers mentioned that they will aim to increase the share of local or regional sourcing while on the other hand a number of shippers mentioned to source more globally. The trend towards local sourcing will impact the air cargo volume to a minor extent since the distances of goods being transported by air will decrease. Hence, other modes of transport such as truck will become more reasonable as well as cost and time efficient. However, this impact is offset by the trend towards global sourcing which makes air freight more viable.

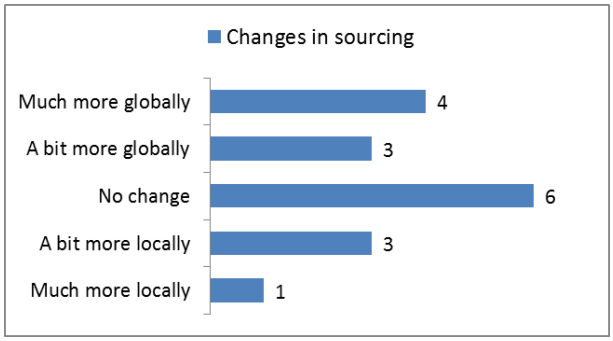


Figure 39: Expected changes in sourcing of supplies

For developed countries in Europe and North America it is anticipated that sourcing out of these areas will grow only for a small amount of shippers while the majority expects no change or even a decline in sourcing. It is expected that shippers will move or expand their production especially to China and emerging Asian. The predominant reasons for such geographical changes are illustrated in Figure 40. The change in the geographical location of production has an impact on the trade lanes. Trade lanes will shift at which exports will increase especially out of China and emerging Asian countries. But also Latin America is expected to become more important as a location to manufacture or assemble goods. This is in line with the result of the interviews were many shippers mentioned that they will predominantly move their production to Asia but also Brazil.

Table 23: Change in production location

	Strong increase	Moderate increase	No change	Moderate decrease	Strong decrease	Not applicable
North America	-	40.0%	33.0%	13.0%	7.0%	7.0%
Europe	6.0%	12.5%	56.5%	12.5%	12.5%	-
China	25.0%	43.5%	19.0%	12.5%	-	-
Mature Asia	6.0%	35.0%	41.0%	12.0%	-	6.0%
Emerging Asia	20.0%	46.5%	20.0%	-	-	13.5%
ME & Africa	7.0%	26.5%	46.5%	-	-	20.0%
Latin America	20.0%	46.5%	20.0%	-	-	13.5%

The main reasons for moving or expanding production to different geographical regions (see Figure 40) are to achieve cost advantages by moving to lower labor countries. Shippers also responded that it is more important to move closer to end consumers. Furthermore, shippers mentioned that production movements or expansions are caused by high import tariffs in certain countries. The movement to new industry clusters or closer to suppliers was less important. To gain market access was only mentioned once as a predominant reason.

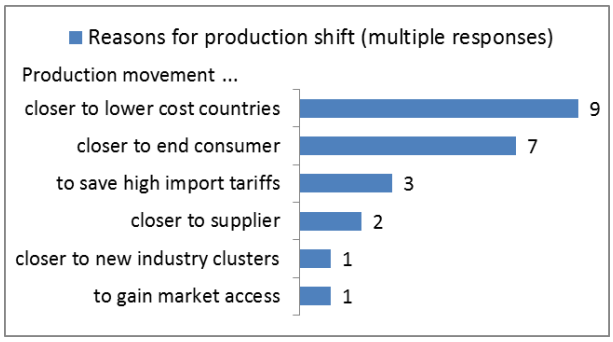


Figure 40: Reasons for a shift in production

The response of shippers to changes in sales locations was leading towards more global distribution. On the one hand, many shippers stated that there will be no significant change. On the other hand, nearly half of the shippers expected to distribute more globally from limited locations. Only one shipper aimed to increase the share of local/regional distribution. Hence, it can be expected that the air freight volume could grow due to an increase in global distribution. Nevertheless, the majority of companies that filled in the questionnaire were high tech companies which already mentioned during the interviews an increase in global distribution.

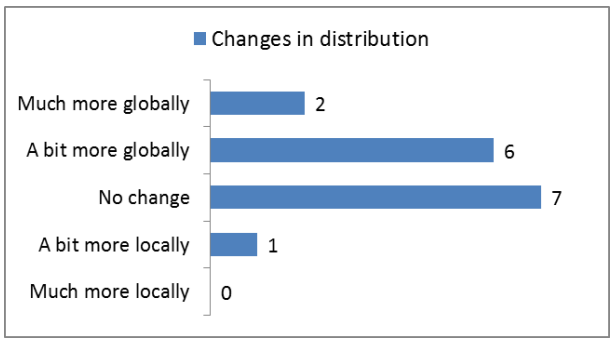


Figure 41: Expected changes in distributing finished products

The transportation of finished goods will especially grow to emerging areas around the globe (see Table 24). Of the seven regions, all are expected to have a strong increase besides Europe and North

America. These two regions are expected to see a moderate change or even a decline. The areas that are expected to have the biggest change in terms of imports are China and emerging Asian countries. It is also expected that Latin America will achieve a sizeable increase of importing goods.

Table 24: Changes in sales location

	Strong increase	Moderate increase	No change	Moderate decrease	Strong decrease	Not applicable
North America	-	60.0%	27.0%	6.5%	-	6.5%
Europe	6.5%	31.0%	25.0%	37.5%	-	-
China	40.0%	53.5%	-	-	-	6.5%
Mature Asia	13.5%	46.5%	20.0%	6.5%	-	13.5%
Emerging Asia	27.0%	46.5%	6.5%	-	-	20.0%
ME & Africa	20.0%	46.5%	20.0%	-	-	13.5%
Latin America	40.0%	40.0%	6.5%	-	-	13.5%

Transportation of products

As already mentioned in the interviews, a mode shift from air to ocean was one of the largest trends among shippers in the three industries. For the next years, the majority of shippers are expecting a moderate shift from air to ocean. However, there are also shippers that transport nearly 100% of their goods by air and hence it is not plausible for them to shift at all. Besides that, none of the shippers are expecting a shift from ocean towards air in the future.

The rather small shift from air to ocean might be an indicator that a large mode shift has already taken place in the past few years. This is also justified by the fact that the average air share of total transportation decreased by 5.4 percent points from 2010 to 2013. For the near term future this share is expected to only decrease by 1.6 percent point from 2013 to 2016. Therefore, it can be concluded that in the future there will be a continuing mode shift, however the degree will be smaller than in the last years.

The main reason for a mode shift from air to ocean is lower transport costs. Furthermore, shippers indicated that sustainability and a better knowledge about which commodities really require air or ocean transportation leads to a mode shift. On the other side, shippers also specified reasons such as slow steaming of ocean vessels and comparable low air freight rates as reasons why there is a shift towards ocean.

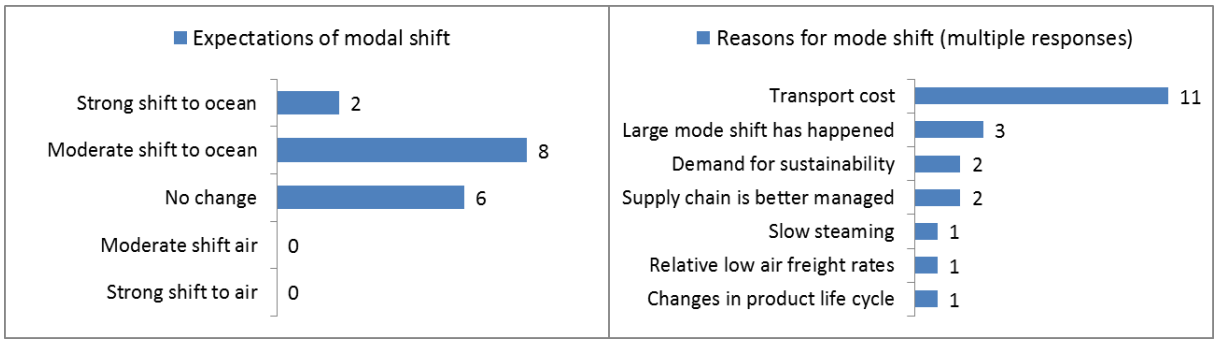


Figure 42: Expected mode shift and predominant reasons

The majority of the shippers will not see any major changes in the usage of integrators versus non-integrated carriers. Still, many shippers mentioned reasons for a potential shift from non –integrated carriers to integrators or vice versa. The most dominant reason was a difference in fares which would lead to a shift from an integrator to an airport-to-airport carrier. Further reasons are changes

in shipments size and frequencies as well as a policy to consolidate consignments. On the other hand, integrators would increase their share because they offer door to door transportation.

Figure 43: Expected shift in carrier type and predominant reasons

Due to cost advantages and the reduction of emergency shipments, the majority of shippers are expected to lower the amount of express or expedited services. There was no shipper that expected an increase in the share of express services. Besides that, some shippers also reported no change in service level in the future. The results from the questionnaire are matching the shift towards more deferred shipments as it was apparent during the interviews.

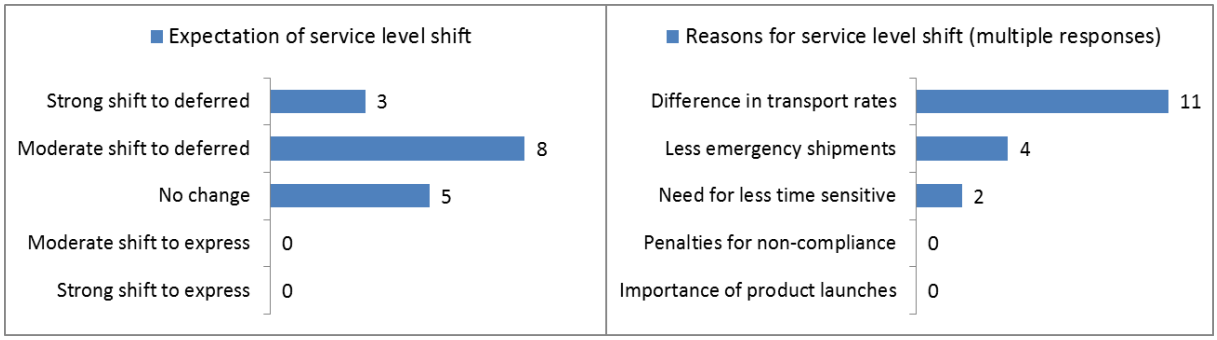


Figure 44: Expected shift in service level and predominant reasons

As a last change in how goods are transported, shippers were asked about their expectation to use smaller more dispersed gateways or bigger hubs and consequently ship their goods on consolidated trunk routes. Nearly half of the shippers stated that they expect to transport goods more from larger gateways. None of the shippers mentioned to increase the share of smaller origin or destination gateways. Again, this finding is in line with the outcome of the interviews.

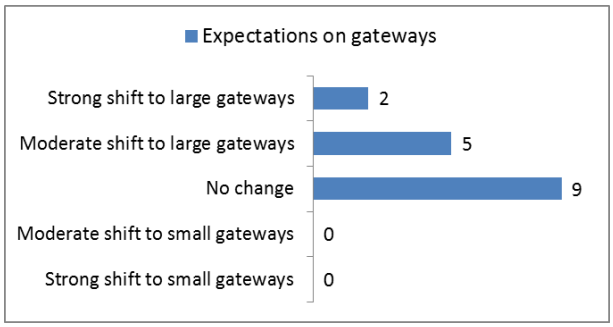


Figure 45: Expected shift to bigger gateways

Product development

In terms of changing product characteristics most shippers reported that products are becoming lighter and decreasing in size. Furthermore, packaging is anticipated to become less voluminous in the future. Hence, air cargo volume will be negatively impacted by these trends. The value-to-weight ratio was only expected to change to a small degree, thus more goods could become more air eligible which consequently increases the air cargo volume. The majority of shippers also mentioned that the product life cycle was getting shorter. However, it is not necessarily evident if this would make goods more prone to be shipped by air. In general, the mentioned changes in product characteristics of the questionnaire are similar to the responses of the interviews.

Table 25: Changing product characteristics

	Strongly disagree	Mostly disagree	Neither agree nor disagree	Mostly agree	Strongly agree
Becoming lighter (Weight)	18.5%	-	40..0%	40.0%	6.5%
Decrease in size (Volume)	12.5%	-	44.0%	25.0%	18.5%
Less voluminous packaging	6.5%	6.5%	6.5%	55.5%	25.0%
Higher value-to-weight ratio	-	6.5%	40.0%	33.5%	20.0%
Shorter product life cycles	-	6.5%	33.5%	40.0%	20.0%

Summary

From the analysis of the questionnaire it can be seen that findings are coherent with the results of the in-depth interviews. Nevertheless, some of the trends that have been investigated in the questionnaire are more apparent than others and hence have a different impact on the air cargo industry. In Table 26, the results of the questionnaire are summarized taking the impact and the extent of each trend qualitatively into account.

Table 26: Summary of the questionnaire results

Trend	*Impact*
Wider geographical sourcing of supplies	Minor impact on air cargo volume: No major impact on air cargo volume since majority reported no changes in in sourcing, expectations on global and local/regional sourcing are evenly distributed
Production shift	Minor impact on air cargo volume: No major impact on the air cargo volume since shippers are expecting to move or expand production closer to end consumer (minor decrease of air cargo volume) while others also expect to move or expand production to low cost countries (minor increase in air cargo volume) Moderate impact on trade lanes: Moderate shift of origin since shippers will move production predominantly to China, emerging countries in Asia and Latin America
Wider geographical distribution of finished goods	Minor impact on air cargo volume: No major impact on air cargo volume, since majority of shippers did not report any changes in the distribution of finished products. Air cargo growth due to an increase in global distribution is offset by a similar trend towards local/regional distribution Moderate impact on trade lanes: Moderate shift to emerging sales markets in China, emerging Asian and Latin America
Mode shift	Moderate impact on the air cargo volume:

	Mode shift from air to ocean is expected to continue, however to a lower degree than in the past. Minor impact on type of carrier: No major impact on type of carrier selection, since majority of shippers did not indicate any expected changes in the future
Speed of product flow	Moderate impact on the type of service level: Sizeable shift from express (time-definite) to deferred (day-definite) shipments because of cost advantages, reduction of emergency shipments and shipments are becoming less time sensitive
Consolidation of trade lanes	Moderate impact on trade lanes: Major trunk routes will increase moderately since shippers expect to ship more from and to large gateways
Dematerialization	Moderate impact on air cargo volume: Sizeable impact on the air cargo volume since many shippers expect their products to decrease in weight and size
Packaging	Moderate impact on air cargo: Sizeable impact on air cargo volume since many shippers expect packaging to become less voluminous
Value-to-weight ratio	No major impact on commodities: Minor increase in commodities becoming more air eligible, which could result in a minor increase of the air cargo volume
Product life cycle	No impact on air cargo volume: No visible change of the air cargo volume

5.7 Chapter Conclusion

In this subchapter the findings from the interviews as well as the questionnaire are summarized. Firstly, trends that have a sizeable impact are discussed. After that, supply chain trends that do not impact the air cargo industry are mentioned.

Trends that have a sizeable impact on the air cargo industry

Based on the analysis of the interviews and the questionnaire it can be concluded that there are certain trends that have an impact on the air cargo industry while some of the identified trends were less apparent and therefore do not impact the air cargo industry to a considerable extent. The impact on the air cargo volume, trade lanes, carrier type as well as the service level of carriers was most noticeable. To return to the causal scheme of Zografos and Giannouli (2001) which was discussed in the beginning of this master thesis, the following figures illustrate the most visible trends as well as their impact and their preceding drivers.

Due to several supply chain trends, the air cargo volume is expected to decrease. The largest impact is caused by the on-going trend of a mode shift from air to ocean, mostly caused by differences in transport costs and a better alignment of the supply chain. The decline of air cargo volume is further intensified by the fact that products are getting smaller in size and lighter in weight. Furthermore, many shippers expect their packaging to become less voluminous. Additionally, sourcing of supplies and distribution of finished products is expected to become more local especially for the automotive industry. On the other hand, high tech as well as pharmaceutical shippers expect to increase the share of global sourcing and distribution to achieve cost advantages and scale economies for production regardless of higher transport costs. Furthermore, supply chain disruptions caused by natural disaster or strikes, temporarily increase the share of air cargo to a small extent. Another factor that impacts the air cargo volume is the overall economy, since air cargo volume is derived

from demand of global trade. Most of the shippers expected to increase their sales which would consequently increase the air cargo volume and could partly offset the negative impact of trends on the air cargo volume.

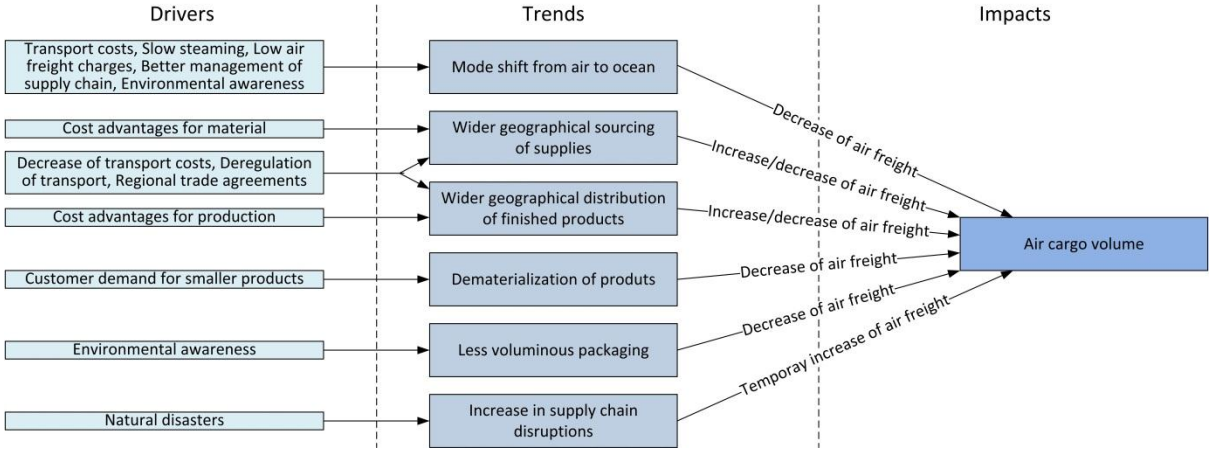


Figure 46: Trends that impact the air cargo volume

Trade lanes are predominately impacted by structural supply chain trends. Due to shifts in the geographical location of production and sales markets trade lanes are expected to change. These trends are triggered by the deregulation of transport and regional trade agreements. Especially, China, emerging Asian countries and Latin America will increase its share of global production and consumptions. Hence, more air freight is estimated to be exported and imported from these locations. The trend of shippers to increase the usage of larger gateways instead of smaller dispersed ones will result in strengthening larger trunk routes. Lastly, due to supply chain disruptions trade lanes will temporary shift because shippers try to divert their transportation.

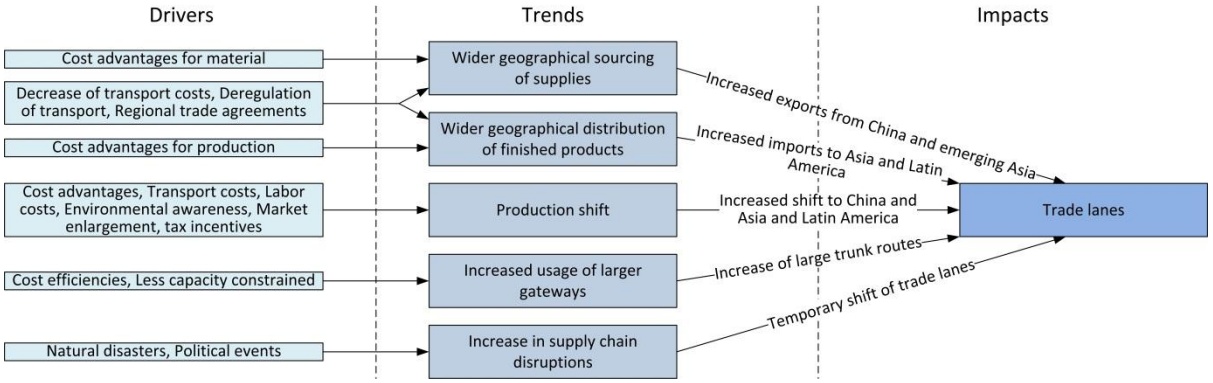


Figure 47: Trends that impact a shift in trade lanes

Due to cost advantages of some shippers are expecting to decrease the share of integrator usage for their air transportation. On the other side, a change in shipment size and frequency makes the usage of integrators more feasible. This is further complemented by the fact that integrators offer door-to-door transportation which becomes more important for many shippers and consequently increases their usage on integrators. Nevertheless, on the basis of the interviews and the questionnaire it cannot be predicted which carrier type will increase its share in the future.

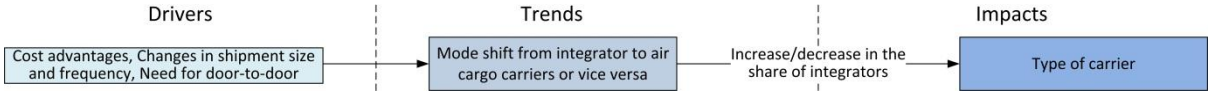


Figure 48: Trends that impact a change in carrier selection

The last major trend that impacts the air cargo industry is a continuous shift from express (time-definite) to deferred (day-definite) shipments. This trend is caused by large cost savings when opting for deferred (day-definite) shipments. Furthermore, the fact that customers require less time sensitive shipments and hence shippers can consolidate their shipments to larger batches leads to a shift towards deferred transportation.

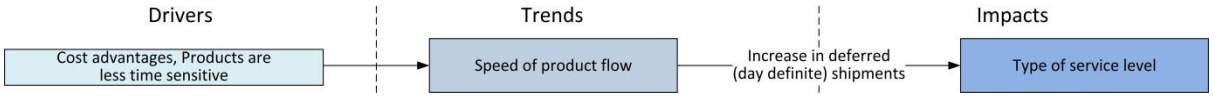


Figure 49: Trends that impact the type of service level

Trends that have no sizeable impact on the air cargo industry

The remaining trends which were researched in more detail by means of interviews and a questionnaire turned out to be not apparent. Surprisingly, trends such as 'e-commerce', 'direct deliveries' as well as 'smaller and more frequent shipments' were not common developments among the shippers that have been interviewed and therefore did not influence the type of carrier selection. However, this might be caused by the fact that most of these shippers operate in a B2B market. Furthermore, being more sustainable did not trigger the majority of shippers to reconsider air transportation and shift towards more ocean transport. Even though, the value density increased for many products it did not make goods more eligible. Lastly, changing product characteristics that require goods to be shipped as 'main deck' instead of 'belly hold' only occurred sporadic. Furthermore, the need for cool chain compliance was only visible for certain pharmaceuticals.

After identifying the supply chain trends that are most impactful on the air cargo industry, in chapter six it is tried to quantify some of the impacts by using Seabury's databases.

6 Quantification of selected Trends and their Impacts

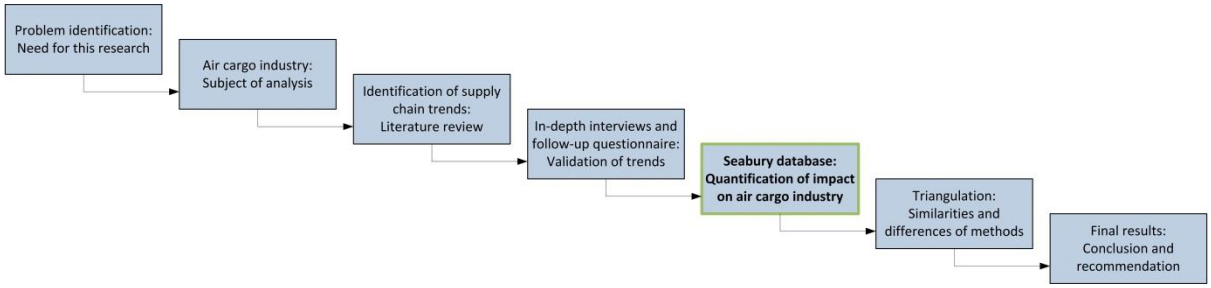
6.1 Introduction

After conducting in-depth interviews and distributing a follow-up questionnaire among supply chain managers of various shippers in three different industries, this chapter aims to quantify the impacts of certain supply chain trends on the air cargo industry. It is tried to quantitatively answer the fifth research sub-question: *What are the impacts of the supply chain trends on the air cargo industry?* This will be done by using Seabury's *Global Trade, Express, Traffic* and *Capacity Database*. For an overview of the databases and a more detailed description, Appendix A and B can be referred to. The fifth sub-research question was first discussed in Chapter 4.6 and analyzed qualitatively in Chapter 5. The quantification in this chapter enables the validation of the findings from the interviews and the questionnaire on the basis of official customs data. Hence, knowledge can be gathered regarding the entire population of this research instead of a snapshot of a limited amount of companies.

This chapter focusses on the following five main impacts:

- Air cargo volume
- Commodities
- Trade lanes
- Type of carrier
- Type of service level

The remaining impact of 'required carriage' which was discussed in Chapter 4.6, will not be analyzed in this chapter since it is impossible to quantify changes in the requirements of carriage by using Seabury's databases.



6.2 Air Cargo Volume

In respect to supply chain trends, the growth or decline of the air cargo industry was mostly impacted by a structural shift of the transportation mode. A temporary mode shift towards air was caused by supply chain disruptions. Examples of such disruptions are the tsunami in Japan or the 2011 flooding in Thailand. The air cargo volume was also impacted by changing product characteristics such as size, weight or the value-to-weight ratio as well as an increase in global sourcing and distribution. To quantify the structural as well as temporary mode shift, data of the *Global Trade Database* will be used. A change in the size and weight of goods as well as changes in packaging and cannot be investigated by means of the data products of Seabury. The same is true for a possible increase or decrease of air cargo caused by trends in sourcing and distribution.

Structural mode shift from air to ocean

For every industry the mode shift within the last six years will be analyzed by using Seabury's *Mode Shift Database*. The *Mode Shift Database* is based on the content of the *Global Trade Database*.

According to Seabury, the air share of containerized goods has declined to nearly 1.7% in terms of weight. There are three main causes for this decline which are the basis of the methodology behind any mode shift analysis at Seabury. The 'lane effect' takes into account that trade lanes with a high percentage of ocean transportation grew faster than lanes with a high air share. The 'commodity effect' recognizes that goods which are more prone to be transported by air grew slower than average global trade. The last effect is the 'mode shift' meaning that goods that were traditionally transported by one mode (ocean or air) shifted to the opposite mode. These three elements are added or subtracted from the unbiased growth to match the actual growth of air cargo volume. In the following part, a negative value represents a mode shift from air to ocean while a positive value represents a shift from ocean to air. For each industry, the mode shift as well as the ten largest trade lanes between seven global regions (see Appendix G), where a mode shift towards ocean in 2011 took place, is illustrated.

High tech

Throughout the last six years, high tech goods shifted continuously from air towards ocean. Only in 2010, there was a small shift from ocean towards air. This shift is related to the improvement of the global economy leading shippers to transport goods by air to restock manufacturing sites with supplies and warehouses or retail outlets with finished products. Still, when comparing this increase to the increase of other industries, the mode shift was marginally small. In 2011, a radical mode shift has taken place. More than 4% of the total trade of high tech products by air switched to ocean transportation.

The biggest mode shift on an individual trade lane was from China to North America. This is not surprising since this is also one of the biggest trade lanes of high tech goods. Trade lanes with the highest mode shift involved exports from China and mature Asia as well as imports to North America, Europe and mature Asia. There are only four trade lanes that achieved an overall shift from ocean to air. The biggest trade lane of this reversed mode shift were from Europe and North America to China with nearly 3% of the trade lanes share.

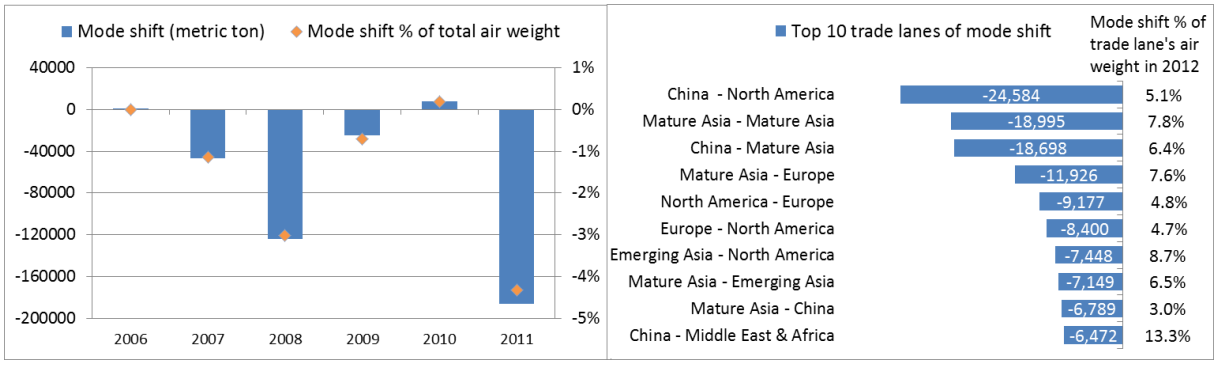


Figure 50: Mode shift for high tech goods (Source: Seabury, 2013b)

Pharmaceuticals

The shift from air to ocean for pharmaceutical products was in the last years rather small and did not account for more than 1.5% of total air trade per year. Still, over time there is a continuous shift

from air to ocean visible. In 2011, the mode shift of pharmaceutical products was around 6,000 tons, representing around 1% of total air trade of pharmaceuticals.

The biggest shift towards ocean was on the trade lane between the Middle East & Africa and North America as well as on the trade lane between matured Asian countries. Imports to mature Asian countries as well as exports from North America also suffered from a severe mode shift. Mostly trade towards Europe and China and trade originating from Europe could benefit from a positive mode shift towards air transportation.

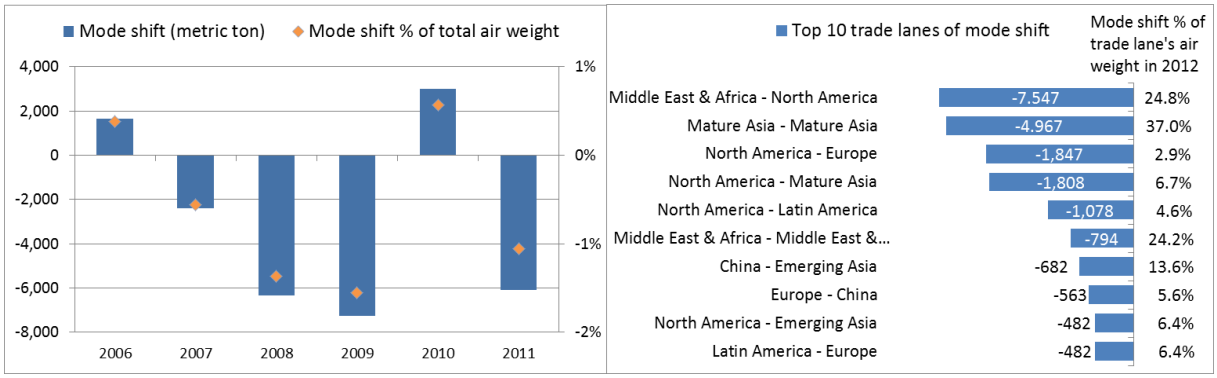


Figure 51: Mode shift for pharmaceuticals (Source: Seabury, 2013b)

Automotive parts

The mode shift within the automotive industry can be considered more variable over the last years in comparison to the other two industries. From 2006 to 2008, there was an extensive shift towards shipping automotive parts by ocean. The following two years, a sizeable mode shift from ocean to air could be seen. This might be caused by the fact that in 2009 and 2010 the number of manufactured cars grew remarkably in countries such as China, Indonesia, India and Thailand. To keep up with the high demand, part manufacturers had to transport their goods by air. Only after demand matured, goods could be transported again by ocean. This is visible by a large mode shift from air to ocean in 2011. Hence, a tremendous shift of 57,000 tons from air to ocean, representing almost 5.3% of total air trade of automotive parts, occurred.

Trade lanes with a high mode shift involved European exports of automotive parts. Nearly 50% of the mode shift towards ocean occurred on trade lanes that originated from Europe, the largest being to emerging Asia with more than 26,000 tons of air freight. Trade towards Europe and emerging Asia suffered from a substantial mode shift. Surprisingly, the biggest shift from ocean to air took place on the trade lane from Europe to North America.

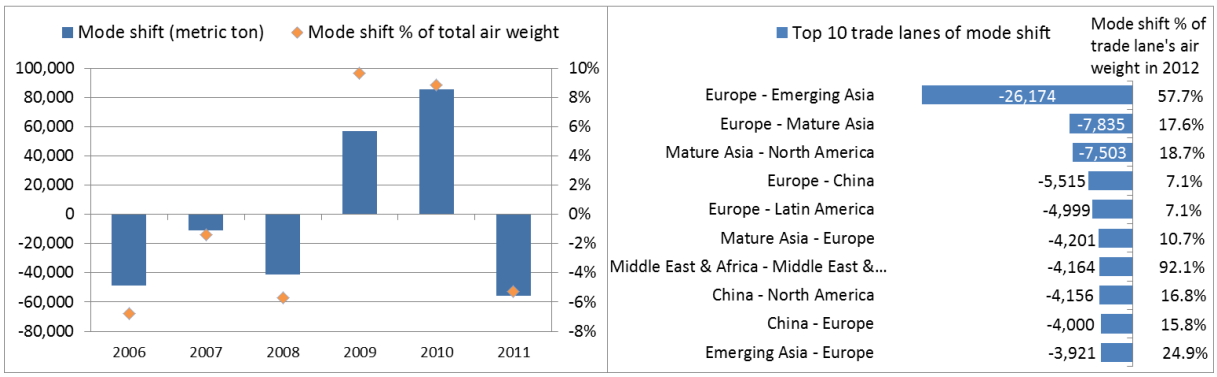


Figure 52: Mode shift for automotive parts (Source: Seabury, 2013b)

Results of the interviews as well as the questionnaire show a large shift from air to ocean within all three industries. Hence, a high consistency between the survey research and the statistical data analysis exist. Especially high tech shippers mentioned a large decrease in the share of air shipments within the last few years. Simultaneously, they also reported that the mode shift in the next years will be declining. Also automotive shippers mentioned a strong shift towards ocean transportation especially within the last two years. The majority of the respondents of the questionnaire also reported a minor shift from air to ocean in the next three to five years.

Temporary mode shift from ocean to air

Due to supply chain disruptions, some shippers stated to temporarily switch from ocean to air transportation. This shift is done to overcome material shortages or to meet due dates of customer orders. The temporary increase of air freight is exemplified with the Thai flood in 2011 which disrupted supply chains of automotive production and caused shortages of global hard disk drives.

In Figure 53, the monthly air freight volume and the air share of total transportation of automotive parts in Thailand is illustrated. It can be seen that until August 2011 the air freight of automotive parts into and out of Thailand was around 2,000 metric tons per month. The decline between 2008 and 2009 can be explained by the economic downturn due to the financial crisis. However, by the end of 2011 the monthly air cargo volume increased abruptly, nearly trebling to the amount before the flood. The air share also quadrupled to 4% of total transportation. During 2012, the amount of air freight as well as the air share slowly declined to levels before the 2011 flood. Hence, due to supply chain disruptions that are caused by natural disasters, it can be shown that on a macroeconomic scale, air freight temporary increases. Nevertheless, the amount is rather small and highly sporadic. Still it can be assumed that for company related supply chain disruptions such as quality issues or failure to comply with due dates, the share of air freight also increases.

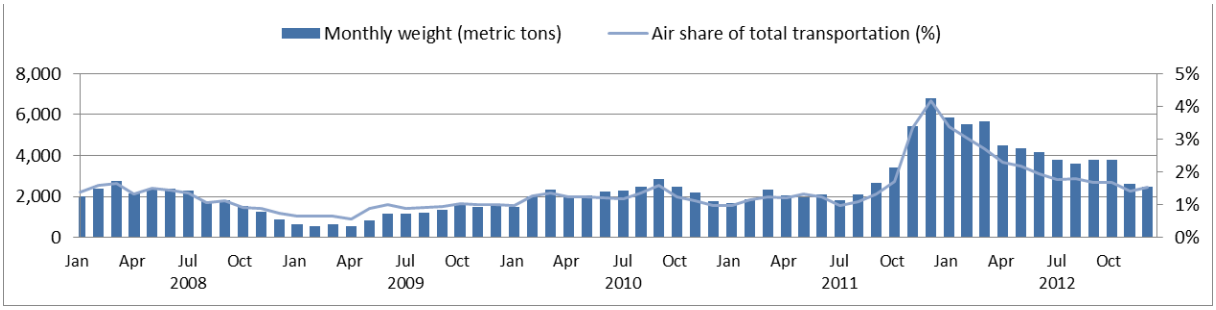


Figure 53: Monthly air freight and air share of automotive parts in Thailand (Source: Seabury, 2013a)

6.3 Commodities

Increasing value-to-weight ratio

As already mentioned in Chapter 4.4.4.2, the value-to-weight ratio is one of the characteristics that can determine whether it is cost efficient to transport goods by air. Especially products with a high value-to-weight ratio are more likely to be shipped by air. In Figure 54, the average value-to-weight ratio of high tech products, pharmaceuticals and automotive parts are illustrated over time. The average value density for high tech products was around 330,000 US$/ton. The average value-to-weight ratio was slightly higher with 390,000 US$/ton. Automotive parts on the other hand ranged at around 38,000 US$/ton in 2012. The lower value density of automotive parts also explains why only a small percentage of automotive parts (2%) are shipped by air. For high tech products and

pharmaceuticals this share is much higher. Nearly 17% of high tech products and 9% of pharmaceuticals are transported by air.

Over the last decade, the average value density of all products increased within these industries. Pharmaceuticals almost doubled its value-to-weight ratio and automotive parts as well as high tech products increased by 50%. As already explained in Chapter 4.4.2.2, this increase is partly caused by inflation. However, after taking inflation into account, the value-to-weight ratio still increased. Nevertheless, from this general analysis it cannot be concluded that due to an increase of the value-to-weight ratio, products became air eligible to a larger extent. Hence, it is necessary to further examine detailed product groups to track an exceptional increase of the value-to-weight ratio which could lead to a shift from ocean to air transportation.

During the interviews and the questionnaire the majority of the respondents stated that products only increased to a small amount or stayed the same in respect to the value density which is in line with value density from the *Global Trade Database*. Therefore, it can be argued that the increase in the value density only has a marginal small impact on the air cargo industry.

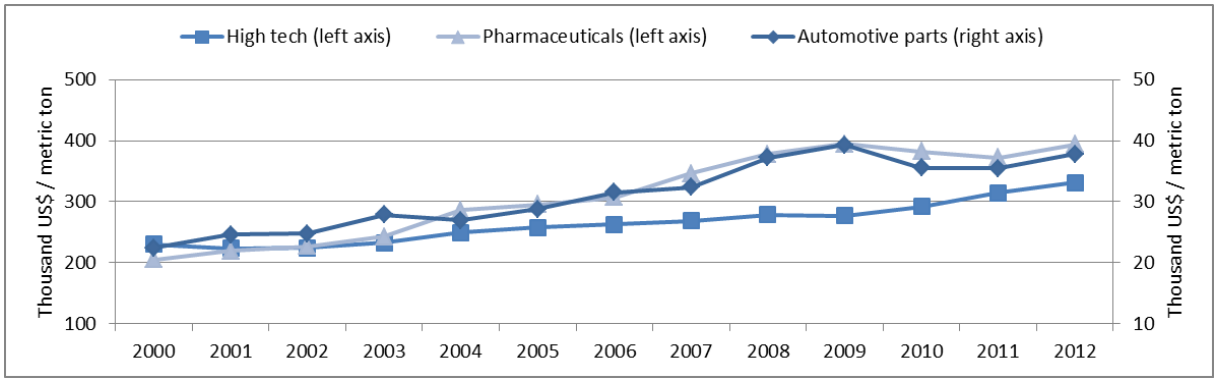


Figure 54: Value-to-weight ratio over time (Source: Seabury, 2013a)

6.4 Trade Lane Changes

Shifts in trade lanes are triggered by structural supply chain trends such as geographical changes in sourcing of supplies, in production and in distribution of finished goods. These trade lane changes will be analyzed and mapped by looking at the individual industry. For this analysis Seabury's *Global Trade Database* will be used. In the course of the interviews, it was mentioned that supply chain disruptions such as the ash cloud in Europe also caused a temporary shift of trade lanes to southern gateways. Since the closure of the airspace in Central and Northern Europe only lasted for six days it is not possible to track a temporary shift from northern/central gateways such as Frankfurt or London to southern ones such as Rome or Madrid. It was further mentioned that shippers tend to use larger gateways and hence reduce the usage of smaller airports. Consequently, this results in an increase of shipping via large consolidated trunk routes. This shift will be analyzed by using Seabury's *Traffic Database* to identify the share of the largest airports over time as well as Seabury's *Capacity Database* to show the share of the largest airport-to-airports routes over time.

Trade lane changes per industry

In this part, an analysis on the permanent shift of trade lanes per industry will be done. This analysis is done by looking at the largest trade lanes between seven different regions (see Figure 55, 56 and 57). In each figure the thickness of each arrow is relative to air trade on each lane in 2012. The color

indicates the expected future growth in the next five years. A green arrow represents a growth above 20% while a yellow arrow indicates an expected growth up to 20%. Red arrows indicate a forecasted decline of air weight per trade lane. The number on each arrow represents the compound annual growth rate from 2007 to 2012. Since only international trade is gathered by customs offices, domestic China and intra-Europe trade is not captured in Seabury's databases.

High tech

In 2012, more than 70% of all high tech products originated from Asia. The major trade lanes were China – Europe and China – North America representing 22% of the global trade. Other major trade lanes are intra-Asian routes. The trade lane between Europe and North America has lost its importance. In both directions, trade decreased from 2007 to 2012 with a compound annual growth rate of 2.7% and 3.0% respectively. The importance of China for the assembly of high tech products will become even bigger in the future. It is expected that high tech products originating from China will increase by 4.2% (CAGR) and would by 2017 represent around 40% of total high tech production shipped by air. The share of European and North American production is expected to remain the same. Only mature Asian countries such as Japan, South Korean and Singapore are expected to decrease their share of high tech products being shipped by air.

The major consumption markets of high tech goods being transported by air are estimated to stay the same. It is anticipated that Europe, North America and mature Asia will each import around 22%. Only the Middle East & Africa and China are expected to have above average growth rates in consumption of high tech products.

Hence, it can be concluded that China as an origin but also as a destination for high tech products will become even more important. This was also apparent during the interviews as well as during the questionnaire. On the other side a strong growth of Brazil which was mentioned by many shippers is not visible in Seabury's database. The rather small growth might be explained by high import tariffs which lead shippers to actually move production to Brazil instead of exporting goods. Europe and North America will continue to have the same share of global production and consumption of high tech products shipped by air.

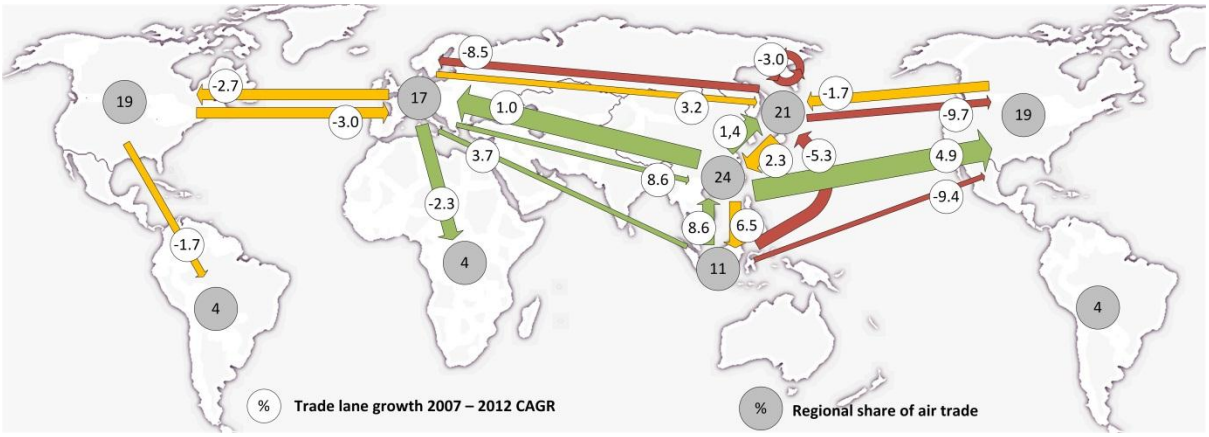


Figure 55: Trade lane changes of high tech products (Source: Seabury, 2013a)

Pharmaceuticals

Pharmaceuticals shipped by air originate for around 60% from Europe and North America. The major trade lane for pharmaceuticals is also between these two regions. However, air trade between these regions actually contracted by 0.2% (CAGR) from 2007 to 2012 and is only expected to increase by

3.4% and 1.3% (CAGR) respectively. The major growth markets are all located in emerging or developing countries or areas such as China, emerging Asia, Latin America and the Middle East & Africa. Air trade from Europe and North America to China increased by 21.3% or 20.0% (CAGR) respectively and is expected to further increase by 8.6% and 6.5% (CAGR) respectively in the next five years. Also trade from Europe and North America to Latin America was increasing within the last years and is expected to increase further. Additionally, air shipments from Europe to emerging Asian countries and the Middle East & Africa are expected to grow continuously.

From Figure 56, it can be seen that most of the pharmaceutical production will stay in Europe and Northern America. This is in line with the interviews where the majority of the respondents stated that manufacturing of high end pharmaceuticals will stay in Europe or North America while lower tech pharmaceuticals or generics might shift to developing countries. However, these generic pharmaceuticals are usually not shipped by air.

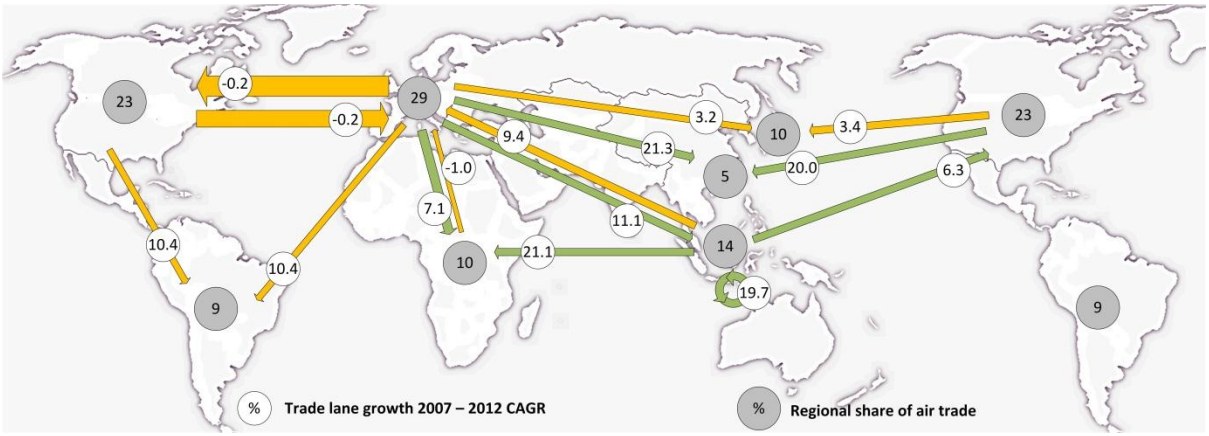


Figure 56: Trade lane changes of pharmaceuticals (Source: Seabury, 2013a)

Automotive parts

Nearly 40% of all automotive parts originated from Europe in 2012. This is followed by North America and mature Asian countries with each 16%. The main trade lane Europe to North America decreased in the last five years while the trade from Europe to China increased by 20.7% (CAGR). This increase in air trade is caused by the opening of many automotive plants in China. For the future, trade from Europe is expected to grow slower than in the last five years. This trend would be in line with the aim of many automotive shippers to be closer to their customers and therefore move production to these new markets. Other countries that strongly increased their production capabilities in the last five years are emerging Asian countries such as Thailand. Emerging Asian countries are expected to be responsible for one tenth of global exports of automotive parts by air. The same is expected for China. These two regions predominantly ship their goods by air to North America. In terms of import, most regions will remain the same. Mature Asian countries as well as Latin American countries are expected to decrease by one or two percentage points while China and North America will increase by two percentage points.

Surprisingly, trade towards Latin America is also expected to decrease or only grow to a small extent from North America and Europe. However, this might be caused by the high import tariffs in countries such as Brazil, leading many companies to expand production to Brazil instead of shipping goods by air from overseas.

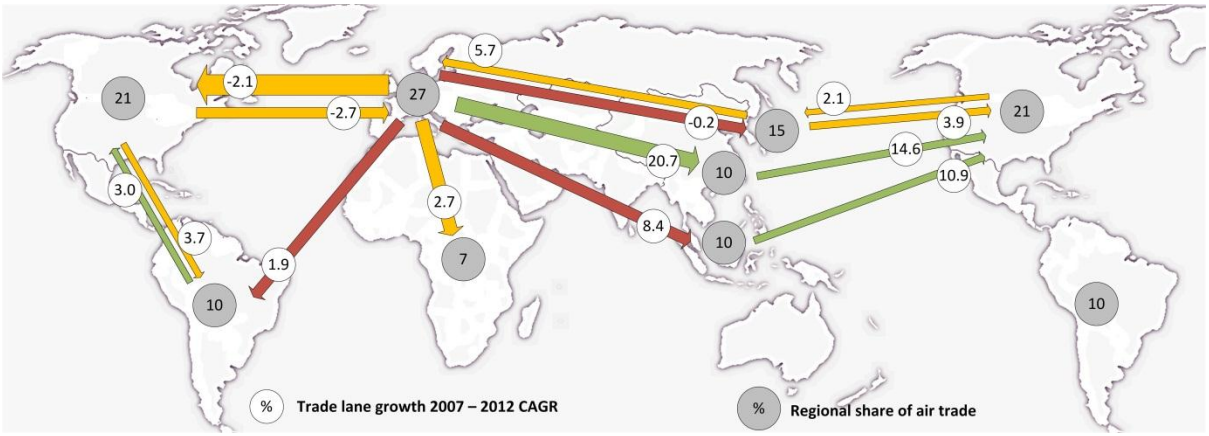


Figure 57: Trade lane changes of automotive parts (Source: Seabury, 2013a)

Increased usage of large gateways

As illustrated in Figure 58, over the last decade, the share of the largest cargo airports remained stable. This is remarkable, since connectivity to secondary airports has increased within the last years. The top 10 airports represent nearly 50% in terms of handled cargo tons. Hence it can be concluded that air cargo is primarily shipped from and/or to large hubs as listed in Chapter 3.2.

As mentioned during the interviews and the questionnaire, shippers decreased the number of gateways or are expected to do this in the future. However, from Figure 58, it is not apparent that the share of the largest cargo airports was increasing in the last years. This inconsistency of the database compared to the results of the interviews and questionnaire might be explained by two reasons. On the one hand, the *Traffic Database* covers all commodities traded by air. Therefore, it might be possible that the researched industry are different in respect to this trend in comparison to other industries. On the other hand, because of a geographical shift in production locations and consumption markets, exceptional growth can be seen at airports in emerging countries, the Middle East (except for Dubai) as well as at secondary airports. For instance, the amount of handled air cargo decreased for the majority of the top 20 cargo airports from 2010 to 2011, while at smaller airports such as Doha (14.2%), Leipzig (16.5%), Bogota (10.7%) and Abu Dhabi (10.3%) the amount of handled cargo increased in the same time (IATA, 2012).

Figure 58: Share of largest cargo airports (Source: Seabury, 2013c)[5]

[5] The traffic database is comprised of data from global airlines covering 60 - 70% of air traffic

In Figure 59, the share of the largest airport-to-airport trade lanes are shown. Within the last six years the share of the largest 400 trade lanes decreased constantly from around 41% to 35. Hence it can be concluded that air trade became more fragmented which does not comply with the results of the interviews and the questionnaire. However, the explanation for this discrepancy might be the same reason as for the share of the largest cargo airports.

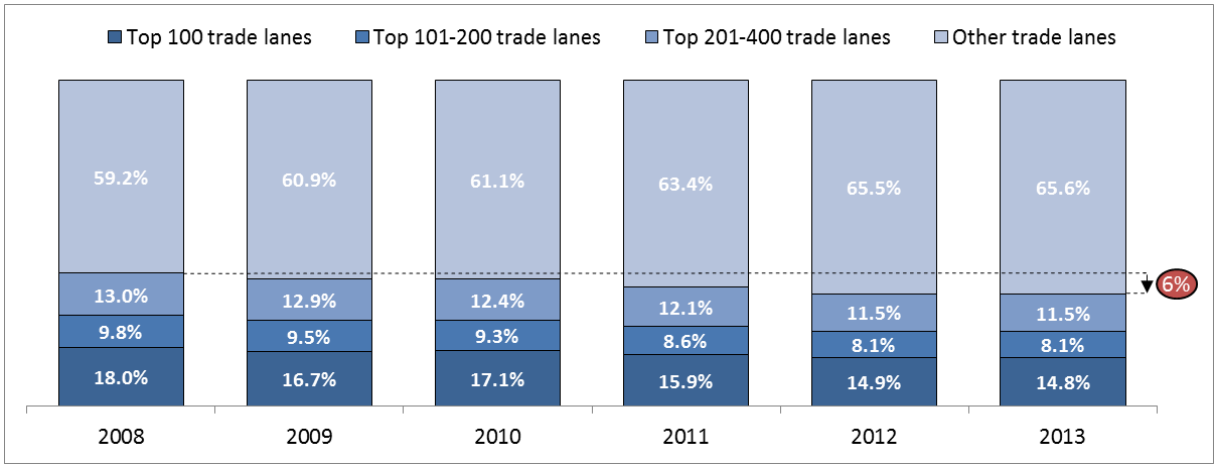


Figure 59: Share of largest trade lanes (Source: Seabury, 2013d)

6.5 Type of Carrier Selection

In Figure 60, the historical and expected express share for the three industries from 2006 to 2016 is illustrated. In general, integrators as well as express like services of freight forwarders are used twice as often for high tech products in comparison to pharmaceuticals and automotive parts. Before the financial crisis in 2008 and 2009, the share of integrators continuously increased. In 2010/2011 the express share decreased while in 2012 more goods were shipped by integrators or express like services of freight forwarders than the year before. In the future, it is expected that the express share is growing. Nevertheless, the growth rate, especially for pharmaceuticals and automotive shippers, is expected to be smaller compared to the growth before the financial crisis.

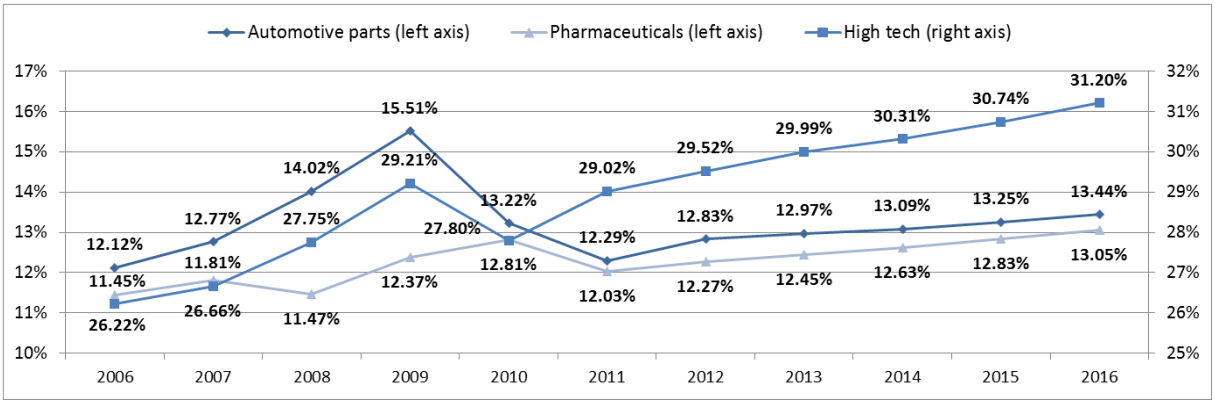


Figure 60: Historical and forecasted express share per commodity (Source: Seabury, 2013e)

During the interviews, a shift from one type of carrier to another was relatively fragmented. Mostly shippers within the high tech industry mentioned a change in both directions. Two high tech shippers stated an increase in the usage of integrators due to a change in the weight threshold and/or because integrators offer a better network, service and door-to-door transportation. On the other hand, one other shipper mentioned a slight decrease in the usage of integrators because goods and parts are becoming bigger in size and therefore require transport by non-integrated

carriers. In the questionnaire most shippers stated no change in carrier selection. Still, possible reasons for a shift were differences in rates and changes in shipment size. The limited increase is also represented in Seabury's *Express Database*. Integrators and express like services are expected to grow faster than non-integrated carriers. However, the magnitude is expected to be smaller than in the past.

6.6 Type of Service Level

During the interviews as well as in the questionnaire, many shippers reported that the need for express shipments is decreasing. Therefore, shippers switch to more deferred shipments. For air freight, there is usually a differentiation between express and deferred transportation while for integrators and express products of forwarders this split is between time-definite and day-definite shipments. Express shipments require the fastest possible transportation. Deferred shipments are regarded as consignments that are not too time sensitive and only require to arrive before an agreed due date. Hence, these shipments can be consolidated and shipped when there is enough capacity on an aircraft resulting in lower fares. Time-definite means that shipments are guaranteed to arrive before a certain time within the next one to three days depending on the destination while day-definite only guarantees to deliver consignments by a certain date.

In Table 27, the share of shipment numbers for time-definite and day-definite service levels of integrators and express products of forwarders is shown. The split between the two service levels is obtained from data of three of the four large integrators. It can be seen that the share of time-definite shipments decreased from 75.6% in 2011 to 73.4% in 2012. The data is the average of all commodities and cannot be applied to a specific commodity.

Table 27: Share of service level for express like shipments (Source: Seabury, 2013e)

Service level	*2011*	*2012*	*Change (absolute shipment numbers)*
Time-definite	75.6%	73.4%	5.0%
Day-definite	24.4%	26.6%	18.3%

By looking at trade lanes between major regions, the share of shipment numbers for day and time-definite shipments is similar to the average. Nevertheless, when looking at the weight share, major differences can be observed. While for intra Europe, only two out of five shipments were done expedited (41.5%), the share of time-definite shipments intra Africa was nearly twice as high (82.3%). The decline of time-definite shipments was largest between Europe and North America while time-definite shipments decreased less than average on intra-European routes.

Since data is compiled from shipments of integrators and express like products of forwarders, such as KNExpress of Kuehne & Nagel, the results cannot automatically be transferred to general air freight. However, it is very likely that the overall share of express deliveries of air freight decreased while deferred shipments increased. This also confirms the findings from the interviews and questionnaire.

6.7 Chapter Conclusion

By using Seabury's databases, a certain number of the impacts on the air cargo industry could be quantified. In general, most of the findings of the interviews and questionnaire could be confirmed

and there are only minor differences between the interview, questionnaire and the results from the database.

The largest effect on the air cargo industry is a continuous shift from air transportation to ocean. The accumulated mode shift of all industries resulted in a cumulated loss of nearly 250,000 tons towards ocean for all three industries in 2011. This represents 4.2% of the total trade by air in these industry sectors. On the other hand, due to supply chain disruptions air cargo temporarily increases. However, the amount is marginally small compared to the structural mode shift.

The value-to-weight ratio increased for all industries. Still, the increase is on average very small. Hence the conclusion that because of an increase in the value density, goods become more air eligible meaning that the air cargo volume would increase to a sizeable extent is therefore not valid.

Due to shifts in sourcing, production and distribution, many of the biggest trade lanes changed over time. For high tech products, China will become even more important as a production country. Pharmaceuticals will continue to be produced predominately in North America and Europe. However, emerging countries such as China and India are becoming more important for sales markets of pharmaceuticals shipped by air. The majority of automotive parts production that is shipped by air will stay within Europe and North America. The importance of China and emerging Asian countries such as Thailand and India as production but also as sales markets will increase. Surprisingly, air trade growth to Latin America was for all three industries lower than the average global growth. This can be related to the high import tariffs of Brazil, the economic powerhouse in the region, which triggers shippers to open new production facilities in Brazil to bypass the high import tariffs.

The share of the largest cargo airports and airport-to-airport trade lanes remained constant or declined by a small degree. Still, the majority of air freight is shipped from and/or to large gateway hubs. The usage of larger gateways, as reported in the interviews, was not necessarily apparent in the database and hence did not shift trade lanes to be more consolidated. In fact, the airport-to-airport trade lanes became even more fragmented and decreased by 6 percentage points within the last six years. The reason for this inconsistency with the survey data might be caused because the statistical data covers all commodities and does not give the possibility to look at an individual commodity level. On the other hand, geographical changes in production locations and sales markets triggered an exceptional growth of airports in emerging countries, the Middle East and at secondary airports.

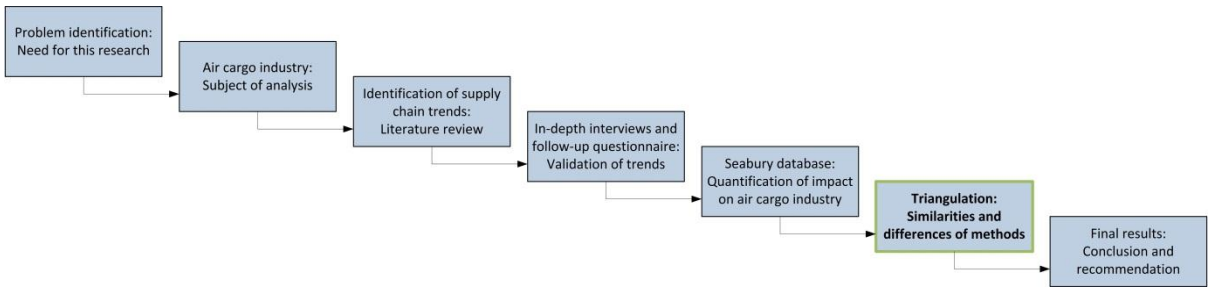
A change in carrier type was only marginal towards integrators. Integrators represent the fastest growing business model. However, a large shift from non-integrated carriers to integrators failed to appear within these industries. This might be related to the fact that most of the shippers within these industries operate predominately in a B2B market instead of a B2C market.

Lastly, the type of service level has changed. A small increase of the share of day-definite shipments was visible. Even though not explicitly discussed during the interviews it was expected that the share of time-definite shipments would decrease since many shippers mentioned to reduce the amount of expedited shipments for air freight.

7 Triangulation

7.1 Introduction

In the past three chapters, different methods were used to research supply chain trends and their impact on the air cargo industry. An extensive literature review identified a number of supply chain trends. Of these trends, a selection was tested by means of interviews and a questionnaire. At the end, Seabury's databases were employed to quantify some of the impact of supply chain trends on the air cargo industry. This chapter aims to show the similarities and differences in findings of the individual research methods.



7.2 Comparing Literature Review, Survey Research and Statistical Data Analysis

During the literature review 21 supply chain trends, categorized in four groups, were identified. Of these 21 trends, eight supply chain trends did not impact the air cargo industry or were out of scope. Hence, these trends were discarded and not considered for the remainder of this research. The remaining trends were verified or falsified by interviewing supply chain managers of large shippers. The presence of the majority of supply chain trends could be confirmed during the course of the interviews and a questionnaire. However, a number of trends were not identified as major trends at the respective shippers. Two additional trends were identified during the interviews. By using Seabury's databases, nearly half of the trends and their impact could be quantified. Of these trends the majority of the database results were consistent with the interviews and the questionnaire.

In Figure 61, the comparison of the literature review, the survey research (interviews and questionnaire) and the statistical data analysis is illustrated. The Y-axis maps the degree of appearance of each researched trend which was identified during the literature review. The X-axis maps the appearance of the researched supply chain trends during the interviews and the questionnaire. Each circle indicates if the trends could be quantified by using Seabury's databases (grey versus green/red). Furthermore, the color of the circle (green versus red) specifies if the database confirmed the qualitative impact, identified during the interviews, or not.

Differences between literature review and survey research

The majority of trends located in the upper left hand side of Figure 61 represent trends that were largely discussed in literature. However, the majority of these trends were not at all or only seldom identified as supply chain trends by the respondents during the interviews.

For instance, the trend of e-commerce in a B2C sense which influences the emergence of direct deliveries and consequently should favor the usage of integrated carriers did not apply for most of the interviewed shippers. This might be caused by the fact that interviewed shippers predominantly operate in a B2B market. Hence, it can be expected, that for industries such as fashion or consumer

goods, the appearance and the impact of B2C e-commerce would be much higher. Other trends that are largely discussed in literature are production shifts. Especially the shift of former off-shored production back to the USA or Mexico or the shift from coastal China to Western China as well as to lower cost countries such as Vietnam, as exemplified in chapter 4.1.1.5, did not take place to a large extent. Instead, a continuous production shift to China, emerging Asia and Latin America was most apparent during the interviews. Furthermore, an increase in product launches and the shortening of product life cycles, both trends that are triggered by the customer, were less reported by the shippers than anticipated after the literature review. The same is true for changes in the size and frequency of shipments.

The supply chain trends that are located in the lower right hand side of Figure 61 are trends that were less discussed in literature but mentioned very often during interviews and questionnaires. The trends of less voluminous packaging and the dematerialization of products were especially mentioned by high tech and automotive shippers. The trend of an increase in the usage of larger gateways was only found during the interviews. Especially high tech and pharmaceutical shippers mentioned to reduce the number of entry and exit gateways which lead to a strengthening of consolidated trunk routes.

Similarities between literature review and survey research

Supply chain trends that are located in the upper right hand side were discussed both in literature and mentioned by the majority of shippers. Hence, the existence of these trends was verified by the interviews and the questionnaire. Additionally, the majority of these trends also turned out to be the trends that are most impactful on the air cargo industry.

A mode shift from air to ocean was mentioned by nearly every shipper. Only a few respondents that ship almost all their products by air were not expecting to shift towards ocean transport. Production shifts were also mentioned by the majority of shippers. By consolidating and deferring consignments many shippers slow down the speed of product flow. Furthermore, many shippers mentioned that the amount of supply chain disruptions is increasing. As mentioned in literature, shippers confirmed the trend of shifts in sourcing of supplies and distribution of finished products. While some shippers opt for global sourcing and distribution, others try to source and distribute more regionally/locally. The trend of being more sustainable was very often mentioned by shippers. However, it did not affect the way goods are transported by air.

The last two trends were not really apparent during the literature review and the interviews. The increase in cool chain products is related to the pharma industry and has an influence on the type of carriage. This trend was identified by every pharma shipper during the interviews. However, since this trend is not relevant for other industries the impact is very low. A very small increase in the value-to-weight ratio was also mentioned by the majority of shippers and hence has a very low impact of goods becoming air eligible.

Comparison of survey research and statistical data analysis

Of the supply chain trends that were apparent during the interviews and thus were further researched by sending a follow-up questionnaire to shippers, the impacts of seven trends could be quantified by using Seabury's databases. Nearly all impacts of these trends could be confirmed. The large mode shift towards ocean is in line with the findings from the interviews and questionnaire. The production shift as well as the growth of sales markets in China, emerging Asia and Latin

America was also verified by the *Global Trade Database*. The trend of 'despeeding' the product flow by consolidating and deferring shipments was confirmed by the *Express Database* which indicated that day-definite shipments outgrew time-definite shipments from 2011 to 2012. The temporary mode shift towards air was also verified by the example of the Thai flood in 2011. Only the 'increased usage of larger gateways' could not be verified entirely by using Seabury's *Traffic and Capacity Database*.

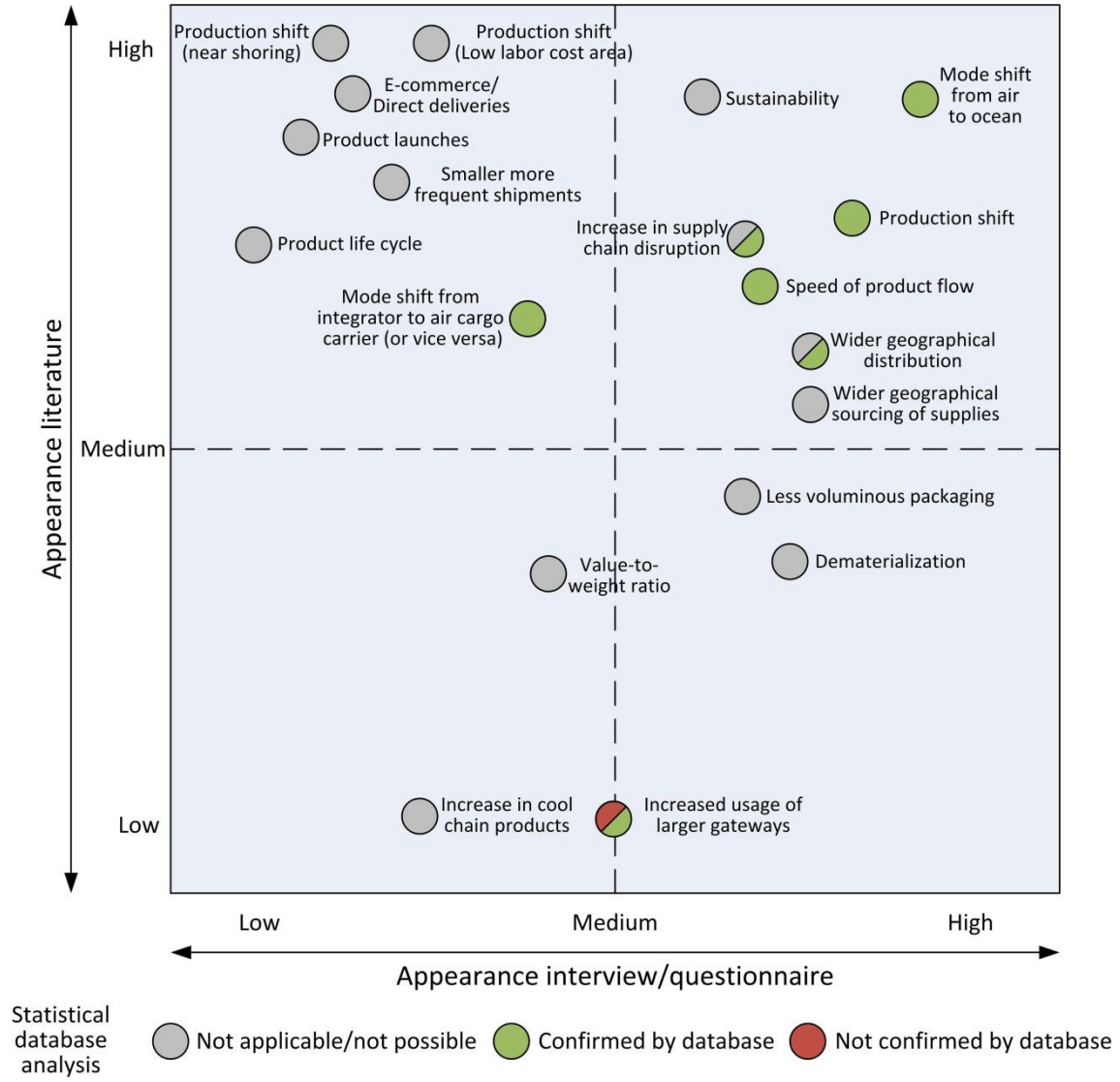


Figure 61: Triangulation of research methods

7.3 Chapter Conclusion

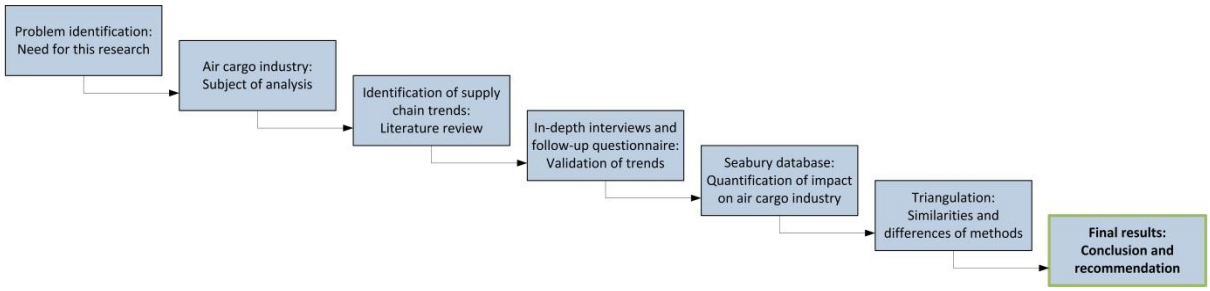
It can be concluded that the findings of the different research methods are very consistent with each other. During the literature review, a large amount of supply chain trends were identified which could be verified by the 19 interviews with supply chain managers. Still, some trends that appeared in literature were less apparent during the interviews which might be caused by the selection of industries. The follow-up questionnaire confirmed the findings of the interviews to a large extent.

The impacts that could be quantified by using Seabury's databases were also highly consistent with the findings from the interviews and the questionnaire. Only one trend (increased usage of larger gateways) was less visible by using the Seabury's database.

8 Conclusion and Recommendation

8.1 Introduction

The aim of this research project is to identify supply chain trends that have an impact on the air cargo industry. This chapter presents the answers and conclusions to the aforementioned research questions as well as a recommendation for Seabury. First, the sub-research questions as well as the main research question are answered. After that, recommendations are provided to Seabury on how to use the results and what further research can be conducted.



8.2 Conclusion of Research Data

Based on the literature review that was conducted in the first chapters, the analysis of interviews and a questionnaire in Chapter 5 as well as a quantification of the impact of some of the supply chain trends by using Seabury's databases in Chapter 6, the main research question can be answered.

What are the global supply chain trends and how are they impacting air transportation?

Prior to answering the main research question, the answers to the five sub-research questions are recapitulated. By answering these questions, the research objective is also accomplished.

The first sub-question identifies the current state of the air cargo industry. This included a thorough analysis of air cargo statistics and of the main market players of the air cargo industry. Air freight (non-integrated) and express (integrated) carriers were identified as the two main business models. The air cargo environment as well as enablers and barriers for air cargo growth were analyzed. The main facilitator of growth is global trade while increasing fuel prices can be regarded as a barrier. By looking at current struggles, it is revealed that the air cargo industry was doing poorly over the last decade. While the average growth rate over the last years deteriorated to 3.4%, the air cargo volume actually declined by 4% from 2011 to 2012. The air share of total international transportation has dropped from 2.9% in 2000 to 1.7% in 2011. Furthermore, the air cargo industry is hampered by trade lane imbalances as well as by an increasing discrepancy between demand and supply.

The second sub-question aimed to identify important industry sectors which also represent the population of this research. Based on the air and value share as well as growth opportunities and market share of large shippers three industry sectors were selected. The three industry sectors – high tech, automotive parts and pharmaceuticals – are responsible for 27% of the total air share by weight and 56% of the value share in US$ in 2012. Hence, the three industries represent a large share of the air cargo volume and more than half of the total value being shipped by air.

By answering the third sub-question, supply chain drivers which trigger the emergence and development of supply chain trends were identified. By conducting a STEEP analysis a potential number of social, technological, economic, environmental and political drivers were found. However, during the interviews and questionnaire not all of them were apparent as actual drivers that triggered the emergence of a supply chain trend.

An extensive literature review on trends identified 21 supply chain trends that potentially have an impact on the air cargo industry. After an initial analysis, based on six different impact criteria, a number of supply chain trends were discarded as these trends had no visible impact on the air cargo industry. The remaining trends were first tested by consulting supply chain managers of large shippers in form of in-depth interviews. The remaining trends were quantified by means of a follow-up questionnaire with a broader scope of shippers in the same three industries. The literature review as well as the interviews and a follow-up questionnaire consequently answered the fourth sub-question. Based on these methods the following supply chain trends were most apparent:

- Structural mode shift from air to ocean
- Wider geographical sourcing of supplies
- Wider geographical distribution of finished products
- Production shifts to China, emerging Asian countries and Latin America
- Dematerialization of products
- Less voluminous packaging
- Increase in supply chain disruptions
- Speed of product flow
- Mode shift from integrator to air cargo carrier or vice versa
- Increased usage of larger gateways

After identifying potential impact criteria during the literature review, the supply chain trends and their impact on the air cargo industry were examined qualitatively during the interviews and the questionnaire. This was complemented by examining the impacts of a number of trends quantitatively by using Seabury's databases. Consequently, the fifth sub-question was answered.

After the five sub-questions have been recapitulated and answered, the main research question can be answered. In Figure 62, each supply chain trend that was verified or falsified during the interviews and the questionnaire is mapped by looking at the appearance of each trend during the interviews/questionnaire (X-axis) as well as the degree of impact on the air cargo industry (Y-axis).

The supply chain trends with a dark blue circle, mostly located in the first and second quadrant, were most apparent during the interviews and impact the air cargo industry to a sizeable degree. The trend of a mode shift in carrier selection was mostly apparent for high tech shippers and is therefore placed in the third quadrant. The light blue circles represent trends that were mentioned by a limited amount of supply chain managers during the interviews. Hence, their impact was very small or even non-existent. Regardless of the fact that shippers reported an increase in sustainability relatively often, it did not have a major impact on the way goods are transported by air. There are a number of supply chain trends which were not as visible during the interviews as expected after the literature review. This might be caused by the selection of industries that make up the population of this master thesis.

Especially a structural mode shift from air to ocean appeared to be most impactful on the air cargo volume. Production shifts and new sales markets by a wider geographical distribution of finished goods influenced a shift in trade lanes. The increased usage of larger gateways also influences the shift of trade lanes. By 'despeeding' the product flow in the supply chain, the share of deferred (day-definite) shipments increased while express (time-definite) shipments decreased. Lastly, the dematerialization of products as well as less voluminous packaging will impact the air cargo volume negatively.

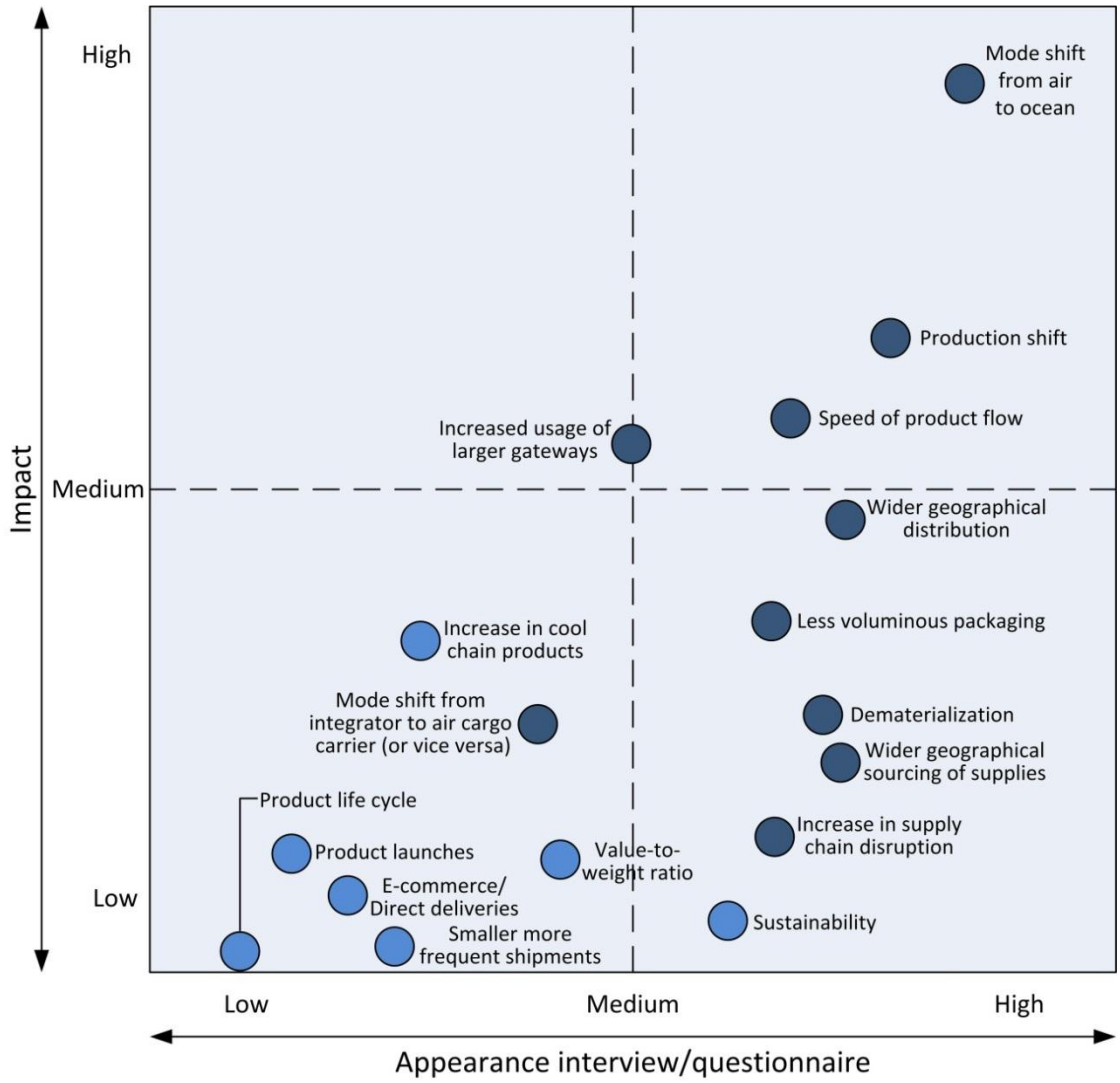


Figure 62: Appearance and impact of supply chain trends

In table 28, the findings of the literature review, the interviews and questionnaire as well as the statistical data analysis are summarized. The largest supply chain trends are identified and the qualitative and quantitative impact on the air cargo industry is assessed.

Table 28: Most apparent trends and their impact on the air cargo industry

Trend	*Qualitative Impact*	*Quantitative Impact*
Mode shift from air to ocean	Decrease of air cargo volume: • Large mode shift occurred in the past, only moderate mode shift expected in future	Decrease of air cargo volume: 250,000 tons of air freight moved from air to ocean representing 4.2% of air trade in 2012: • High tech 186,000 tons (4.3%) • Pharmaceuticals 6,000 tons (1.1%) • Automotive parts 56,000 tons (5.3%)

Wider geographical sourcing of supplies	Increase/decrease of air cargo volume: • Automotive shippers will decrease air cargo volume • High tech will increase air cargo volume	Not possible to quantify
Production shift	Shifts of trade lanes: • Increase of production out of China, emerging Asia and Latin America • Limited production shift back to North America • Limited production shift from China to low cost countries in Asia or Western China	Shifts of trade lanes: • High tech: Increase of air transported production in China (23%), decrease in mature Asia (-2%) • Pharmaceuticals: Increase of air transported production in China (69%) and emerging Asia (36%), however majority stays in EU (36%) and North America (22%) • Automotive: Increase of air transported production in China (36%), Latin America (49%) and emerging Asia (30%)
Wider geographical distribution of finished products	Increase/decrease of air cargo volume: • Automotive shippers will decrease air cargo volume • High tech/pharmaceuticals will increase air cargo volume Shift of trade lanes: • China, emerging Asia, Middle East & Africa and Latin America will increase as sales markets	Not possible to quantify Shift of trade lanes: • High tech: Increase of air imports in China (26%) and Europe (20%) • Pharmaceuticals: Increase of air imports in China (45%), emerging Asia (47%) and Middle East & Africa (36%) • Automotive: Increase of air imports in North America (27%) and China (27%)
Dematerialization of products	Decrease of air cargo volume: • High tech/automotive parts are getting smaller and lighter	Not possible to quantify
Less voluminous packaging	Decrease of air cargo volume: • Less voluminous packaging for high tech and automotive parts	Not possible to quantify
Increase in supply chain disruptions	Increase of air cargo volume: • Temporary mode shift from ocean to air	Increase of air cargo volume: (Thai flooding) • Air cargo volume and air share for automotive parts tripled
Increased usage of larger gateways	Shift of trade lanes: • Consolidated trade lanes for high tech and pharmaceuticals	Shift in trade lanes: • No change in the share of top 10 (20) cargo airports, minor decrease in the share of largest airport-to-airport trade lanes
Mode shift from integrator to air cargo carrier or vice versa	Increase/decrease of the share of integrators: • High tech: Deviation between increase and decrease • Automotive/pharmaceuticals: will not significantly change	Increase of the share of integrators • High tech: 29.5% (2012), 31.2% (2016) • Pharmaceuticals: 12.3% (2012), 13.1% (2016) • Automotive: 12.8% (2012), 13.4% (2016)
Speed of product flow	Shift in service level: • Air freight carrier: shift from express to deferred • Integrator: shift time-definite to day-definite	Shift in service level: • Decrease of the share of time-definite service levels from 75.6% to 73.4% for all air express shipments • absolute growth (2011-2012) for day-definite 18% and time-definite 5%

The main findings of this research can be summarized in the following points:

1. Structural mode shift from air to ocean is expected to continue in the future but to a lesser extent than in the past
2. Production shift is expected predominantly to China, emerging Asia and Latin America for high tech and automotive parts while production of pharmaceuticals is expected to primarily stay in Europe and North America
3. Shippers are expected to continuously 'despeed' the product flow resulting in an increase consolidated and deferred air freight shipments
4. Day-definite express shipments are expected to outpace the growth of time-definite shipments
5. High tech and pharmaceutical shippers are expected to increase their usage of large gateways resulting in a consolidation of trunk routes
6. High tech and pharmaceutical shippers are expected to distribute more globally from limited geographic locations while automotive shippers will distribute more locally/regionally from various geographic locations, hence the increase of air cargo volume because of global distribution is partly offset by local/regional distribution
7. The majority of shippers operate in a B2B market, hence e-commerce in a B2C sense does not play a major role for most shippers, shippers that operate a B2C e-commerce channel expect this channel to grow slowly in the future
8. High tech goods and automotive parts are expected to further decrease in weight and size and will therefore decrease the air cargo volume; pharmaceuticals are not expected to decrease in size and weight to a large extent
9. Packaging for high tech and automotive parts is expected to further become less voluminous, thereby decreasing the air cargo volume; packaging of pharmaceuticals is not expected to become less voluminous to a large extent
10. The trend of near shoring former off-shored production back to the developed countries or a production shift from coastal China to Western China and low cost areas in Asia is not occurring to a large scale

8.3 Recommendations for Seabury

This section represents several recommendations for Seabury in regard to the research study. The following four recommendations were identified which are explained in more detail.

1. Coherence of interview and questionnaire results with Seabury's databases
2. Conduct interviews/surveys with shippers to continue knowledge sharing
3. Expand the study to other industry sectors
4. Research response modes in the air cargo industry

Coherence of interview and questionnaire results with Seabury's databases

The results of the interviews/questionnaire and the database analysis were coherent to a large extent. Hence, it can be concluded that the existing data as well as the forecast function of the *Global Demand and Express Database* are accurate.

However, by quantifying the trend of shippers increasing the usage of larger gateways differences between the interviews/questionnaire and the database were apparent. This inconsistency might be caused by the fact that data is not available on a commodity basis of the three industry sectors.

Instead, the used data covers all commodities shipped by air. Hence, other industries might diminish the effect of certain supply chain trends within the researched industry sectors.

Seabury is already aware of a lot different supply chain trends. This is for instance the case with the mode shift analysis that is done within Seabury for internal usage. In general, some of their market dynamic slides that describe developments in the air cargo industry such as shifting trade lanes or growth and decline of the air cargo volume are similar to the results of this study. However, the current trends should not be taken for granted. The examined industries are changing fast and what might be a trend today can be outdated in a short amount of time. Therefore it is required to continue the process of researching trends and current developments which leads to the second recommendation.

Conduct interviews/surveys with shippers to continue knowledge sharing

The majority of the interviewees responded positive to the research study and are looking forward to receive the results. They indicated that they would like to have a continuous discussion on trends and developments in the shipper community and the air cargo industry. Therefore, Seabury should actively engage in continuing this research on an annual basis by contacting the same shippers in form of an interview or a questionnaire. Furthermore, Seabury should try to establish contact to a larger scope of shippers. This can be accomplished by being introduced to the shippers by the larger network forwarders or by intermediaries such as Joost van Doesburg of EVO in the Netherlands. The interview guide as well as the questionnaire that were developed and used can be taken as a basis for a further analysis on trends. Of courses, every year the questions should be updated since certain trends can be outdated. Besides extending the shipper contacts within the industry sectors that were analyzed in this research, Seabury should also try to gather knowledge on supply chain trends in other industry sectors.

Expand to other industry sectors

Since only three industry sectors were researched in detail, it is recommended to expand this study to other industries. Even though the three industry sectors represent around 27% of global air weight and 57% of air value, there are multiple industry sectors that are of interest as well. An expansion of this research to other sectors such as the fashion or consumer goods industry might lead to different outcomes and the number of trends and their impact might also be different.

Research response modes in the air cargo industry

After the fundamental supply chain trends that impact the air cargo industry have been researched in this master thesis, it is recommended to research how different players within the air cargo industry can respond to the changes. By identifying possibilities on how air cargo airlines, integrators and freight forwarders can adopt their operational activities in the short term but also their strategic focus in the long term, Seabury is able to enhance its consulting competence towards its client base.

9 Reflection

On February 1st, I started this research project leading to this finale report. This chapter describes the process of conducting this research. Hence, special emphasize is given to the following issues:

- Research contribution
- Research objective and research questions
- Deliverables
- Further research possibilities
- Coherence of findings
- Research limitations and problems

Research contribution

The research contribution of this research is as following. First, global supply chain trends have been outlined by conducting a thorough literature review. These trends were tested within three different industries (high tech, pharmaceuticals, automotive) by conducting in-depth interviews with 19 shippers as well as conducting a follow-up questionnaire to quantify the findings of the interviews. Thereby it was tried to verify or falsify supply chain trends that have a potential impact on the air cargo industry. Apart from that, in-depth interviews as well as a questionnaire were used to qualitatively identify the impact of certain supply chain trends on the air cargo industry. This was complemented by quantifying the impact of some of the trends by using Seabury's databases.

With the help of interviews, a questionnaire and Seabury's databases, it was possible to 'de-mystify' some of the discussion on trends in literature and to put proof and numbers to them. Especially trends such as an increasing usage of e-commerce or a shift of former off-shored production closer to consumption markets i.e. USA, were not apparent and were therefore eliminated from the research. On the other side, the supply chain trend of a mode shift towards ocean proved to be evident to a large extent. This is a widely discussed issue in the aviation industry and not acknowledged by every industry leader such as Boeing (Harris, 2013).

Research objective and research questions

All research objectives as well as researched questions were achieved and answered in the course of this master thesis. In Chapter 1.4, five sub-research questions were formulated to answer the main research question: *What are the global supply chain trends and how are they impacting air transportation?*

The first and second sub-research questions were answered by analyzing the current state of the air cargo industry in Chapter 3. In chapter 4, different drivers were identified that trigger the emergence of certain supply chain trends and thereby answering the third research sub-question. Global supply chain trends were identified in Chapter 4 throughout a comprehensive literature review. These trends were tested during in-depth interviews and a follow-up questionnaire and consequently answered the fourth sub-question. The last sub-question which was related to identify the impact of each trend was answered qualitatively in Chapter 5 and quantitatively in Chapter 6.

Consequently, by answering all sub-research questions the main research question could be answered. By conducting in-depth interviews as well as a follow-up questionnaire, it was possible to start a structural dialogue with a limited number of global shippers and Seabury. Since the majority

of shippers seemed interested and showed the willingness to continue this knowledge sharing process on supply chain trends between the shipper community and Seabury, it will be possible to pursue with this research on an annual basis in the form of interviews or a more extensive questionnaire. Hence, a structural setup to approach shippers was established and it can be concluded that the main objective for Seabury was achieved. Some of the contacts that were approached during this research project were already contacted and consulted on a current Seabury project.

Deliverables

Next to achieving the research objective and answering all research questions, a number of deliverables were set by Seabury in the beginning of this project:

- Sufficient number of interviews (goal 10 interviews per industry)
- Design of relevant interview guide and online questionnaire
- Thank you presentation for the shippers that participated in the study

The initial aim of Seabury was to conduct around ten interviews with supply chain mangers per industry. The sample of 19 interviews consists of 12 high tech shippers, 4 pharmaceutical manufacturers and 3 automotive parts producers. The goal could only be achieved for high tech shippers. The lower response rate for pharmaceutical manufacturers and automotive parts producers is caused by the fact that it was very difficult to arrange interviews with large shippers in these industries. Large effort was undertaken to increase the response rate. Nevertheless, many shippers felt reluctant to share proprietary information. Furthermore, Seabury might have been too confident about the involvement of the larger network forwarders to get introduced to their key accounts.

A comprehensive interview guide was designed to conduct in-depth interviews with supply chain mangers of each shipper. The structure of the interview guide was discussed internally and can be used for further studies on supply chain trends. Besides the interview guide, an online questionnaire on 'Surveymonkey' was set up to quantify the findings from the interviews. Both, the interview guide and the questionnaire were designed in such a way that future participation and continuous feedback can be assured.

To assure a further knowledge sharing between Seabury and the shipper a 'thank you' presentation for the participants of this study was made. This presentation informs the shippers on the high level results of this research project and will be sent out at the end of August 2013.

Further research possibilities

To be able to finish this research project within the projected time frame, three important industries were selected to perform this research. However, there are also other sectors that are potentially important for the air cargo industry. The research provides a clear framework on how to research supply chain trends impacting the air cargo industry. Therefore, this research can be redone within other sectors that have a certain degree of importance on the air cargo industry. Furthermore, some of the supply chain trends such as a mode shift are highly complex and could therefore enable an entire research by itself. Hence, this study aims to provide inspiration for further in-depth research by indicating potential trends and their impact on the air cargo industry.

Coherence of findings

In the course of this research project several methodologies were used. A literature review was conducted to identify potential supply chain trends. The in-depth interviews and the follow-up questionnaire aimed to verify or falsify the identified supply chain trends. By using different databases of Seabury it was tried to quantify some of the impacts of these trends on the air cargo industry in a quantitative manner.

Throughout the different methodologies, research findings were highly coherent. The majority of the supply chain trends that were identified in Chapter 4 were also visible during the interviews. Of course, the extent of certain trends was sometimes lower or higher than anticipated. This is for instance the case for the supply chain trend of increased usage of e-commerce. However, this trend was less apparent due to the fact that the interviewed shippers operate primarily in a B2B market. On the other hand, shippers within the fashion or the retailing industry will most likely see such a trend taking place. Furthermore, only a few new trends came up during the interviews showing that the literature review captured the majority of trends. The follow-up questionnaire tried to quantify the results of the in-depth interviews. The findings were mostly identical to the ones of the interviews. The quantitative results of the statistical data analysis were mostly in line with the qualitative findings of the interviews and the questionnaire.

Nevertheless, while many shippers mentioned during the interviews and the questionnaire that they are increasingly using larger gateways, the database actually showed that the share of the largest cargo airports stayed the same while the share of the largest airport-to-airport trade lanes decreased over time.

Research limitations and difficulties during the research

Like any type of research, this master thesis is also constrained by certain limitations. The sample of 19 interviews is well proportioned for a master thesis. Nevertheless, the expectations of Seabury in terms of the number of interviews were higher at the beginning of this research project. The findings from the interviews represent a snapshot of 19 shippers selected on a judgmental basis. Hence, the findings have to be considered with care on generalizability. More importantly, the response rate of the follow-up questionnaire which aims to quantify the results of the interviews is very small. Since only 17 shippers responded to the questionnaire, a limited quantification can be done. To increase the response rate, tremendous effort was done by calling and sending reminders to shippers. A further limitation of the interviews and questionnaire is that predominately shippers within the high tech industry were interviewed and responded to the questionnaire. This makes the results more biased towards this industry sector.

The quantification of impacts is based upon Seabury's databases. Even though data is gathered by customs offices of almost 50 countries and UN Comtrade data, the data set needs to be corrected for errors and inconsistencies. Firstly, the weight of trade flows needs to be estimated for missing values. After that, a split between sea and air trade flows is used. At the end, the final data is checked and corrected manually for outliers. Also, Seabury uses proprietary splits to distinguish between express and standard shipments in the *Express Database*. Hence, the values are a close estimate based on certain assumptions. Another limitation is that the *Traffic Database* comprises of data from airlines representing between 60 - 70% of world traffic.

As for many projects, there were a few difficulties that needed to be tackled during this master thesis. Since this master thesis is based on the insights gathered through interviews and a questionnaire, there was a high dependence on external expert knowledge. From the beginning of the project, the larger network forwarders were very enthusiastic about this project and assured their support by introducing this research to their key accounts. Unfortunately, some shippers were very reluctant to conduct interviews. Therefore many e-mails as well as calls had to be made to convince shippers to participate in this study.

Conclusion

With this research, the initial research objective was achieved and the main research question was answered. The research approach is clear and reproducible. As a result, different supply chain trends and their impact on the air cargo industry were indicated. This research encourages others to engage in further research by choosing different industry sectors or by studying certain trends more in detail. Even though there are certain limitations within this study, it was tried to increase reliability and validity through different measures. All difficulties and problems that appeared during this master thesis were successfully managed. The master thesis was conducted according to a thesis schedule and stayed within the anticipated time frame.

References

Aberdeen Group. (2012). Direct Delivery Distribution Models: Increasing Supply Chain Velocity in Consumer Markets. [online] Available at: http://aberdeen.com/Aberdeen-Library/8080/RP-direct-delivery-distribution.aspx [Accessed 21 March 2013].

Accenture. (2011). Wage Increases in China: Should Multinationals Rethink their Manufacturing and Sourcing Strategies? [pdf] Available at: http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture_Wage_Increases_in_China.pdf [Accessed 7 March 2013].

Ageron, B., Gunasekaran, A., & Spalanzani, A. (2011). Sustainable supply management: An empirical study. International Journal of Production Economics, 140(1), 168-182.

Air Cargo News. (2011). Lufthansa to ground four freighters. [online] Available at: http://www.aircargonews.net/news/single-view/news/lufthansa-to-ground-four-freighters.html [Accessed 27 February 2013].

AlixPartners. (2011). Executives Perspectives on Near-Shoring. [pdf] Available at: http://www.alixpartners.com/en/LinkClick.aspx?fileticket=Qj7k-IZ4z0M%3D&tabid=947 [Accessed 8 March 2013]

Anderson, W. P., Chatterjee, L., & Lakshmanan, T. R. (2003). E-commerce, Transportation, and Economic Geography. Growth and Change, 34(4), 415-432.

Andreoli, D., Goodchild, A., & Vitasek, K. (2010). The rise of mega distribution centers and the impact on logistical uncertainty. Transportation Letters: The International Journal of Transportation Research, 2(2), 75-88.

BCG. (2012). Made in America Again – U.S. Manufacturing Nears the Tipping Point. Which Industries, Why, and How Much? [pdf] Available at: http://doingwhatmatters.cccco.edu/portals/6/docs/US%20Mfg%20Nears%20Tipping%20Point.pdf [Accessed 8 March 2013].

BCG. (2013). U.S. Consumers Don't Value Same-Day Delivery, Despite Rush of New Services by Retailers and Carriers. [online] Available at: http://www.bcg.com/media/PressReleaseDetails.aspx?id=tcm:12-129157 [Accessed 26 March 2013].

Beesley, A. (2010). Time compression in the supply chain. In: D. Waters (ed.) Global Logistics: New Directions in Supply Chain Management, 6th edition, 69-91.

Blanchard, D. (2009). When You'd Rather Not Do It Yourself. Material Handling Management, 64(10), 48.

Boeing. (2003). Freighter Reference Guide. [pdf] Available at: http://www.jofair.com/news/archives/2003-Freighter-Reference-Guide.pdf [Accessed 10 February 2013].

Boeing. (2005). World Air Cargo Forecast, 2004-2005. [pdf] Available at: www.boeing.com/commercial/cargo/WACF_2004-2005.pdf [Accessed 24 February 2013].

Boeing. (2012). World Air Cargo Forecast, 2012–2013. [pdf] Available at: www.boeing.com/commercial/cargo/wacf.pdf [Accessed 10 January 2013].

Bohn, C. (2012). Sourcing's Home Run. Journal of Commerce, 13(4), 31.

Bowen, J. T. (2012). A spatial analysis of FedEx and UPS: hubs, spokes, and network structure. Journal of Transport Geography, 24(10), 419-431.

Bowen, J. T., & Leinbach, T. R. (2004). Market concentration in the air freight forwarding industry. Tijdschrift voor economische en sociale geografie, 95(2), 174-188.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77-101.

Brennan, P. (2011). Lessons learned from the Japan earthquake. Disaster Recovery Journal, 24(3), 22-26.

Briano, E., Caballini, C., Giribone, P., & Revetria, R. (2010). Resiliency and vulnerability in short life cycle products' supply chains: a system dynamics model. WSEAS Transactions on Systems, 9(4), 327-337.

Buck, A., Herrmann, C. & Lubkowitz, D. (1998). Handbuch Trendmanagement. Frankfurter Allgemeine Zeitung, Verlag-Bereich Buch, Frankfurt am Main.

Burnson, P. (2011). Near-Shoring/Right-Shoring Strategies: Weighing the Risks of Global Sourcing. Logistics Management, 50(8), 62-64.

Cairncross, F. (2001). The death of distance: How the communications revolution is changing our lives. Harvard Business Press, Boston.

Capgemini. (2013). 2013 Third-Party Logistics Study. The State of Logistics Outsourcing Results and Findings of the 17th Annual Study. [pdf] Available at: <> [Accessed 23 April 2013].

Cargonews Asia. (2011). Products associated with celebrities help boost air transport. [online] Available at: http://www.cargonewsasia.com/secured/print_view.aspx?article=25997&issue=20111-07-04 [Accessed 26 March 2013].

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. International Journal of Physical Distribution & Logistics Management, 38(5), 360-387.

Christopher Jr., C. G. (2011). The economic impact of e-commerce. [online] Available at: http://www.supplychainquarterly.com/columns/scq201102monetarymatters/ [Accessed 12 April 2013].

Christopher, M. (2011). Logistics and Supply Chain Management: creating value-adding networks. 4th edition, Pearson.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. International Journal of Logistics Management, 15(2), 1-14.

Christopher, M., Mena, C., Khan, O., & Yurt, O. (2011). Approaches to managing global sourcing risk. Supply Chain Management: An International Journal, 16(2), 67-81.

Cottrill, K. (2011). MIT Center for Transport and Logistics White Paper- Transforming the future of supply chains through disruptive Innovation: Additive Manufacturing. [pdf] Available at: http://www.misi.edu.my/student/spv1/assets/Disruptive_Innovations4_1.pdf [Accessed 11 March 2013].

Cristea, A., Hummels, D., Puzzello, L., & Avetisyan, M. (2013). Trade and the greenhouse gas emissions from international freight transport. Journal of Environmental Economics and Management, 65(1), 153–173.

DC Velocity. (2012). Shippers continue to shift from air to ocean freight on European trade lanes, monthly study finds. [online] Available at: http://www.dcvelocity.com/articles/20121119-shift-to-ocean/ [Accessed 26 March 2013].

Deloitte. (2013). The Ripple Effect. How manufacturing and retail executives view the growing challenge of supply chain risk. [pdf] Available at: http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Consulting/us_consulting_therippleeffect_022013.pdf [Accessed 17 April 2013].

DHL. (2013). What 3D printing means for you. [online] Available at: https://www.dhlsupplychainmatters.dhl.com/innovation/article/237/3d-printing-means-to-you [Accessed 12 March 2013].

Doganis, R. (2010). Flying off course: The economics of international airline. Routledge: Taylor and Francis Group, 4th edition, London.

Duncan, R. (2010). Internet traders can increase profitability by reshaping their supply chains. In: D. Waters (ed.) Global Logistics: New Directions in Supply Chain Management, 6th edition, 331-346.

Economist. (2011). 3D printing – The printed world. Three-dimensional printing from digital designs will transform manufacturing and allow more people to start making things. [online] Available at: http://www.economist.com/node/18114221 [Accessed 12 March 2013].

Economist. (2012a). Additive manufacturing – Solid print. Making things with a 3D printer changes the rules of manufacturing. [online] Available at: http://www.economist.com/node/21552892 [Accessed 12 March 2013].

Economist. (2012b). Print me a jet engine. [online] Available at: http://www.economist.com/blogs/schumpeter/2012/11/additive-manufacturing [Accessed 12 March 2013].

Economist. (2013a). Reshoring Manufacturing Coming Home. [online] Available at: http://www.economist.com/news/special-report/21569570-growing-number-american-companies-are-moving-their-manufacturing-back-united States [Accessed 8 March 2013]

Economist. (2013b). Thailand's booming car industry – Detroit of the East. [online] Available at: http://www.economist.com/blogs/schumpeter/2013/04/thailands-booming-car-industry?fsrc=scn/tw/te/bl/DetroitEast [Accessed 9 April 2013]

Econsult. (2012). Economic Impacts of FAA Budget Sequestration on the U.S. Economy. [pdf] Available at: http://secondtonone.org/wp-content/uploads/2012/08/FINAL-Econsult-Report.pdf [Accessed 24 February 2013].

Epstein, Z. (2012). RIM and HTC are Q3's biggest smartphone losers. [online] Available at: http://bgr.com/2012/11/08/smartphone-market-share-q3-2012/ [Accessed 23 March 2013].

Ernst, E. E. (2002). Voll im Trend: Cross Docking. Logistik Inside, 1(4), 24-26.

Fink, A. (1998). Conducting research literature reviews: From paper to the Internet. Thousand Oaks: Sage Publications.

Fishman, C. (2012) The Insourcing Boom. [online] Available at: http://www.theatlantic.com/magazine/archive/2012/12/the-insourcing-boom/309166/ [Accessed 8 March 2013].

Forbes. (2012). Key Trends to Watch in Gartner 2012 Emerging Technologies Hype Cycle. [online] Available at: http://www.forbes.com/sites/gartnergroup/2012/09/18/key-trends-to-watch-in-gartner-2012-emerging-technologies-hype-cycle-2/ [Accessed 25 March 2013].

Friedman, T. (2005). The World Is Flat: A Brief History of the Twenty-First Century. New York: Farrar, Straus and Giroux.

Gartner. (2012). Press Release. [online] Available at: http://www.gartner.com/newsroom/id/1986016 [Accessed 23 March 2013].

Glenn, J. C. (2003). Scenarios. In: J. C. Glenn & T. J. Gordon (ed.) Futures Research Methodology (Version 2.0), AC/UNU Millennium Project, Washington, DC.

Goel, A., Moussavi, N., & Srivatsan, V. N. (2008). Time to rethink offshoring? The McKinsey Quarterly, 14, 1-5.

Golicic, S. L., Davis, D. F., & McCarthy, T. M. (2005). A balanced approach to research in supply chain management. In: H. Kotzab, S. Seuring, M. Müller & G. Reiner (ed.) Research Methodologies in Supply Chain Management, Physica-Verlag, Heidelberg, 15-30.

Gordon, T. J. (1992). The methods of futures research. The Annals of the American Academy of Political and Social Science, Vol. 522, The Future: Trends into the Twenty-First Century, 25-35.

Gordon, T. J. (2003a). The Delphi Method. In: J. C. Glenn & T. J. Gordon (ed.) Futures Research Methodology (Version 2.0), AC/UNU Millennium Project, Washington, DC.

Gordon, T. J. (2003b). Trend impact analysis. In: J. C. Glenn & T. J. Gordon (ed.) Futures Research Methodology (Version 2.0), AC/UNU Millennium Project, Washington, DC.

Gordon, T. J., & Glenn, J. C. (2003). Environmental Scanning. In: J. C. Glenn & T. J. Gordon (ed.) Futures Research Methodology (Version 2.0), AC/UNU Millennium Project, Washington, DC.

Gordon, T. J., & Glenn, J. (2004). Integration, comparisons, and frontiers of futures research methods. In: EU-US Seminar - New Technology Foresight, Forecasting & Assessment Methods, 13-14 May 2004, Seville, Spain.

Grant, D. B., Teller, C., & Teller, W. (2005). Web-based surveys in logistics research: an empirical application. In: H. Kotzab, S. Seuring, M. Müller & G. Reiner (ed.) Research Methodologies in Supply Chain Management, Physica-Verlag, Heidelberg, 139-154.

Griffis, S. E., Goldsby, T. J., Cooper, M. (2003). Web-Based and Mail Surveys: A Comparison of Response, Data and Cost. Journal of Business Logistics, 24 (2), 237-258.

Guest, G., MacQueen, K. M., & Namey, E. E. (2011). Applied thematic analysis. SAGE Publications, Thousand Oaks.

Gunasekaran, A., Marri, H. B., McGaughey, R. E., & Nebhwani, M. D. (2002). E-commerce and its impact on operations management. International Journal of Production Economics, 75(1), 185-197.

Halldórsson, A., & Arlbjorn, J. S. (2005). Research methodologies in supply chain management–what do we know? In: H. Kotzab, S. Seuring, M. Müller & G. Reiner (ed.) Research Methodologies in Supply Chain Management, Physica-Verlag, Heidelberg, 107-122.

Hammer, R. M. (1998). Strategische Planung und Frühaufklärung. Oldenbourg, 1st edition, München.

Harris, D. (2013). Modal shift: Real or imaginary? [pdf] Available at: http://cargofacts.net/profiles/blogs/modal-shift-real-or-imaginary [Accessed 16 June 2013].

Hastings, P. (2013). 3D printing to change logistics industry. Air Logistics China, February 2013, 12-15.

Heckmann, P., Shorten, D., & Engel, H. (2003). Supply chain management at 21. Transportation & Distribution, 19, 1-9.

Henstra, D., Ruijgrok, C., & Tavasszy, L. (2007). Globalized trade, logistics and intermodality: European perspectives'. In: T. R. Leinbach and C. Capineri, ed. Globalized freight, transport: intermodality, e-commerce, logistics and sustainability. Edward Elgar Publ. Comp., London, 135-162.

Hesse, M. (2002). Shipping news: the implications of electronic commerce for logistics and freight transport. Resources, Conservation and Recycling, 36(3), 211-240.

HSBC. (2013). The great migration - How FDI is moving to ASEAN and India. [pdf] Available at: http://www.hsbc.com.vn/1/PA_ES_Content_Mgmt/content/vietnam/abouthsbc/newsroom/attached_files/FDI_migration_to_ASEAN_2013_en.pdf [Accessed 8 March 2013].

Hummels, D. L. (2007). Transportation Costs and International Trade in the Second Era of Globalization. Journal of Economic Perspectives, 21(3), 131-154.

Hummels, D. L., & Schaur, G. (2012). Time as a Trade Barrier – Working Paper 17758. [pdf] Available at: http://www.nber.org/papers/w17758.pdf [Accessed 12 April 2013].

IATA. (2008a) Monthly Traffic Analysis November 2008. [pdf] Available at: http://www.iata.org/whatwedo/Documents/economics/archive/MIS_Note_Nov08.pdf [Accessed 17 January 2013].

IATA. (2008b) Monthly Traffic Analysis December 2008. [pdf] Available at: http://www.iata.org/whatwedo/Documents/economics/archive/MIS_Note_Dec08.pdf [Accessed 17 January 2013].

IATA. (2012). WATS World Air Transport Statistics Edition 56, International Air Transport Association, Monteral, Geneva.

IATA. (2013a). Carrier Tracker Based on IATA Monthly International Statistics (MIS), December 2012. International Air Transport Association, Montreal, Geneva.

IATA. (2013b). FACT SHEET: Fuel. [pdf] Available at: http://www.iata.org/pressroom/facts_figures/fact_sheets/Documents/fuel-fact-sheet.pdf [Accessed 25 March 2013].

ICAO. (2012). Expanding Market Access for International Air Transport. In: Worldwide Air Transport Conference Sixth Meeting. Montreal, Canada, 18-22 March, 2012. [pdf] Available at: http://www.icao.int/Meetings/atconf6/Documents/WorkingPapers/ATConf6-wp013_en.pdf [Accessed 24 February 2013].

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. Administrative science quarterly, 24(4), 602-611.

Journal of Commerce. (2012). Manhattan Associates Predicts Supply Chain Trends for 2012: Cost Reduction, Risk Mitigation and Contingency Planning. [online] Available at: http://www.joc.com/manhattan-associates-predicts-supply-chain-trends-2012-cost-reduction-risk-mitigation-and_20120227 [Accessed 16 April 2013].

Jüttner, U., Peck, H., & Christopher, M. (2003). Supply chain risk management: outlining an agenda for future research. International Journal of Logistics: Research and Applications, 6(4), 197-210.

Kahn, A. E. (2002). Airline deregulation. The Concise Encyclopedia of Economics. [online] Available at: http://www.econlib.org/library/Enc1/AirlineDeregulation.html [Accessed 24 February 2013].

Karlsen, J. E., & Karlsen, H. (2013). Classification of tools and approaches applicable in foresight studies. In: M. Giaoutzi & B. Sapio (ed.) Recent Developments in Foresight Methodologies, Springer, 27-52.

Kasarda J. D., & Green, J. (2004). Air Cargo: Engine for economic development. In: The International Air Cargo Association Air Cargo Forum. Bilbao, Spain, 15 September, 2004.

Kotzab, H. (2005). The role and importance of survey research in the field of supply chain management. In: H. Kotzab, S. Seuring, M. Müller & G. Reiner (ed.) Research Methodologies in Supply Chain Management, Physica-Verlag, Heidelberg, 125-137.

Kulisch, E. (2012). Right shoring: global cost structures have manufacturers reevaluating outsourcing phenomenon. American shipper, 54(6), 8-15.

Kumar, S., & Craig, S. (2007). Dell, Inc.'s closed loop supply chain for computer assembly plants. Information, Knowledge, Systems Management, 6(3), 197-214.

La Londe, B. J., & Masters, J. M. (1994). Emerging logistics strategies: blueprints for the next century. International Journal of Physical Distribution & Logistics Management, 24(7), 35-47.

La Londe, B. J. (1997). Supply chain management: myth or reality?. Supply Chain Management Review, 1(1), 6-7.

Lam, G. (2012). Li & Fung's Flat World Perspective – How could China move up the value chain and compete successfully in it? In: P. Faust and G. Yang, (ed.) China Sourcing, Springer Berlin Heidelberg, 274-291.

Larson, P. D., & Halldórsson, Á. (2004). Logistics versus supply chain management: an international survey. International Journal of Logistics: Research and Applications, 7(1), 17-31.

Leach, P. T. (2012). Vessel Schedule Reliability Improved in July. [online] Available at: http://www.joc.com/maritime-news/international-freight-shipping/vessel-schedule-reliability-improved-july_20120815.html [Accessed 26 March 2013].

Leinbach, T. R., & Bowen, J. T. (2004). Air cargo services and the electronics industry in Southeast Asia. Journal of Economic Geography, 4(3), 299-321.

Lloyd's List. (2013). Hi-tech shippers switch from air to ocean. [online] Available at: http://www.lloydslist.com/ll/sector/containers/article418466.ece [Accessed 26 March 2013].

MacCarthy, B. L., & Atthirawong, W. (2003). Factors affecting location decisions in international operations–a Delphi study. International Journal of Operations & Production Management, 23(7), 794-818.

Makridakis, S. G., Wheelwright, S. C., & McGee, V. E. (1983). Forecasting: methods and applications, Wiley, 2nd edition, New York.

Manners-Bell, J. & Lyon, K. (2012). The implications of 3D printing for the global logistics industry. [pdf] Available at: http://www.transportintelligence.com/forms/get_whitepaper.php?wpID=76 [Accessed 11 March 2013].

McKinnon, A. C. (2007). Decoupling of road freight transport and economic growth trends in the UK: An exploratory analysis. Transport Reviews, 27(1), 37-64.

McKinnon, A. C. (2010). Optimizing the road freight transport system. In: D. Waters (ed.) Global Logistics: New Directions in Supply Chain Management, 6th edition, 284-304.

McKinnon, A., & Forster, M. (2000). Full Report of the Delphi 2005 Survey: European Logistical and Supply Chain Trends: 1999–2005. Report for TRILOG–Europe.

McKinsey. (2008). How companies act on global trends: A McKinsey Global Survey. [pdf] Available at: https://www.mckinseyquarterly.com/PDFDownload.aspx?ar=2130 [Accessed 14 March 2013].

McKinsey. (2012). Manufacturing the future: The next era of global growth and innovation. [pdf] Available at: http://www.mckinsey.com/insights/manufacturing/the_future_of_manufacturing [Accessed 13 March 2013].

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. Journal of Business Logistics, 22(2), 1-25.

MergeGlobal. (2008a). End of an Era? - Why the 'super spike' in fuel prices may signal the end of 'super growth' in air freight. American Shipper, 50 (8), 32-47.

MergeGlobal. (2008b). Forwarder Momentum - Opportunities for value creation in freight forwarding. American Shipper, 50 (3), 36-53.

Mićić, P. (2006). Das ZukunftsRadar. Die wichtigsten Trends, Technologien und Themen für die Zukunft, Glabal, 2nd edition, Offenbach.

Milliot, J. (2012). E-books Market Share at 22%, Amazon Has 27%. Publishers Weekly, 259(45), 6.

Monczka, R. M., & Trent, R. J. (1991). Global sourcing: a development approach. International Journal of Purchasing and Materials Management, 27(2), 2-8.

Moore, N. Y., Baldwin, L. H., Camm, F., & Cook, C. R. (2002). Implementing Best Purchasing and Supply Management Practices. Lessons from Innovative Commercial Firms. [pdf] Available at: http://www.rand.org/content/dam/rand/pubs/documented_briefings/2005/DB334.pdf [Accessed 8 March 2013].

Morrell, P. S. (2011). Moving Boxes by Air: The Economics of International Air Cargo. Ashgate Publishing.

Mouritsen, J., Skjøtt-Larsen, T., & Kotzab, H. (2003). Exploring the contours of supply chain management. Integrated Manufacturing Systems, 14(8), 686-695.

Müller-Stewens, G., & Müller, A. (2009). Strategic Foresight-Trend-und Zukunftsforschung als Strategieinstrument. In: M. Reimer & S. Fiege (ed.) Perspektiven des Strategischen Controllings, Wiesbaden, 238-257.

Näslund, D. (2002). Logistics needs qualitative research–especially action research. International Journal of Physical Distribution & Logistics Management, 32(5), 321-338.

Neate, R. (2012). iPhone 5 demand leads to 'huge' increase in air freight costs. [online] Available at: http://www.guardian.co.uk/technology/2012/oct/11/apple-iphone5-demand-huge-increase-air-freight-costs [Accessed 12 April 2013].

Netherlands Central Plan Bureau. (2013). World trade monitor. [online] Available at: < http://www.cpb.nl/en/world-trade-monitor> [Accessed 24 February 2013].

Niepmann, F., & Felbermayr, G. J. (2010). Globalisation and the Spatial Concentration of Production. The World Economy, 33(5), 680-709.

Nordås, H. (2010). Time as a trade barrier. In: D. Waters (ed.) Global Logistics: New Directions in Supply Chain Management, 6th edition, 347-364.

Norrman, A., & Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. International Journal of Physical Distribution & Logistics Management, 34(5), 434-456.

O'Connell, J. F. (2011). The rise of the Arabian Gulf carriers: An insight into the business model of Emirates Airline. Journal of Air Transport Management, 17(6), 339-346.

O'Reilly, J. & Trunick, A. P. (2010). Trends—May 2010: Despite Interruptions European Integrators Express Themselves. [online] Available at: http://www.inboundlogistics.com/cms/article/trends-may-2010/ [Accessed 17 April 2013].

OICA. (2012). World Motor Vehicle Production. [pdf] Available at: http://oica.net/wp-content/uploads/ranking.pdf [Accessed 23 March 2013].

Pearce, B. (2012). The state of air transport markets and the airline industry after the great recession. Journal of Air Transport Management, (21), 3-9.

Pearson, J. N., & Semeijn, J. (1999). Service priorities in small and large firms engaged in international logistics. International Journal of Physical Distribution & Logistics Management, 29(3), 181-192.

Pomfret, J. (2010). Special report: World's workshop heads to inland China. [online] Available at: http://www.reuters.com/article/2010/08/25/us-china-manufacturing-idUSTRE67O19420100825 [Accessed 8 March 2013].

Porter, M. (1998). Clusters and the New Economics of Competition. Harvard Business Review, 76(6), 77-90.

Porter, M., & Rivkin, J. (2012). Choosing the United States. Harvard Business Review, 90(3), 81-93.

PRTM. (2008). Global Supply Chain Trends 2008 – 2010 Driving Global Supply Chain Flexibility through
Innovation. [pdf] Available at: http://www.prtm.com/uploadedFiles/Strategic_Viewpoint/Articles/Article_Content/Global_Supply_Chain_Trends_Report_%202008.pdf [Accessed 16 April 2013].

PwC. (2008). Global Sourcing: Shifting Strategies. A Survey of Retail and Consumer Companies. [pdf] Available at: http://www.pwc.com/en_GX/gx/retail-consumer/pdf/global-sourcing_2008.pdf [Accessed 8 March 2013].

PwC. (2010). See the future - Top industry clusters in 2040 revealed. [pdf] Available at: https://www.pwc.com/gx/en/consulting-services/see-the-future/assets/see-the-future.pdf [Accessed 8 March 2013].

PwC. (2012). Global supply chain survey 2013. Next-generation supply chains: Efficient, fast and tailored. [pdf] Available at: http://www.pwc.com/gx/en/consulting-services/supply-chain/global-supply-chain-survey/assets/pwc-next-generation-supply-chains-pdf.pdf [Accessed 16 April 2013].

Rietze, S. M. 2006. Case studies of postponement in the supply chain. Master's dissertation, MIT, Cambridge, MA. Available at: http://dspace.mit.edu/bitstream/handle/1721.1/34601/71271545.pdf?sequence=1 [Accessed 13 March 2013].

Ritchie, J., & Lewis, J. (2003). Qualitative research practice: A guide for social science students and researchers. SAGE Publications, Thousand Oaks.

Rodrigue, J. P. (2013). Order-Delivery Sequence of an Apple iPad. [online] Available at: http://people.hofstra.edu/geotrans/eng/ch5en/appl5en/ipad_fedex_order.html [Accessed 17 January 2013].

Rubin, J., & Tal, B. (2008). Will soaring transport costs reverse globalization. CIBC World Markets Inc, StrategEcon, 4-7.

Saddle Creek. (2011). 2011 Cross-Docking Trend Report. [pdf] Available at: http://www.logisticsmgmt.com/article/2011_cross-docking_trends_report/#download [Accessed 12 March 2013].

Satariano, A. & Tyrangiel, J. (2012). Apple to Invest in Manufacturing Macs in U.S., CEO Cook Says. [online] Available at: http://www.bloomberg.com/news/2012-12-06/apple-to-invest-in-manufacturing-macs-in-u-s-ceo-cook-says.html [Accessed 8 March 2013].

Schleicher-Tappeser, R., Hey, C. and Steen, P. (1998). Policy approaches for decoupling freight transport from economic growth. 8th World Conference on Transport Research, Antwerp, Belgium, 12–17 July, 1-20.

Scholz, A. B. (2011). Network Structures of Cargo Airlines - An Empirical and a Modelling Approach. KIT Scientific Publishing, Karlsruhe.

Schwarz, J. O. (2008). Assessing the future of futures studies in management. Futures, 40(3), 237-246.

Seabury. (2012a). Air cargo market dynamics More insights, better decisions… Amsterdam: Seabury Transportation Holdings B.V.

Seabury. (2012b). Cargo Databases. [online] Available at: http://www.seaburygroup.com/management-consulting/cargo-logistics/cargo-databases [Accessed 17 January 2013].

Seabury. (2013a). Global Trade Database. [online] Available at: http://www.seaburycargo.com/ibmcognos/cgi-bin/cognosisapi.dll [Accessed 10 February 2013].

Seabury. (2013b). Mode Shift Database. [online] Available at: http://www.seaburycargo.com/ibmcognos/cgi-bin/cognosisapi.dll [Accessed 10 February 2013].

Seabury. (2013c). Traffic Database. [online] Available at: http://www.seaburycargo.com/ibmcognos/cgi-bin/cognosisapi.dll [Accessed 22 June 2013].

Seabury. (2013d). Capacity Database. [online] Available at: http://www.seaburycargo.com/ibmcognos/cgi-bin/cognosisapi.dll [Accessed 22 February 2013].

Seabury. (2013e). Express Database. [online] Available at: http://www.seaburycargo.com/ibmcognos/cgi-bin/cognosisapi.dll [Accessed 10 February 2013].

Sekaran, U., & Bougie, R. (2009). Research Methods for Business: A Skill Building Approach, Wiley, 5th edition.

Shaw, S. (2011). Airline marketing and management. Ashgate Publishing, 6th edition, Aldershot.

Shell. (2008). Scenarios: An Explorer's Guide. [pdf] Available at: http://www.shell.com/global/future-energy/scenarios/explorers-guide.html [Accessed 12 July 2013].

Simchi-Levi, D. (2011). How volatile oil prices will rock your supply chain. [online] Available at: http://www.supplychainquarterly.com/topics/Strategy/201201reading/ [Accessed 8 March 2013].

Skjoett-Larsen, T. (2000). Third Party Logistics – from an interorganizational point of view. International Journal of Physical Distribution & Logistics Management, 30(2), 112-127.

Slob, B. (2005). Acer Incorporated: Company Profile. Stichting Onderzoek Multinationale Ondernemingen (Centre for Research on Multinational Corporations). [pdf] Available at: http://somo.nl/publications-en/Publication_559/at_download/fullfile [Accessed 8 March 2013].

Solomon, M. (2013). The end of inventory. [online] Available at: http://www.supplychainquarterly.com/news/20130326-the-end-of-inventory/ [Accessed 16 April 2013].

Steer Davies Gleave. (2010). Air Freight Economic and Environmental Drivers and Impacts. [pdf] Available at: http://assets.dft.gov.uk/publications/economic-and-environmental-drivers-and-impacts/report.pdf [Accessed 24 February 2013].

Steinmüller, K. (1997). Grundlagen und Methoden der Zukunftsforschung: Szenarien, Delphi, Technikvorausschau. WerkstattBericht 21, Sekretariat für Zukunftsforschung, Gelsenkirchen.

Stilwell, V. (2012). Greenspan's Lightweight Economy Squeezes Cargo Airlines. [online] Available at: http://www.businessweek.com/news/2012-09-27/greenspan-s-lightweight-economy-squeezes-cargo-airlines#p1 [Accessed 19 March 2013].

Straube, F., Nagel, A. & Rief, D. (2010). Trends and strategies in global logistics. In: D. Waters (ed.) Global logistics: New directions in supply chain management. Kogan Page, 6th edition, 31-48.

Sulogtra. (2002). Effects on Transport of Trends in Logistics and Supply Chain Management. [pdf] Available at: http://www.transport-research.info/Upload/Documents/200607/20060727_160425_40578_SULOGTRA_final_report.pdf [Accessed 13 March 2013].

Tavasszy, L., & Ruijgrok, K. (2013). Freight transport demand: indicators, determinants and drivers of change. In: B. van Wee, J. A. Annema and D. Banister (ed.) The Transport System and Transport Policy: An Introduction, Edward Elgar, 51-77.

Thun, J. H., & Hoenig, D. (2011). An empirical analysis of supply chain risk management in the German automotive industry. International Journal of Production Economics, 131(1), 242-249.

Trent, R. J., & Monczka, R. M. (2003). International Purchasing and Global Sourcing-What are the Differences?. Journal of Supply Chain Management, 39(4), 26-36.

Tsai, H. H., & Chi, Y. P. (2010). Trend analysis of supply chain management productivity based on SSCI database by bibliometric methodology. In: New Trends in Information Science and Service Science (NISS), 2010 4th International Conference on IEEE, p. 451-456.

US Bureau of Transportation Statistics. (2013). North American Transborder Freight Data. [online] Available at: http://transborder.bts.gov/programs/international/transborder/TBDR_VWR.html [Accessed 18 March 2013].

US Census Bureau News. (2013). Quarterly Retail E-commerce Sales 4th Quarter 2012. [pdf] Available at; http://www.census.gov/retail/mrts/www/data/pdf/ec_current.pdf [Accessed 12 April 2013].

US Department of Transportation. (2004). Freight Shipments in America Preliminary Highlights from the 2002 commodity flow survey. [pdf] Available at: http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/freight_shipments_in_america/pdf/entire.pdf [Accessed 21 March 2013].

US Department of Transportation. (2011). Freight Facts and Figures 2011. [pdf] Available at: http://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/11factsfigures/pdfs/fff2011_highres.pdf [Accessed 10 January 2013].

US Energy Information Administration. (2013). Spot Prices. [online] http://www.eia.gov/dnav/pet/pet_pri_spt_s1_m.htm [Accessed 24 February 2013].

Verschuren, P., & Doorewaard, H. (2010). Designing a research project, Eleven International Publishing House, 2nd revised edition.

Vespermann, J., Wald, A., & Gleich, R. (2008). Aviation growth in the Middle East–impacts on incumbent players and potential strategic reactions. Journal of Transport Geography, 16(6), 388-394.

Vitasek, K. & Geary, S. (2003). Living in a (de) material world. [online] Available at: http://www.dcvelocity.com/articles/20030701leadership/ [Accessed 18 March 2013].

Wensveen, J. G. (2011). Air transportation: a management perspective. Ashgate Publishing 7th edition, Farnham.

Wisner, J. D., Tan, KC. & Leong, G. K. (2011). Principles of supply chain management: a balanced approach. Thomson South-Western.

World Bank. (2013). GDP growth (annual %). [online] Available at: http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG/countries/1W?display=default [Accessed 24 February 2013].

World Economic Forum. (2013). Building Resilience in Supply Chains. [pdf] Available at: http://www3.weforum.org/docs/WEF_RRN_MO_BuildingResilienceSupplyChains_Report_2013.pdf [Accessed 17 April 2013].

Wu, J., Dunn, S., & Forman, H. (2012). A Study on Green Supply Chain Management Practices among Large Global Corporations. Journal of Supply Chain and Operations Management, 10(1), 182-194.

Wulf, T., Meissner, P., & Stubner, S. (2010). A scenario-based approach to strategic planning-integrating planning and process perspective of strategy. [pdf] Available at: http://www.hhl.de/fileadmin/texte/publikationen/arbeitspapiere/hhlap0098.pdf [Accessed 12 July 2013].

Zakery, A. (2011). 6 - Logistics Future Trends, In: R. Farahani, S. Rezapour and L. Kardar, (ed.) Logistics Operations and Management: Concepts and Models, Elsevier, London, 93-105.

Zhang, A., & Zhang, Y. (2002). Issues on liberalization of air cargo services in international aviation. Journal of Air Transport Management, 8(5), 275-287.

Zhang, A., Huang, G. Q., & Liu, X. (2012). Impacts of business environment changes on global manufacturing in the Chinese Greater Pearl River Delta: a supply chain perspective. Applied Economics, 44(34), 4505-4514.

Zografos, K. G., & Giannouli, I. M. (2001). Development and application of a methodological framework for assessing supply chain management trends. International Journal of Logistics, 4(2), 153-190.

Appendices

Appendix A: Seabury's Databases

Seabury Cargo Advisory offers various database products to its customers which can be tailored to meet individual needs. There are four main subscription types:

- Global Trade Database (Air/Ocean):
  - Trade data on a true origin/destination basis (over 200 countries), available per month, per major commodity group (up to 2000 commodities), per flow direction (export & imports), per origin country (clustering of cities into 4 Chinese regions and 6 US regions), per destination country (regional clustering of cities for China and US)
  - Available measures are: weight by air, weight by surface, value by air and value by surface (USD)
  - Trade history is available from 1994 to/from USA, 1997 to/from Europe, 2000 to/from rest of world.
- Air Express Database:
  - Data is available per year, per major commodity group (75 commodities), per direction, per origin country (clustering of cities into 4 Chinese regions and 6 US regions), per destination country (regional clustering of cities for China and US)
  - Volumes are split per express versus standard freight, small versus large parcels
  - Available measures are weight by air, value by air, volume by air and number of shipments
- Traffic Database:
  - Data is available per month, per carrier, per origin/destination airport, per equipment type (main deck freighter/passenger/combi)
  - Available measures are carried freight tons, mail tons, cargo tons
  - Volumes cover roughly 60% of all carriers, as they report their data through sources such as IATA and others
- Capacity Database:
  - Capacity data is available per month, per origin/destination airport, per airline and per aircraft type & model
  - Available measures are capacity in weight, volume and ATKs (Available Ton Kilometers)
  - Capacity history is available from

In addition, the Global Trade and Express Database also include a 5-year forecasting module.

Appendix B: Global Trade Database

Data sources:

The primary data sources for the global trade database are custom offices. Raw data is directly sourced on a monthly basis from 45 individual countries' customs/statistics offices representing 97% of global air trade coverage by weight (see Table 29). The remaining data is sourced indirectly by UN Comtrade data (22 countries) which is available on a yearly basis enabling the coverage of non-direct sources such as Mexico-Vietnam (see Table 30).

Table 29: Direct sourcing countries

Asia	Americas	Europe		
China	Brazil	Austria	Hungary	Romania
Japan	Chile	Belgium	Ireland	Slovakia
Korea	Canada	Bulgaria	Italy	Slovenia
Hong Kong	USA	Cyprus	Latvia	Spain
Taiwan	Colombia	Czech Republic	Lithuania	Sweden
Philippines		Denmark	Luxembourg	Switzerland
Indonesia		Estonia	Malta	United Kingdom
Malaysia		Finland	Netherlands	
Singapore		France	Norway	
New Zealand		Germany	Poland	
Australia		Greece	Portugal	

Table 30: Indirect sourcing countries

Asia	M. East & S. Asia	Americas	Africa	Europe
Mongolia	Egypt	Argentina	Kenya	Russia
Thailand	India	Bolivia	South Africa	
Vietnam	Israel	Costa Rica		
	Pakistan	Cuba		
	Saudi Arabia	Ecuador		
	Turkey	Mexico		
	U.A.E	Panama		
		Peru		
		Venezuela		

It has to be noted that UN Comtrade data is object to certain quality issues:

- Relatively high level of aggregation: Annual versus monthly reporting, low commodity detail
- Accuracy: Inexplicable flaws within the data which require manual cleaning
- Timeliness: In many cases data is not available within 2 or more years

Intra-regional data is covered for Intra-Asia and NAFTA (North American Free Trade Agreement) with complete model split; Intra-Europe, but without a modal split, a result of the free movement of goods within the European Union; Latin America by combining direct & indirect data sources. On a country-region basis the database covers trade to and from the USA and China by identifying gateway (export) and destination (import) districts.

Commodity code:

Most sources use the Harmonized System of commodity classification (HS) for customs declarations, with additional sub-divisions giving an increased level of commodity detail (21 sections, 99 chapters, 5,000 products). Seabury converts these HS-codes into a more compact listing by aggregating common commodities. The Seabury system consists of 12 sectors (G1 level), 70 industries (G2 level) and around 2,000 products (G4 level). For instance under the HS-classification auto parts and vehicles are spread over seven different sections, nine different chapters and 118 products. Using the Seabury classification auto parts and vehicles are distributed over one sector (Land vehicles and parts), two industries (Land vehicles and Land vehicle parts) and 57 products such as electric vehicle batteries, vehicle gearboxes or vehicle brakes.

Table 31: Commodity system

	Harmonized System	**Seabury System**
Definition	Harmonized System (HS) is an internationally standardized system for classifying traded products, into: • 21 sections • 99 chapters • Around 5,000 products	Based on the Harmonized System and tailored to air & ocean cargo transport, into: • 12 Sectors (G1 level) • 70 Industries (G2 level) • Around 2,000 products (G4 level)

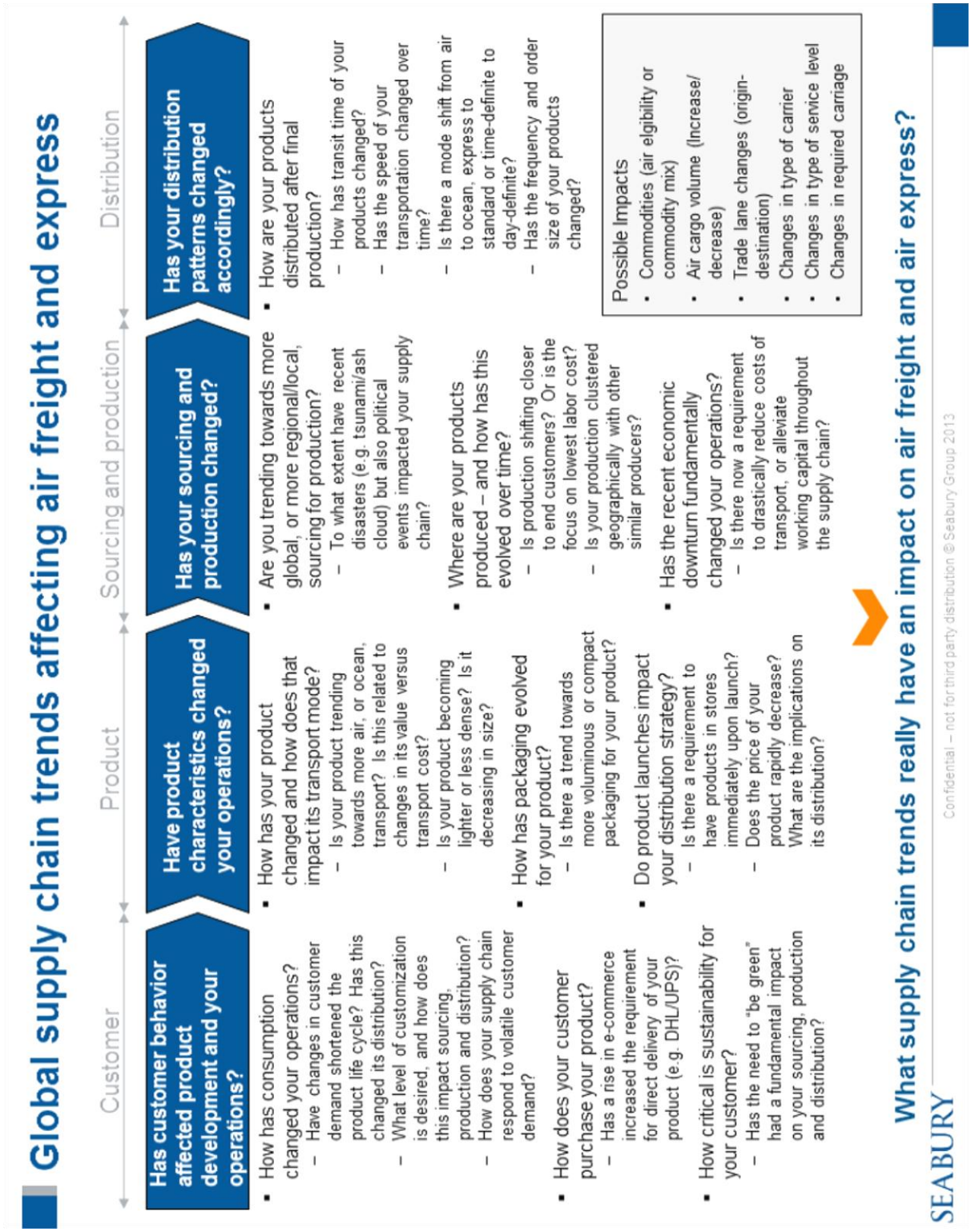
Example: Automotive	Auto parts and vehicles are spread across multiple categories:
	• 7 different sections:
	  ○ Rubber, Articles of stone/plaster, Base metals, Machinery, Vehicles, Optical
	• 9 chapters:
	  ○ Rubber, Articles of stone/plaster, Glass, Furniture, Clocks
	• 118 products
		Auto parts and vehicles are grouped in:
		• 1 sector:
		  ○ Land vehicles & parts
		• 2 industries:
		  ○ Land vehicles, Land vehicles parts
		• 57 products:
		  ○ Electric vehicle batteries, Vehicle gearboxes, Vehicle brakes

Appendix C: Future Research Methods

Method	Content
Agent Modeling	Agent modeling is a replication of dynamic systems by using differential equations. It involves the creation of computer generated agents which interact with each other according to set rules. Agent modeling is used for complex situations such as epidemic modeling.
Bibliometrics/ Text Mining	Bibliometrics counts the number of publications or other bibliographic items to track scientific and technological developments. Text mining extracts information from electronic text sources to learn about current activities.
Causal Layered Analysis	A causal layered analysis tries to integrate empiric, interpretive, critical and action learning types of knowledge. The aim is not to predict the future but to create a transformative space to generate an alternative future. It consists of four levels: 1. "Litany" – quantitative trends presented by media, trends are disconnected 2. Analysis of social causes by policy institutions or news papers 3. Analysis of deeper social, linguistic, cultural structures that are actor-invariant 4. Metaphor or myth – deep stories of the paradox By using a causal layered analysis the researcher needs to move up and down these layers and therefore uses different ways of knowledge.
Cross-Impact Analysis	A cross-Impact analysis is an analytical approach which gives probabilities of an event in a forecasted set. The probability that a certain event will take place is directly determined by the occurrence or non-occurrence of another event. The cross impact analysis aims to distinguish the probability of occurrence of an event in dependence on other events.
Decision Modeling	Decision modeling tries to develop a model of the decision process which is used by decision makers. The model assumes that there are different factors being used when comparing alternatives which result in a decision.
Delphi Techniques	The Delphi method is a structured communication technique by using a panel of experts to forecast the future. Experts answer questionnaires anonymously in two or more rounds. After each round the researcher gives a reflection on the responses and uses them for the next questionnaire. Thereby experts might revise their answers to find a consensus among each other.
Econometrics and Statistical Modeling	Econometrics and statistical modeling analysis historical data which is extracted in one or more mathematical equations to reproduce historical patterns and extrapolate them to the future. Methods include: • Time series analysis (Curve-fitting, Exponential Smoothing) • Explanatory or Causal Analysis (Regression analysis)
Environmental Scanning	Environmental scanning is the central input for trend research and contains methods such as: • Expert panels • Literature review • Key person tracking and conferencing monitoring
Field Anomaly Relaxation	The Field Anomaly Relaxation method aims to identify the development of a range of plausible future scenarios and an understanding of how they may evolve. Field anomaly relaxation tries to give a background of internally consistent futures as a setting for policy and decision makers in a broad field.
Future Wheels	A future wheel is a method to identify secondary and tertiary consequences of trends and events. It can also be described as structured brainstorming by which a certain trend is placed in the middle from which spokes are drawn representing impacts or consequences.
Genius Forecasting, Vision and Intuition	Genius forecasting is an unspecified set of processes which are used by geniuses (futurist) to arrive at statements about the future.

Multiple Perspectives	**Multiple perspectives are looking at the future from three different perspectives:** **1. Technical perspective → Scientific-technological view** **2. Organizational perspective → Group or institutional view** **3. Personal perspective → Individual view**
Participatory Methods	Participatory methods are integrative techniques that use a cross-section of the public and/or professional community to identify issues, future possibilities or common aspirations. Possible methods are: • Focus groups and opinion polling • Charrette (face to face process to bring a small group of people to consensus) • Public Delphi (repeating questionnaire which allows respondents to react to each other's judgments)
Relevance Trees and Morphological Analysis	A relevance tree is an analytic technique which subdivides a rather broad issue/topic into smaller sub-issues. The aim is to present a hierarchical structure of a given topic in more detail. The opposite is a morphological analysis which is used to identify new product opportunities. This method maps different options to obtain an overall perspective of possible solutions.
Road Mapping	Road maps usually comprise of multi-layered and time-based graphical charts that enable developments to be aligned with certain trends and drivers.
Scenarios	A scenario is a story which connects a description of specific future to present realities in a series of causal links that illustrate decisions and consequences. There are three types of scenarios: • Surprise-free or business-as-usual scenario where trends are extrapolated • Worst case scenario based on mismanagement or bad luck • Worst case scenarios based on good management or good luck
Simulation-Gaming	Simulations can give the opportunity to explore various options for dealing with situations that may come up in the future. Therefore, it explores what will happen if certain actions are taken. A game is any activity where a person or a group of persons are put into competition against each other.
State of the Future Index	The state of the future index is a combination of various methodologies such as historical data and future forecasts, quantitative as well as qualitative techniques, mathematical derivation as well as human judgment to systematically draw conclusions of the state of the future. Construction of an index to aggregate many factors into a single value which indicates if future conditions are getting better or worse.
Structural Analysis	A structural analysis is a tool to linkup different ideas. It describes a system by using a matrix that links up all its constitutive elements. This method enables to emphasize the variables that are essential to a system's development.
System Dynamics Modeling	System dynamics modeling generates a deterministic model that links probabilities to events or elements. The method aims to present various outcomes and providing the ability to do sensitivity testing to identify which of the expected events are important to the outcome.
Technological Sequence Analysis	A technology sequence analysis is a method to produce a probabilistic forecast at what time a technology-dependent system becomes available. The future is viewed as a series of interlocking, causal steps or decisions leading to some future state. The time between the events is given as a probability. The emergence of the end-product can be computed similar to the Program Evaluation and Review Technique.
Trend Impact Analysis	A trend impact analysis uses historical data to extrapolate the data to a baseline. A database of potential events, their probabilities and impacts is created and the former surprise free baseline is adjusted by taking into account the events from the database.

Appendix D: Interview Guide



Appendix E: Interview Summaries

Interview 1:

Date:	March 27, 2013
Industry:	High tech
Type of interview:	Face to face
Position:	Transportation Manager, Global Cluster Manager

General Information:

- 15,000 metric tons of air freight per year
    - 10,000 metric tons of service parts and 5,000 metric tons for systems (this is the amount which is controlled – total may be double this amount)
- Strong growth expected for the next 3 years – 60% revenue increase, will have effect on tonnage growth as well (slightly lower), more importantly changing incoterms will increase company's controlled flows
- Transport of systems and service parts all by air, even reverse logistics for refurbishing or overhauling
- No sea freight, trucking within Europe
- Sales: 70% Asia, 25% North America, 5% Europe however Europe increasing slightly
- 80% market share for new systems, biggest competitors are located in Asia
- Assembly, testing, disassemble of new systems in Western Europe, transport to customer and reassembly at site of customer; production of some mature systems is done locally in Asia
- Regional hub for parts in Korea (Seoul, Incheon) and USA (Austin, Texas)

Customer:

- No useful information

Product:

- All systems need freighters, too large for belly hold
- Trend towards heavier and larger systems, therefore size and weight of service parts increases as well
- Systems are getting larger, difficulty to fit in B-777, fear of not having enough B-747 around
- Air freight is expected to grow further, because systems and spare parts are becoming larger and because sales are increasing
- Share of service parts of total freight increasing because install base of systems is growing
- Most service parts do not require main deck
- Systems and parts need special packaging, packaging in clean environment (bag and container), however no changes
- Product launch has no real impact on air freight, high value/low quantity good and everything is transported by air anyways

Sourcing and production:

- Most of sourcing is done in the Western Europe (80%)
- Shift in geographical location of suppliers, sourcing might increase in Northern America and Asia which is shipped by air to Western Europe
- Local Asian sourcing for production of mature systems in Asia

- Transport of supplies mostly by forwarder, smaller parts by integrator→ aim to increase the share of integrator by increasing weight break
- No production changes in the near future, all new systems will be assembled in Western Europe, more mature products can be produced in Asia to be closer to customer

Distribution:

- Customer base will stay predominately in Asia, however customers of new systems will decrease in number since new products are highly advanced and therefore costly and maybe not within competence of customers, decrease of customer numbers also in Northern America especially for new systems
- In Asia there are around 10 customers of new systems but number is decreasing, less clients but with higher spend in the future requiring competence and cash flow.
- Problem: not enough airlift out of Incheon, customers require morning, midday and evening distribution in case of emergency, however, regional hub expected to stay
- Distribution of spare parts to customer from regional hub in Asia or production plant in Europe, depending on who can serve faster
- Large parts usually stored centrally near production plant, might be cannibalized from system that is currently assembled and tested
- USA has 3 key regions Northwest, Northeast And South
- Warehouses close to customers, there will not be a major shift in the next three-five years
- Shift towards integrator if possible especially in Northern America because more reliable, better network, faster and door-to-door service, however shipment size get bigger, rule of thumb under 70kg shipment by integrator, but depends on trade lane and product
- Majority of shipments is standard air freight, next day deliveries are being reduced from 10% to 5%
- No modal shift from air to ocean because too much capital is looked (high pipeline costs)
- Frequency and order size is not changed, again parts and systems tend to become bigger
- Reverse logistics of defect parts all done by air since high value and urgency, not just spare parts returning but also the special containers

Interview 2:

Date:	April 8, 2013
Industry:	Miscellaneous (partly high tech)
Type of interview:	Face to face
Position:	Purchasing Manager, Director Airfreight/Parcel Express

General Information:

- around 60.000 tons of air freight per year
- 10 % of total transport is done by air, mostly ocean transport but also other forms of intermodal transport such as sea-air, rail-air are currently being investigated
- Most air transport (50%) caused by bad planning and insufficient forecasting
- Air freight spending:
    - 200 million
- Air express spending:
    - ≈ 100 million international, ≈ 50 million domestic US
- Number of air express shipments has remained constant: 1 million international and 5 million domestic
- New initiative to optimize company's operations in every business unit, it is a holistic, end-to-end approach by employing cross-functional teams consisting of marketing, sales, production, procurement, logistics, R&D and other departments
    - Example Parcel Express: Different business units within company used to choose four different contractors by preference, now the four contractors are allocated mainly based on the price for each origin and destination of the product
    - Furthermore a shift from time-definite to day-definite (switch to cheaper services)
    - not by preference since service levels are regarded as equal
    - most effect will be anticipated by allocation of carrier by origin and destination, in total cost savings of up to 10-15%

Customer:

- B2C E-commerce is already a common practice especially in consumer products mostly intra Europe and US domestic which allows for economy trucking by integrator
- Sustainability:
    - Carbon reduction program in place to save yearly 5% on CO_2 emission
    - production and transport both use 50% of total CO_2 emission
    - for production it is rather difficult to reduce CO_2
    - consequence for transport: usage of slow steaming, for intra Europe mostly everything should be shipped by truck, reconsider air freight in general, slowest air freight, packaging smartly, carriers are chosen based on if they have sustainability programs, early supplier involvement reducing development cycle time from 12-18 months to 9 months

Product:

- Only a few large machines require main deck, less than 5%, expected to stay the same
- Packaging is being optimized by benchmarking products of competitors, however most 'Products are not designed for logistics'

Sourcing and production:

- Former decisions to source and produce globally are revisited within new initiative, depending on product there is a trend towards local for local and regional for regional, however mostly for consumer product
    - i.e. white goods are produced locally for local markets
- Shift of production for simple products to emerging countries such as Vietnam or Inland China for Asian market or Rumania for Europe, however these products are not prone to be shipped by air (only if forecasts are faulty)
- High-end products will remain within Western Europe or North America since products are very advanced
- Most production shifts start within consumer goods (low end products) because there is the biggest cost pressure which might require production to move to low cost countries, production shift can be realized as quickly as six months
- However, some former off-shored products are in-shored again back to where products are sold
- Production locations for high tech products:
    - Western Europe, Israel, USA, China
    - no major shift in the upcoming years

Distribution:

- With the new initiative every transport decision for each product should be revised:
    - Take total landed cost approach into account
    - Company wants to challenge why does a certain product has to be shipped by air
    - Therefore, certain products are send by default by ocean and need approval of higher management if shipped via air
- Customer due date is responsible for mode of transport, if due date is critical products are shipped by air even if all margin is lost since penalties for late deliveries are large
- Distribution for large high tech products mostly project based for instance to Iran, Africa
- Spare parts for health care: globally structured in three distribution centers: Singapore, USA, Western Europe
- For all business units there is a decrease of warehouses in Europe
- Company is able to react to external shocks such as ash cloud or tsunami, able to identify location of all product and stocks within three days, able to divert product flows and charter planes; however no changes are made to the existing supply chains. This is also rather difficult because company is highly fragmented and has around 1200 different trade lanes for its various products, while competitors have less products and hence also more streamlined trade lanes

Interview 3:

Date:	April 8, 2013
Industry:	Pharmaceuticals
Type of interview:	Face to face
Position:	Global Transportation Specialist

General Information:

- 3,500 metric tons of air freight per year
    - of which around 35% are temperature controlled volumes (2-8°C)
    - on average 5 charters each year, no change expected in terms of charters
- Nearly all shipments are by regular air freight that means via freight forwarders but company also has direct contact with air carrier, furthermore carrier has to comply to certain guidelines on transportation
- Many pharmaceuticals are time and temperature sensitive products: this means they have to be shipped within a certain time frame, company determines 96 hours for total transport time, pre-haulage can be maximum 24h, main haulage 48h and onward haulage 24h
- Most generic pharmaceuticals are shipped by ocean

Customer:

- No useful information

Product:

- Share of temperature controlled transport (2-8 °C) of pharmaceuticals is increasing: five years ago: 10-15%, now around 35% and in 3-5 years around 50%
- Products are relatively light, therefore company pays for volume and not weight
- It is tried to optimize pallets and stowing of products in containers
- Packaging of most products cannot be changed

Sourcing and production:

- Sourcing of supplies for pharmaceuticals is mostly by air, however the amount is negligible small
- Partial production shift of main product being shipped by air to Central America because of tax reasons to serve entire US market, therefore, the flow between EU and USA will disappear
- Possible shift of sourcing and production of simple products to emerging countries such as China and India, however these products are not shipped by air anyways

Distribution:

- Active and passive distribution
    - Active: used for more than 10 pallet shipments, since it takes too long to build an passive pallet, 2,5-3 pallets fit in one Envirotainer (company is top 3 client for Envirotainers)
- Company faces difficulties to have guarantees for Envirotainers and capacity on almost every route for special occasion, i.e. Chines New Year
- Preference for belly hold on passenger flights since these carriers have higher reliability and higher frequencies, therefore products do not require main deck and very large shipments can also be split

- 95% of transportation is controlled by company, only products such as Aids delayers might be transported by Unicef or other aid organizations especially to Africa
- Express services are limited to Benelux and Western Europe as well as domestic USA but than by truck
- 75% of temperature controlled pharmaceuticals are shipped in active containers and this is expected to further increase, however there are issues with customs especially in Middle East
- Company usually has regional offices to which goods are distributed and from there further transported to neighboring countries, however more and more countries have larger sales, hence pharmaceuticals can be shipped directly to the designated country, no impact on type of carrier, transportation is still with freight forwarder and airline
- Carrier is chosen by airline and gateway
    - Company has around 10 airlines that are suitable for transport since they offer time and temperature sensitive products, however some gateways are not working such as EVA Air will only be used for direct transportation but not for connecting flights via Taiwan
    - Company prefers direct transport, however if indirect route is cheaper and more reliable than obvious to choose this one
    - Usage of airlines is quite diverse, of all 10 airlines the share is equal, but of course it depends on trade lane and destination
    - Company would like to use as many different carriers as possible, preferred 2-3 per lane, therefore more carries should offer time and temperature controlled products (Etihad, Qatar, Saudia)
- Many of generic pharmaceuticals need to be stored and transported in ambient temperature (15-25°C), however only a few countries (Canada, Saudi Arabia, Israel) are really strict on having right temperature during transport, these pharmaceuticals have to be transported by reefer container by sea or as air freight. If GDP (Good distribution practice) guideline policies are strictly followed by more countries (and interviewee anticipates this to become true in countries of the Middle East, Brazil, Latin America or Australia). Hence, there will be an increase in reefer containers and a shortage of reefer containers might lead to an increase usage of more air transportation
- New markets for products: Brazil, China, Australia, New Zealand, Taiwan, especially emerging markets are expected to grow above average
- Switch from one entry gateway to another within Brazil because of better service, different tax schemes
- 10 years ago 80% of total sales of company were in the US and 20% internationally now 40% of sales in US and remaining 60% international, aim to have around 50% of sales in emerging markets in the upcoming years

Interview 4:

Date:	April 15, 2013
Industry:	High tech
Type of interview:	Face to face
Position:	Operations Manager EMEA

General Information:

- All products of company destined for EMEA (Europe, Middle East and Africa) go via the Netherlands as gateway and will then be further distributed to end costumers
- Volumes of air freight are confidential, all products are shipped by air because of high value and economic perishability, within Europe products are trucked
- Volumes declined to Europe and Northern America, however one type of product is now shipped by air after relocation of plant from Western Europe to China
- 2 types of product/customer combinations:
    - Trade products mostly to OEM (i.e. HP and Dell) but also a few distributors
    - 'Ready to use' product: complete assembled system with processor, fan and other components, not for OEM mostly to distributors (Media Markt)

Customer:

- Demand used to be steady, however declined in last years, now company experiences small spikes at the end of a quarter, unfortunately no need for any charters since demand is too low
- Shipments are getting smaller due to lower demand, therefore company sometimes uses integrators, however only small percentage and in general company prefers forwarders
- Sustainability plays a minor role, partially applied for trucking within Europe
- No direct distribution to end consumers (no B2C)

Product:

- Products are getting smaller in size therefore value-to-weight ratio increases
- Packaging has especially changed for 'Ready to use' products, packaging becomes less voluminous
    - Therefore some shipments are getting heavier and some truck shipments are too heavy and shipments need to be split
- Company and its competitor did not expected tablet market to boom, slowly catching up with new products

Sourcing and production:

- Most supplies are sourced from plant in Western Europe, company is sole customer, however the contract allows sourcing from other manufacturers, sourcing especially from Asia is gradually growing i.e. Taiwan,
- 'Ready to use' production in Europe was closed in mid-2012 and shifted to China
    - Most supplies used to be shipped to Western Europe by ocean and only some parts by air, complete assembly in Europe
    - Shift to China because of higher labor costs and longer lead times of supplies in Europe
    - Now all 'ready to use' products are shipped by air to Europe and then delivered to distributor

- Production shift from Singapore to China a few years ago
- Company expected to follow trend to go further into mainland China and planed already warehousing space, however due to economic situation plans are on hold and will not be executed in the next years, therefore location in coastal China will stay as major assembly, test and packaging facility
- Production is mostly organized by built-to-order on a global scale and shipped across the world therefore no local for local production (except China), however increasing local/regional sourcing

Distribution:

- Most customers are located within Asia (China, Taiwan) and are slightly growing, new customers in South America but only a small percentage, customers in Europe and Northern America are stagnating/declining
- Within Europe:
    - Most EU customers are located in Germany, Poland, Czech Republic, especially shift towards Eastern Europe which are expected not to change in the next years
    - Customers used to be dispersed throughout EU now two smaller manufacturing clusters in Eastern Europe
    - There was an expected shift further to Turkey however customers (OEMs) did not and are not expected to shift or expand its operations due to economic situation
    - Company uses a dedicated trucking company for transportation within Europe
    - Company used to have up to 9 vendor managed inventory locations near key customers, now decreased to 2 (Czech Republic, Poland) and aim to reduce to zero and transport everything directly from the central warehouse
- Distribution to Northern America is decentralized and is usually shipped only to airport and customer picks up product from airport
- Company tries to consolidate shipments, therefore delivery to customers has changed for instance from five days a week delivery to only once a week
- Value of shipments is very high, therefore company prefers forwarders and less integrators (bad experience)
- Company wants to know all the time where products are located, therefore they use hidden devices to control location of shipments

Interview 5:

Date:	April 24, 2013
Industry:	Miscellaneous (partly high tech)
Type of interview:	Telephone
Position:	Director Global Premium Freight Purchasing

General Information:

- 4,000 metric tons of air freight per year, 3,500 metric tons of air express per year
- The amount of air freight is stable over time even though some markets have changed, overall figure does and is expected not to deviate by more than 10 percent
- 200.000 TEU of ocean freight per year
- 30 % of air shipments are finished products, while 70 % are supplies (mostly mother boards)
- Air shipments of finished products only happen when pre-sold and goods need to reach customer as fast as possible, default mode of international transport is in general ocean

Customer:

- There is customization for different markets but this is mostly restricted to large products that are not shipped by air
- Demand is volatile but usually combined with certain occasions such as holidays or government subsidies → to satisfy demand peaks products are usually air freighted instead of being shipped by ocean
    - Example: charter flights of white goods because of unexpected demand increase, but there is no increase of charters due to demand fluctuations
- Starting to accept online bookings which require last mile delivery, this needs to be discussed with logistics service providers, the way goods are being ordered is and will change → therefore company is looking into options using integrators
- Company started sustainability programs already years ago, for air freight commitment to reduce carbon emission by 15% until 2015, but difficult to take control of that, therefore company uses the same airlines as everyone else, company cannot demand a carrier to use new fleet

Product:

- Product life cycle is not really shortening for most goods
- Products are getting lighter and smaller
- For large appliance (washing machines, stoves) if they are air freighted because of urgency a lot of these products require main deck, large appliances are actually increasing by size (around 5%)
- Value density of products is not expected to increase over time and will therefore not enable products to move by air
- Product launches require air freight
    - Example of refrigerator launch in the USA → first 5 months 150 tons per month of air freight after that switch to ocean
    - number of product launches is expected to increase in the next years across different products

- for product launches conventional 3PLs are used, integrators are limited in use for product launches because they are restricted to size and weight, only if necessary company uses next flight out option

Sourcing and production:

- Getting closer to supplier and customer base → shift towards local for local and near-shoring
- Sourcing of air eligible products are staying within China, Korea, Japan or Taiwan
- Company has moved production already years ago to low cost countries (Western Europe to Eastern Europe and Asia) continuing movement to even lower cost countries but rate has been reduced, no major movement of plants in the next 3-5 years
- No plan for moving manufacturing back to consumption markets in developed countries

Distribution:

- Factory should always plan for deferred air service (4-5 days)
- Expedited services are only used in case of emergency and require permission of supervisor
- Frequency of expedited services is still the same and not expected to change
- Sea-air, rail-air services are on a project basis, not used that often because air freight is quite cheap at the moment
- Frequency and order size has not changed

Interview 6:

Date:	April 25, 2013
Industry:	High tech
Type of interview:	Telephone
Position:	Strategic Sourcing Manager

General Information:

- 50,000 tons of international air freight, of that is a small amount of air express (share of total freight 25%), expected to be slightly decreasing because of mode shift due to be more cost conscious
- 200,000 tons of international freight (air and ocean)
- Products transported by air usually use cheapest type of transport (general air freight)

Customer:

- Customer has low impact on how products are transported, it is more driven by company internal policies
- Customer demand is extremely volatile, however only a few aircrafts per year need to be chartered (no shift in the future), capacity on commercial aircrafts is enough only to Africa there are expected difficulties
- E-commerce and therefore carrier switch to integrators in expected to increase, but the current amount is very small and therefore this trend only has a limited impact, furthermore because of the higher costs for integrators company is actually trying to avoid integrators
- Being sustainable is increasing but driven internally, but has no influence on how products are transported

Product:

- Products are decreasing in size and getting lighter, therefore if value-to-weight ratio will be increasing company expects to shift certain product types formerly transported by ocean to air, however switch will not be very significant
- Packaging has been reduced that products are smaller than 1,6m so they can be shipped in 'belly' of aircraft

Sourcing and production:

- Currently sourcing is mostly done from China, Eastern Europe and India, there is no change expected in the next years
- There is an ongoing trend to source locally but this has happened already in the past
- Aim was to get closer to customers with manufacturing facilities, therefore several plants have been opened, transportation costs are taken into account, a lot of production has been shifted to low cost countries, currently 12 production facilities (Brazil, Eastern Europe, China, India, Mexico, Italy), no expected further shift
- In case of supply chain disruption company relies on more air freight, number of disruptions is slightly increasing

Distribution:

- Economic downturn has triggered more cost consciousness and therefore lead to a shift from air to ocean transportation, the share of ocean transport is quite good and therefore there will only be minor changes for certain products and trade lanes

- If economic situation would improve drastically, there would be no shift from ocean to air since transportation by ocean is working very fine
- Starting to export from Indian and Brazilian facilities to serve beyond their home markets (Brazil → Latin America, mostly transported by air)
- Trend to switch from express services to economy mode, but only few goods are transported by express anyways
- Large mode shift has happened in the past
    - now share is 25% two/three years ago it was around 50% air share, only slight changes towards ocean expected in the future because company has nearly reached the optimum
- Decrease in the number of freighter and increase in the number of passenger air crafts, might have an impact on capacity to Africa were freighters might be needed in the future
- New transport management system should enable company to better consolidate smaller shipments to one large shipment

Interview 7:

Date:	April 29, 2013
Industry:	High tech
Type of interview:	Telephone
Position:	Logistics Manager Aftermarket EMEA

General Information:

- Aftermarket has rather small volume of air freight, biggest trade lane from China to Germany 320 tons per year, total air freight around 400-450 metric tons per year
- 65% air freight, 10% small packages, 25% intra Europe express (truck)
- Aftermarket inbound: 90% of flows airfreight, 10% surface → usually regardless of the commodity
- Aftermarket outbound: air freight to the Middle East and beyond, small package providers intra Europe, but mostly trucking
- Airfreight is expected to increase because customers purchase more and more electronic goods, therefore repair will grow as well, furthermore OEM are further outsourcing repairs to company, stable growth

Customer:

- No useful information

Product:

- No major changes in packaging, it is determined by customer anyways

Sourcing and production:

- Geographical location of sources has and will not change much:
  - Shanghai number one source, after that Taipei and Shenzhen/Hong Kong
  - China to Germany (than to Hungary by truck) is around 320 tons per year, total into Europe around 400-450 tons per year
- At the moment air freight is relatively cheap therefore no pressure to shift and this is expected to stay like this, furthermore, shift to ocean would lengthen transit time and therefore increase inventory costs
- Company's own initiative is to shift from air to ocean in the future wherever it makes sense
- Company tries to decrease the amount of small packages, therefore decrease in usage of express services of integrators and shift towards general air freight, try to reduce weight break point, currently 65% air freight, 10% air express, EMEA small package flows (truck)
- Weight break between air freight and air express 10-25 kg depending on trade lane
- Repair services for EMEA are taking place in Eastern Europe due to lower labor costs, not expected to change and shift further away in the future

Distribution:

- Distribution is mostly intra Europe and by truck, no changes
- Industry wide: trend to shift towards ocean as much as possible especially for larger volumes

Interview 8:

Date:	May 2, 2013
Industry:	High tech
Type of interview:	Face to face
Position:	Section Manager SCM & Logistics

General Information:

- Total air freight of biggest product is around 30,000 tons per year expected to increase around 5%
- All shipments are done by air because of economic perishability and looked capital and inventory for 6 weeks instead of 3-4 days
- Major trade flow from Far East to Europe (9,000 tons per year)

Customer:

- E-commerce on a B2C basis is increasing but is does not impact the type of carrier in regard of air transportation, furthermore this channel is marginal small

Product:

- Packaging has been reduced and is getting less voluminous
- Total weight also decreased for instance from 0.7 kg to 0.53 kg, volume was decreasing in a similar way, vast majority of products are charged by actual weight
- New product releases are either bi-annual or annual, however do not affect the type of service level or carrier, all general air freight with forwarders and conventional airlines

Sourcing and production:

- Assembly facilities in Thailand, Indonesia, China, Taiwan, Brazil (in total 8), shift from Hong Kong area to Shanghai area, outsourced assembly plants might change but the owned plants are staying because it is difficult to move
- Closure of Vietnam assembly which used to be an overflow facility
- Gateway is not important, often products get sourced via different routes (products move from Bangkok via Taipei to Europe)
- No express services used for inbound deliveries to Europe
- Supply chain disruptions i.e. flooding in Thailand: rerouting of supplies to other facilities, dual sourcing to expensive, no change in production locations due to structural supply chain disruptions
- Other companies have been moving from air to ocean, but company is not doing it ‘Everyone is talking about model shift, but we are not doing it’
- Ocean transportation is very slow and air transportation is very fast, however there is nothing in between and that is a pity → transit time of 8 days would also be okay if charges go down
- Other options like sea-air are not a feasible solution, alternatives such as train are interesting but not used
- Company would like to have smaller shipments, on a daily basis would be great, however it does not impact carrier type

Distribution:

- Regional distribution centers to centralized inventory however it is important to have high flexibility because last mile is very important and there is an increased in timed deliveries furthermore products can be bundled, no usage of cross-docking
- Growth areas are emerging markets (Brazil, Russia, India) but also Europe

Interview 9:

Date:	May 7, 2013
Industry:	High tech
Type of interview:	Telephone
Position:	Director Global Logistics

General Information:

- Yearly air freight around 22,000 metric tons (general air freight)
- Large air freight will stay about the same, growth in sales but mode shift from air to ocean
- Small packages increasing
- Sales increased by 10-15% in the last years and are expected to continue, reason: increasing markets share, acquiring other companies, diversifying high tech manufacturing to general manufacturing
- Air share by tonnage: 25% air, 60% ocean, 15% road transportation, share is more or less expected to stay the same, large mode shift in the last couple of years from air to ocean, it used to be only 40% by ocean but now it is 60%, no more major shift to ocean, maximum 5% more in the next years
- Reason for mode shift:
    - Better understanding for which product we can have longer lead time
    - Cost pressure since it ocean is only 10% of air transportation
    - Negligible small amount of being sustainable
- Increasing the weight of small packages, a lot of lanes used to be 100kg weight break for using integrators instead of freight/network carrier, now it is up to 1000kg, possibility to further increase the weight break

Customer:

- No useful information

Product:

- Products continue to get smaller
- Products are expected to increase its value-to-weight ratio
- Not many changes in packaging, company would like to decrease the volume of packaging to reduce chargeable weight factors, but no solution at this point has been found
- Pipeline products/product launches are usually done expedited for the beginning and switch to standard air or even to ocean later, no increase In the amount of product launches

Sourcing and production:

- Two thirds of supplies are sourced in Far East, Asian supplies are increasing especially out of China and Vietnam but also shift from coastal to inland China (around 5-10% of total sourcing will change), majority of supplies should remain in current location
- Expanding of supplier sourcing due to supply chain risk, currently diversifying supply base by looking at new suppliers outside of Korea because of the issues between North and South Korea
- Movement of production from coastal China to inland China, from China to Vietnam and from China to Mexico (again around 5-10% of total production for all location changes)
- Reason for near shoring:
    - Costs, flexibility, shorter lead times

Distribution:

- Not much growth in Brazil, Russia and Mexico is increasing, Asian consumption is increasing
- Next day vs. standard air freight is staying about the same
- Continued mode shift from air to ocean of around 5%
- Change in weight break from 100kg to 1000kg, resulting in a shift from non-integrated carrier to integrator

Interview 10:

Date:	May 8, 2013
Industry:	High tech
Type of interview:	Face to face
Position:	Manager European Supply Chain

General Information:

- Total yearly international freight 1.5 million m^2, of all products 2% by air and 98% by ocean (weight share), by value share 10% air and 90% by ocean
- 30,000 m^2 air freight → 5,000 tons of air freight per year
- Within the largest product segment 26% of products are shipped by air and 74% by ocean, it used to be 100% by air in 2010 → therefore huge mode shift in the last two to three years

Customer:

- Air shipments remain for products with small product life cycle (less than a year)
- Company does not engage in B2C e-commerce, more from distributors or large retailers (Media Markt, Amazon), → company is not sure if they will engage in e-commerce because transport is too expensive
- Sustainability encourages to ship by ocean, however cost advantages are far more important

Product:

- No increase in product launches, remain stable, for certain products there is a price erosion therefore shift towards ocean
- Products are decreasing in size and getting lighter (new models will be 20% smaller than current size), however the limit will be reached in terms of size and weight
- Packaging: thinner card box is used, packaging gets smaller and therefore less voluminous, however there is a limitation because of manuals that are not getting smaller as well as the manual CD
- For Europe, manuals are added in Europe, weight share of manual is around 48% of total weight, for American and Chinese market manuals are already added at production location → therefore air shipments of products is heavier to the US/China

Sourcing and production:

- Mostly local sourcing especially from China and Vietnam, looking for second option out of China because of 'China Risk' → conflict between China and Japan over Senkaku Islands
- For the high-end products manufacturing takes place in mature Asia countries, low-end production in China and Malaysia
- Expansion of production to Thailand, Philippines (because of cheap labor, however low-end products not likely to be transported by air anyways), Brazil (high import taxes, therefore assembly for local market), Mexico (for US market → near-shoring)

Distribution:

- Policy from top management in 2010 to eliminate air freight completely but it is not possible, large mode shift towards ocean from 100% air share to 26% of air transportation and 74% ocean transportation, only small adjustments towards ocean → mode shift has taken place
- Other competitors are probably not shifting that much towards ocean

- Issues with transport:
    - Ocean it is not reliable, large fluctuations with estimated time of arrival
    - Air is to expensive
- Large systems were always shipped by ocean, smaller systems have been shifting in the last 2 years and will continue to shift further towards ocean
- Transportation mode is determined per product and trade lane, first waves of products are shipped by air and then moves to ocean
- To prevent theft, shipments are consolidated and not send in small shipment sizes, company tries to fulfill a complete air pallet → average shipment size per invoice is increasing
- aim to have large flows to one gateway from manufacturing locations (in Europe for instance Amsterdam)
- Supply chain disruptions increased the need for air transportation (example of Tsunami in Japan, huge shift to air, however air charges were relatively low especially since there was excess capacity to USA)
- Limited usage of integrators especially because rates are very high, no need for faster services than general air freight
- Company wishes for low cost transportation that is between the transit time of air (4 days) and ocean (30 days), sea-air as well as rail between Asia and Europe are not really an option
- No need for express services because no e-commerce and no direct distribution to retailer, wish to increase direct distribution to retailers and not store products in central warehouse which would consequently increase the usage of integrators
- Strong shift towards deferred air shipments, as long as final delivery date is meet it does not matter if product arrives today or in one week, reliability is very important

Interview 11:

Date:	May 13, 2013
Industry:	Pharmaceuticals
Type of interview:	Telephone
Position:	Strategy & Business Development Director

General Information:

- 25,000 tons of air freight per year
- Transportation 30% by air and 70% by ocean, it used to be 35% air and 65% ocean, strategy is air freight by exception→ moderately successful to implement
- Large cost improvements of this strategy by moving freight from air to ocean

Customer:

- Most manufacturing facilities are designed for blockbuster production, however user requires customized solutions (certain gen types react differently to drugs) → smaller batch production
- Supply chain is still very traditional → e-commerce plays no role in terms of air freight, it only exists within a market

Product:

- 19 pipeline products are expected to enter the market in the next three years, product launch will always require air freight for the first wave and might then gradually change to ocean after 3-6 months (however depends on products)
- Cool-chain:
    - 1% biopharma: large complex molecules frozen by -70°C
    - 5-8% vaccines: 2-8°C throughout whole supply chain
    - 90% less than 25°C do not freeze: most challenging transport, passive packaging, thermal blankets, bock special services on carriers, not willing to pay for Environtainer, difficulty for runway loading→ as a consequence no transit in summer via Middle East for Asian market → need for temperature compliant solutions from carriers
    - 2-5% Ambient: general cargo
- Transportation is more often checked and needs to be in compliance with regulations (FDA for instance requires to show that temperatures remain within limitations)
- Packaging becomes more robust, possible for double stacking, help to retain temperature within limits

Sourcing and production:

- Most manufacturing is located in Europe, one manufacturing location in North America, no new locations for own manufacturing expected in the future (lots of capacity within own network)
- 20% of products is manufactured externally, this amount is expected to grow within the emerging markets
- Trying to source/produce locally for emerging markets

Distribution:

- Total amount of air freight will continue to grow by small amount (now 25,000 tons/years)

    - Mode shift from air to ocean → in the past 65% ocean vs. 35% air, now 70% ocean vs. 30% air
    - Sales increase of products that are shipped by air especially to non-traditional markets
    - New product launches → 19 new pipeline products in the next three years (quite unusual for pharmaceutical company to have that many)
- North American market is static/declining, Europe also static but mostly intra Europe and therefore by truck
- Most growth is in non-traditional markets with double digit growth (BRIC, Asia Pacific, Latin America)
- Need for robust service provision for trade lanes that were rather small in the past
- In case of constrained capacity, company has to buy express services (30% more expensive than general air freight) → also one reason why company wants to switch to ocean, there is a relationship on expedited shipments and distance to main airport, however expedited services is a small proportion (3 million pounds a year)
- Poor forecast on airlift for the next 7 days for block space → accuracy is around 20%
- Desire for using fewer airlines but to have strategic relationship with the remaining carriers and therefore bypassing the freight forwarders, however airlines are stuck with forwarders which sell 97% of their capacity to shippers
- Shift from many dispersed gateways (20 European airports) to more consolidated pipelines (in Europe for instance: London, Madrid, Milan, Frankfurt and Paris)
    - i.e. lift from Ireland is 45 pence more expensive instead of trucking to London and then air transport, while products are most likely transited via London anyways
    - difficult to implement: export from own countries because of VAT issues, difficult to move goods through EU
- Consolidation also at destination: multimarket warehouses (e.g. Panama for Caribbean and maybe even Columbia, Venezuela, Peru and Ecuador; possibility to do the same for Latin America) → result will be fewer prime destinations
- Lost and damaged goods points towards ocean freight: 1% of air shipments has some issue → 10% of these products need to be written off→ high value but low recovery, with ocean freight this is way better
- Cost of ownership does not matter, because length of overall supply chain is quite long, furthermore manufacturing costs are far less than sales value
- Transit time is really long even though the percentage of being in the air is only 10% because of documentation, clearance → huge focus on reducing transit time on each mode
- Integrators are only used for documentation, clinical trial shipments and development products, but not business critical

Interview 12:

Date:	May 13, 2013
Industry:	Pharmaceuticals
Type of interview:	Telephone
Position:	Global Procurement, Freight & Logistics

General Information:

- 7,000-8,000 tons of air freight per year
    - 35% of all international transportation by air, all air freight is under pharma products of carrier → no general cargo
- Total transport volume has increased, however decrease of air shipments due to mode shift
- Company does not have many new pipeline products coming up in the next years, rather niche products

Customer:

- Sustainability has limited influence on the way products are transported, company is aware of sustainability, main driver for transportation by ocean are financial issues → sustainability is more of a consequence

Product:

- No large product launches expected in the next years, similar to the past, rather niche products will be brought to the market
- Shipments are becoming more heavy because there is a shift from final products to bulk transportation and final packaging closer to customer
- Packaging and arrangement on pallets is optimized in a way that it fits best the containers
- Packaging is changed to comply with cool chain transportation
- Cool chain transportation has increased in importance, especially passive cooling, less active because of high costs, for ocean freight it is 100% reefer container
- Product launch:
    - usually first batches go by air freight and second batches by ocean, but depends on size and product availability of product in the market

Sourcing and production:

- trend towards local sourcing, focus on the current factories which are mostly located in Europe
- new factories in North Africa, Eastern Europe and South East Asia are set up to gain market access but access to quality of labor restricts company to build production facilities in low cost areas
- there are business contingency plans and the awareness on supply chain risks has increased however no fundamental changes on how to source or distribute

Distribution:

- Large mode shift from air to ocean (used to be 12,000 tons per year, now around 7,000-8,000 tons per year), in 2010 only 10% by ocean, now 60-65% by ocean, aim is to reach 70% by ocean until end of 2013
- Mode shift on all lanes, especially on lanes with large trade
- Key reason for transport by ocean:

    - Quality (more stable solution, less damage) → offsets capital costs because there is a large difference between manufacturing costs and sales value, lead time of products is very long anyways
    - financial attractiveness
    - sustainability is a nice by product
- Shift from ocean to air in case of supply chain constraints (i.e. unexpected growth in certain areas, bad forecasting)
- Biggest markets remain to be developed countries (US, JP and EU) but these markets are static, emerging markets such as China, South America, especially Brazil are growing, Africa did not grow as much as expected
- Shift from transportation of final products to bulk transportation and regional packaging closer to end consumer (it used to be only 20% bulk, no it is up to 50% bulk), however mostly for tablets and capsules
- All air transportation is done with pharma products of carriers (passive solutions around 50%, active solutions around 5%), no general cargo
- No changes in transit times
- EU regulations are getting more stricter, there is an increase in monitoring, Africa and Middle East are also requiring regulations but there is no right infrastructure and equipment which is a big challenge
- Air express is also used but much less than 1% for clinical parts, samples

Interview 13:

Date:	May 21, 2013
Industry:	Pharmaceuticals
Type of interview:	Face to face
Position:	Regional Sourcing Analyst, EMEA

General Information:

- 2,000 tons of air freight per year (probably only for EU), 10,000 TEU ocean freight per year, amount of air freight is expected to stay the same in the next years, in the past the amount of freight increased because of mergers and acquisitions
- Transportation 40% by air and 60% by ocean, five years ago it used to be nearly 100% by air, the aim is to have only 30% share of air freight
- All transportation Intra Europe and Intra North American by truck (these areas are also main markets)
- Sales increase of around 10% per year, however air freight expected to stays the same because of continued mode shift
- Company has generally a lot of stock to be able to ship by ocean, however market value is way higher than costs of production

Customer:

- Sustainability is a moderate driver to ship products by ocean
- No direct distribution (therefore no e-commerce in a B2C sense), maybe for simple products (i.e. anti-conception pill, but not in the next three to five years)

Product:

- Cool chain:
    - Active cooling: 10%, increasing within the next years because passive cooling is only valid for 5 days and sometimes transit time is prolonged and therefore requires active cooling
    - Passive cooling: 30%
- 3 new product launches, more than usually: new products will be shipped by air for around 1-1,5 years, once sales have picked up it shifts to ocean
- Products will not change in size or weight → all transportation is by chargeable weight
- Packaging is one way to decrease volume, but this has reached its limits, for vaccines it is studied if files can switch from glass to plastic (but no major change)
- All products must be shipped with temperature device to track temperature of products, if products temperature out of required range than products might be discarded → shift to active cooling which can be done by ocean freight (reefer) or air freight (Environtainer)

Sourcing and production:

- Most sourcing of raw materials from Mexico, China and India → no change expected
- Most production in USA and Europe
- New production sites in Brazil and China
    - Reason: be closer to the market (near-shoring), but also avoiding high import tariffs to Brazil, the same for India
    - However, production of mature products shifts to emerging countries while high end products will remain in USA and Europe

Distribution:

- Huge mode shift within the last 5 years from 100% air freight to now only 40% air freight
    - Reason for shift:
        - volumes became so big that transportation by reefer became more cost efficient since Environtainer are very expensive
        - custom clearance and transit time fluctuates which makes passive cooling very difficult
- In the next years mode shift will continue to a smaller extent, aim is to have only 30% air freight
- Ocean freight is standard mode by default for transport (air freight requires approval of manager)
- Consolidation of shipment is introduced throughout the company, shipping in large batches once a week → this is the case for all modes, therefore speed of transport is not so important → despeeding of supply chain (deferred shipments), 'if it takes another day it does not matter'
- Currently distribution is directly to each country, however company will set up distribution centers and then ship from there to different markets → consolidation of trade lanes
- Express service only for samples, documentation and for rush shipments (very seldom)
- Sales are increasing due to merger and acquisition in all markets, very high increase in sales in China, Brazil and Africa
- Because of high stock levels company is not exposed to a lot of supply chain risk/disruptions, the ash cloud had no impact on company
- Capacity constraints for certain routes because of A380 (less belly hold than other commercial air crafts)

Interview 14:

Date:	May 23, 2013
Industry:	Automotive
Type of interview:	Telephone
Position:	Corporate Supply Chain Manager

General Information:

- Air and ocean freight is seen as one commodity, therefore no split, both are handled under one budget (42 million US$ per year)
- Interviewee does not know how much volume is shipped by air or ocean, also no indication
- Share of air transportation is around 40%, ocean 60%; has been decreasing over last years
- A lot of regional transportation by truck especially in Europe and North America
- Electronic parts are transported by air because of high value (also very low inventory) while large parts are transported by ocean because of the high weight

Customer:

- Company tries to consolidate shipments due to cost savings, however customers still demand just-in-time, still interviewee sees a trend towards consolidation, most of the time customer organizes outbound freight themself
- Company has no B2C channels and also no e-commerce channels, not expected to change in the future, company has no network to directly ship to the small B2C customer
- Sustainability is very important for company and its customer, however it does not drive a modal shift from air to ocean, it is more important to utilize transportation better, such as higher load factors on all modes or utilize a container in the best possible way

Product:

- There is an aim to reduce size and weight of products, this is also requested by the customer, however it is difficult to realize
- Packaging become less voluminous, furthermore, company thinks that returnable packaging will increase in the future

Sourcing and production:

- Shift from global sourcing (low-cost country driven) to regional sourcing
- Because of supply chain disruptions company is looking for alternative sourcing location
- Shift also from global production to regional/local production, company tries to be as close as possible to customer, for all product lines not just the mature products are manufactured in emerging countries
- New production sites are expected in booming automotive markets such as Brazil, China and Russia
- Company has already moved to emerging automotive clusters in Brazil (Sao Paulo area), China (Nanjing, Shanghai), Thailand and Malaysia

Distribution:

- Main issue currently within the logistic departments of product lines is to continue with the mode shift from air freight to ocean freight → aim to have only 20% air freight
- In the past there has been already an extensive shift towards ocean, so far very successful
- → volume of air freight is decreasing even though sales are increasing

- Premium freight is mostly used for road transportation, express air freight only by exception
- Supply chain disruption usually increase air freight, however company does not see an increase in the occurrence

Interview 15:

Date:	May 24, 2013
Industry:	Automotive
Type of interview:	Telephone
Position:	Logistics Manager EMEA

General Information:

- 3000 tons of air freight per year, 400-500 TEU ocean freight per year, only a few tons air express per year
- air share is around 70%, 30% ocean transportation, no change in the upcoming years
- air freight will be increasing because the strategy of company is to double its size and sales within the next 4 years
- main air flows between USA to Western Europe and China, Philippines to Western Europe
- most flows within Europe by truck, only some by air express, air shipments to North and South Africa as well as Middle East from distribution center in Western Europe

Customer:

- no B2C market, will not change because it does not fit the strategy
- Sustainability is very important and growing, furthermore it is demanded more and more by customer, however no impact on the way products are transported, however redesign of packaging

Product:

- Products are getting smaller, combination of many products in one product → reduction of volume and weight of the product
- Redesign and optimization of packaging resulted in an increase of 35% more products shipped per pallet → partly shift from paying chargeable weight to actual weight

Sourcing and production:

- Company moved to Mexico from the USA more than 20 years ago because of cheaper labor,
- recent move towards Eastern Europe (Lithuania, Romania), there will not be a shift towards the USA or Western Europe
- if production will move than towards China, however no shift to inland China, importance of short road feeder or proximity to large ports/airport
- supply chain disruptions are expected to increase (port strike at the US East coast), this increased the amount of air shipments, but no fundamental change in terms on how products are transported, no dual sourcing or dual production

Distribution:

- air express and general air freight will increase due to strategy of doubling in size and sales, air express will increase by 50%, general air freight will increase even more, air express is caused by market circumstances (demand volatility) and product availability
- most air freight shipments are deferred consolidated, aim to reduce as much as possible in express → however difficult to realize because of demand volatility and product availability
- no major mode shift in the past and future, it is constantly assessed but because of long transit time it is not possible, the same for sea-air movements
- Intra-Asia there will be a slight mode shift towards ocean (Philippines to Hong Kong distribution center) because transit time is not that much different

- Temporarily there is a mode shift towards air to catch up with demand, air freight is then used to fill up the gap between demand and supply, demand is often higher than supply
- Mode shift towards air also because of supply chain disruptions of ocean carrier
- Air shipments should in general take no longer than 7 days (deferred consolidated), does not matter if it arrives after 4 or 7 days as long as arrives before expected day of arrival, reliability is very important, no changes expected in using that strategy
- Distribution follows where cars are produced, so even cars are not sold in Europe there are still largely produced in Europe, however sales will grow more in Brazil, China and India where car manufacturers have been and continuously are setting up new production locations

Interview 16:

Date:	May 27, 2013
Industry:	Automotive
Type of interview:	Telephone
Position:	Global Carrier Manager

General Information:

- 40,000 metric tons per year, 4,000 tons of small packages, air freight share of total international transportation is around 50%, 50% of ocean freight,
- Continued small shift towards ocean in the future for air freight, also small shift towards consolidated air shipments from air express (small packages)
- Because of recession number of shipments is staying the same but weight per shipment decreased a bit

Customer:

- JIT deliveries are not playing such a big role, it depends if shipment relates to customer order or to replenish stock at warehouse
    - Customer order most often by air → because of the urgency there is no possibility for ocean freight
    - For stock order there is not too much rush → decision if by ocean or air, standard mode is ocean but if ocean transportation is not quick enough, then air will be used
- No E-commerce channels in terms of B2C, also not expected to happen in the future
- Sustainability has no impact on transport mode, however there is a focus on ocean transport,
    - sustainability becomes more and more important, therefore company tries to reduce transportation between supplier and plant and plant and customer (near sourcing, near shoring)

Product:

- average product is getting smaller and lighter in size but not much impact in the short term
- Packaging is still rather voluminous 'there is too much air in the packaging, big opportunity to use less voluminous packaging, furthermore, better optimization of boxes and consolidation in containers and pallets, reducing packaging has a big focus in the upcoming years
- Only a few products remain main deck, no change in the future, there are no specific airline products used, for time sensitive products airline products such as TD flash are used

Sourcing and production:

- continuing the trend of local sourcing to be closer to supplier, but also continuously going closer to customer, however this has already taking place, company is truly international and has been moving production were new customers have evolved over the last year
- supply chain disruptions have increased and triggered the move to be closer to customers and suppliers, furthermore company goes for dual or multiple sourcing because of supply chain disruptions

Distribution:

- less global distribution since company tries to be as close as possible to customer
- rather small mode shift from air towards ocean in the past but also future

- shift in type of service level from expedited services to deferred shipments due to higher costs → decline of premium freight
- aim to consolidate shipments to and from major gateways → streamlining of trade lanes

Interview 17:

Date:	May 28, 2013
Industry:	High tech
Type of interview:	Telephone
Position:	Manager Global Logistics Operations

General Information:

- Approximately 75.000 to 100.000 metric tons of air freight, of that 15.000 tons express (small packages)
- 6.000 metric tons → 600 TEU of ocean freight per year
- 125.000 tons by truck
- Air freight share of total international transportation is around 90%-95%

Customer:

- Demand is rather volatile, skewed to the end of quarters and because it is all build-to-order it is usually going by air freight
- Sustainability is important, especially for ground transportation in US and Europe, but would not change the mode goods are transported since it does not fit client requirements → at the end client comes first

Product:

- Products are expected to become bigger and heavier, most products come in a rack configuration (2m high, 500kg), increase in these products and less small products → shift from integrator to freighter
    - Especially for intra North America this drives the need for wide body planes
- Because more goods are transported by air, packaging has changed to wooden boxes instead of card boxes, other than that no major changes in packaging (such as getting less voluminous) expected in the future

Sourcing and production:

- Successful mode shift in the past from air to ocean on the inbound for parts from suppliers, however only a small percentage
- Air freight will be increasing and mainly driven by consolidating production to one or two global facilities to low cost areas (Mexico, China, Eastern Europe, Singapore) → global, company used to have local sourcing and production
    - Reasons: low cost labor as well as hard ware volumes have declined therefore it does not make sense to have the infrastructure in multiple locations to achieve scale economies
    - Most finished goods are in one or two plants for global demand → no localized production
- No shift at least at the moment to even lower cost countries/areas like Vietnam or Africa, because of undeveloped infrastructure, especially transportation, utility and IT infrastructure and security government corruption → the assessment of new production locations is done every two years
- Recent production shift from USA to Mexico → shift towards low cost countries
- Supply chain risk/disruption:
    - Increasing in the future

  - Did not have a big impact on the delivery of finished products
  - Inbound supply chain from parts suppliers has been causing disruptions in the past, but company and suppliers have now disaster recovery plans that are tested once a year (during floods in Thailand, company had no difficulties getting all its supplies)
  - Ash cloud, diverting via Southern European countries and trucking before or after

Distribution:

- No mode shift from air freight to ocean because it is very important to meet client requirements, most products are build-to-order, therefore ocean transport is often not possible
- Trying to increase the share of ocean transportation but unsuccessful in the past because of client requirements, only possible if the orders are not erratic and it is planned to deliver a number of machines over a certain time period to one client a shift to ocean is possible, but no structural mode shift
- Service level: business as usual perspective, most of the shipments go as deferred (non-expedited) transport, but within the last year and also in the future, shipments have seen strong increase in expedited services
  - Reason: to meet business partners sales out process
- Most freight goes either with integrator (small packs until 75kg) or with freighter (upper deck cargo because of size), commercial cargo (belly hold) has decreased
- Weight break of 75kg for deciding between integrator or commercial carrier/freighter will remain the same
- Trend towards leveraging and consolidating on major routes, if something has to be transported on smaller route it is tried to move via ground because of cost efficiencies and capacity constraints
  - Example: products to Italy are shipped to Frankfurt or Amsterdam and then trucked to Italy
- Rare use of charters, only for large scale and critical client orders (2 in the last year), it used to be more due to the change of transportation to a direct delivery model
- Growing markets with biggest opportunities are the BRIC countries, Africa is starting to grow and Middle East will grow faster in proportion to its size
- North American market is staying flat while the Western European market is actually declining, Argentina is also declining because of government policy (protectionism)

Interview 18:

Date:	June 20, 2013
Industry:	High tech
Type of interview:	Telephone
Position:	Senior International Transport Manager

General Information:

- 16.000 tons inbound Europe, → 60.000-70.000 tons of global air freight, expected to decrease because of product becomes smaller
- Air express rather small, around 2.000 tons
- Air share is around 15-20% in terms of volume, has been decreasing in the past

Customer:

- Number of shipments stays the same but the average shipments size decreased (referring to weight) since products are becoming smaller
- There is a small B2C market (depending on commodity) which is handled by integrators, there has been a rise in the usage of integrators and it is expected to grow in the future
- Sustainability is of less importance, costs are more important → nice to have, but difficult to be in line with costs, sustainability does not determine the type of carrier

Product:

- Products have been mostly decreasing in size and weight, however there will be a near end to this dematerialization → still it is a main factor for the decreasing air freight volume
- Products used to be shipped completely from plant to distribution center, now manual is added at DC also reducing the volume of air freight
- For the majority of products, once it has been moved to ocean it usually stays there, only a few exceptions where products were moved back to air
- Packaging is getting less voluminous, simultaneously it is expected from carrier to handle products with more care so less packaging can be used, i.e. reduction of plywood boards to

Sourcing and production:

- Shift towards regional sourcing, but depends per product
- Production usually takes place in one locations for the entire world (mostly in China), high end products are assembled near final consumer
- Company is investigating the option to move production to Vietnam/Myanmar but the infrastructure is not there yet → movement will not happen in the next 3 to 5 years, near term future production will stay in China

Distribution:

- Growth markets are Latin America and Africa & Middle East, Asia is static and Europe and North America is declining in sales → hence trade flows will change
- Certain products have been moved to Brazil for local market couple of years ago
- Especially for high tech products that are brought to market four times a year first batches are transported by air but also by sea→ near the middle of a quarter share of air freight is decreasing, in the past it used to be all air freight throughout the quarter
- Service levels are not expected to change, there are standard lead times, only small variations depending on demand of customer

- The number of touch points is reduced to disallow theft, preference direct flights and/or trucking to distribution center from large gateways
- Reduction of the number of gateways into Europe from 25 to 5, the same for other regions (LAX and ORD for North America), trucking from these points by direct delivery, i.e. products for Barcelona come in via AMS and are trucked directly, moving via big gateway and then trucking is usually more cost effective, i.e. stopped using CDG because handling was too expensive and now move everything via AMS
- Capacity used to be an issue to move to larger gateways, but now there is enough capacity to smaller airports
- It is tried to extend lead time for especially lower value products

Interview 19:

Date:	July 18, 2013
Industry:	High tech
Type of interview:	Telephone
Position:	Global Transport and Procurement Manager

General Information:

- Amount of air freight is around 40,000 tons per year
- Amount of air freight is decreasing, moderate mode shift happening and expected to continue in the next 2 years, after that slowing down
- Share of air freight around 20%
- Combination of ocean and air freight on same trade lanes, this enables to keep stock levels on a low rate, air freight often complemented in case of emergency or for maintenance and repair

Customer:

- No e-commerce available, does not fit the business model, no B2C
- Shipment size has not changed and are also expected not to change
- Sustainability is important (monthly CO_2 output is monitored) but costs and lead time are more important, therefore, sustainability is a second tier qualifier

Product:

- Weight and size of average product is decreasing, however the packaging cannot keep up and is therefore not getting smaller → packaging becomes more voluminous ('we sometimes ship by air')
- Big challenge to decrease the size of packaging in the future → it is expected that packaging becomes less voluminous in the future

Sourcing and production:

- Supplies are usually purchased outside Europe, usually Asia
- Shift of production has happened in the past from Western Europe to Asia, Latin America and Eastern Europe, Production that is still located in Western Europe is expected to be closed and moved to Asia in the future
- Most of the production locations are situated in India and China, No shift within China or to other low costs countries in Asia expected

Distribution:

- Mode shift has happened to a large extent but relatively slowly, it is expected that mode shift will continue in the next 2 years and then slow down
- There are still areas that have not been covered, many countries in Africa, Asia or Latin America are opening their markets (often project based)
- No change in the type of carrier type expected, however the number of carriers and logistic providers is consolidated
- No shift towards large consolidated amount of airports for entry or exit point, this decision is left with forwarder (cost and lead time is crucial)

Appendix F: Follow-up Questionnaire

Supply chain trends impacting air freight and air express

Introduction

Thank you for taking the time to participate in this survey.

Seabury Cargo Advisory is currently conducting a study on global supply chain trends impacting air freight and air express. The aim of this survey is to quantify the findings from a first round of in-depth interviews with shippers.

The survey should not take longer than 7 minutes. Your input is highly appreciated and the results of this study will be treated anonymously. After the study you will be informed on the findings of this survey by receiving a concise presentation.

Supply chain trends impacting air freight and air express

General Information

1. What is your company name? (Will be kept anonymous)

2. What is your job title?

3. If you would like to receive a concise presentation with the findings of the survey, please specify your e-mail address:

4. In which industry does your company operate? (Check all that apply)

- ☐ High tech
- ☐ Automotive
- ☐ Pharmaceuticals
- ☐ Fashion

Other (please specify)

5. Please provide an indication of the annual amount of metric tons / number of shipments / TEU and its expected annual growth in the next 3 - 5 years shipped by your company internationally:

	Metric tons / TEU	Annual growth
Air freight (metric tons per year)		
Air express (number of shipments)		
Ocean (TEU per year)		

6. Please provide an indication for your air freight share of total international transportation in tonnage (e.g. 40% air):

Air share (in %) of total international transportation in 2010

Air share (in %) of total international transportation in 2013

Expected air share (in %) of total international transportation in 2016

Supply chain trends impacting air freight and air express

Sourcing & Production

7. Are you expecting to source the majority of your supplies locally/regionally or globally in the next 3 - 5 years?

- ◯ Much more globally (>10%)
- ◯ A bit more globally (0% - 10%)
- ◯ No change
- ◯ A bit more locally/regionally (0% - 10%)
- ◯ Much more locally/regionally (>10%)

8. In terms of geographical locations for producing, manufacturing or assembling goods, what are the largest growth markets of your company in the next 3 - 5 years?

	Change
North America	
Europe	
China	
Mature Asia Pacific (Japan, Taiwan, Korea, Singapore, Australia)	
Emerging Asia (India, Thailand, Vietnam, Indonesia, Philippines)	
Latin America	
Middle East & Africa	

9. If there is an expected shift in production location, what are the predominant reasons? Moving production ...
(Check all that apply)

- ☐ ... closer to supplier (e.g. near-sourcing)
- ☐ ... closer to end consumer (e.g. near-shoring)
- ☐ ... to lower cost areas/countries (e.g. labor cost)
- ☐ ... to new industry clusters (e.g. Thailand for automotive)
- ☐ ... to new markets to gain market access
- ☐ ... to save high import tariffs

Other (please specify)

Supply chain trends impacting air freight and air express

Distribution

10. Are you expecting to distribute most of your finished products locally/regionally from various geographical locations or globally from limited geographical locations in the next 3 - 5 years?

- ◯ Much more globally (>10%)
- ◯ A bit more globally (0% - 10%)
- ◯ No change
- ◯ A bit more locally/regionally (0% - 10%)
- ◯ Much more locally/regionally (>10%)

11. In terms of geographical locations where do you expect a change in sales for finished products of your company in the next 3 - 5 years?

	Change
North America	
Europe	
China	
Mature Asia Pacific (Japan, Taiwan, Korea, Singapore, Australia)	
Emerging Asia (India, Thailand, Vietnam, Indonesia, Philippines)	
Latin America	
Middle East & Africa	

Supply chain trends impacting air freight and air express

Transportation of products

12. Are you expecting a modal shift in transportation from air to ocean or vice versa?

- ◯ Strong shift from air to ocean (>10%)
- ◯ Moderate shift from air to ocean (0% - 10%)
- ◯ No change
- ◯ Moderate shift from ocean to air (0% - 10%)
- ◯ Strong shift from ocean to air (>10%)

13. What are the predominant reasons for this shift in transport mode? (Check all that apply)

- ☐ Transport cost
- ☐ Need for faster transport because of slow steaming
- ☐ Increased demand for sustainability
- ☐ Comparable low air freight charges
- ☐ Supply chain is better managed
- ☐ Reliability of ocean vessels
- ☐ Changes in product life cycle
- ☐ Large mode shift has already taken place in the past

Other (please specify)

14. Are you expecting a shift of transport provider from air cargo carrier to integrator or vice versa?

- ◯ Strong shift from air cargo carrier to integrator (>10%)
- ◯ Moderate shift from air cargo carrier to integrator (0% - 10%)
- ◯ No change
- ◯ Moderate shift from integrator to air cargo carrier (0% - 10%)
- ◯ Strong shift from integrator to air cargo carrier (>10%)

Supply chain trends impacting air freight and air express

15. What are the predominant reasons for this shift in carrier selection? (Check all that apply)

- ☐ Difference in transport rates
- ☐ Changes in shipment size and frequency
- ☐ Increase in e-commerce and direct deliveries
- ☐ Integrators offer door to door transportation
- ☐ Policy to consolidate shipments to larger batches
- ☐ Change in the treshhold weight break that determines transport by air cargo carrier or integrator
- ☐ Need of freighter charters

Other (please specify)

16. Are you expecting a shift in air service level from express (time definite) to deferred (day definite) transportation or vice versa?

- ◯ Strong shift from express to deferred (>10%)
- ◯ Moderate shift from express to deferred (0% - 10%)
- ◯ No change
- ◯ Moderate shift from deferred to express (0% - 10%)
- ◯ Strong shift from deferred to express (>10%)

17. What are the predominant reasons for this shift in service level? (Check all that apply)

- ☐ Difference in transport rates
- ☐ Reduction of emergency shipments
- ☐ Risk of penalties for non-compliane to meet delivery dates
- ☐ Desired service level of customer is less time sensitive
- ☐ Importance of product launches

Other (please specify)

18. Are you expecting a shift from smaller / dispersed gateways to larger gateways (consolidated trunk routes) for air shipments or vice versa?

- ◯ Strong shift towards large gateways (>10%)
- ◯ Moderate shift towards large gateways (0% - 10%)
- ◯ No change
- ◯ Moderate shift towards small gateways (0% - 10%)
- ◯ Strong shift towards small gateways(>10%)

Supply chain trends impacting air freight and air express

Product development

19. Do you expect your products to change in the future in terms of:

	Strongly disagree	Mostly disagree	Neither disagree nor agree	Mostly agree	Strongly agree	Not applicable
Becoming lighter (Weight)	○	○	○	○	○	○
Decrease in size (Volume)	○	○	○	○	○	○
Less voluminous packaging	○	○	○	○	○	○
Higher value-to-weight ratio	○	○	○	○	○	○
Shorter product life cycles	○	○	○	○	○	○

20. Are there any key supply chain trends in your company impacting air cargo that we have not addressed? Please specify

Supply chain trends impacting air freight and air express

Thank You

21. Thank you for participating in this questionnaire. We highly appreciate your time and information. The findings of this questionnaire will be send in form of a concise presentation by September 2013.

If you would like to receive a concise presentation and you have not entered your e-mail address earlier, please specify:

Appendix G: Breakdown of geographical Regions

Table 32: Regions and corresponding countries

Region	Countries
North America	USA, Canada
Europe	Albania, Austria, Belarus, Belgium, Bosnia Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Greenland, Hungary, Iceland, Irish Republic, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Montenegro and Kosovo, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom
China	China
Mature Asia	Australia, Hong Kong, Japan, Macao, New Zealand, Singapore, South Korea, Taiwan
Emerging Asia	Afghanistan, Bangladesh, Brunei, Burma, Cambodia, French Polynesia & New Caledonia, India, Indonesia, Kazakhstan, Kyrgyzstan, Laos, Malaysia, Maldives, Minor Pacific Islands, Mongolia, Nepal, North Korea, Pakistan, Papua New Guinea, Philippines, Tajikistan, Thailand, Turkmenistan, Uzbekistan, Vietnam Sri Lanka
Middle East & Africa	Algeria, Angola, Armenia, Azerbaijan, Bahrain, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Dem. Rep. of the Congo (Zaire), Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Georgia, Ghana, Guinea, Guinea Bissau, Iran, Iraq, Israel, Ivory Coast, Jordan, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Rep. of the Congo, Reunion, Rwanda, Sao Tome, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syria, Tanzania, Togo, Tunisia, Turkey, Uganda, United Arab Emirates, Yemen, Zambia, Zimbabwe
Latin America	Argentina, Aruba & Netherlands Antilles, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guadeloupe & Martinique, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad & Tobago, Uruguay, Venezuela