

[CONFIDENTIAL]

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Shipbuilding with less shipping

A business case for the improvement of logistical activities and sourcing strategy in the supply chain of Damen Shipyards with particular attention to quality concerns


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Delft University of Technology, Transport Infrastructure and Logistics
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Summary

Nature of the research

Due to increasing cost pressure, disturbances from customs and an opportunity seen in reducing costs by increasing the procurement and construction in the Far East, Damen Shipyards Gorinchem is changing the requirements for its supply chain.

Changes to the supply chain however not only inflicts a large number of stakeholders, but the cost reduction through procurement in Asia gives an intrinsic difficulty: on one hand the costs of the components potentially decrease, but on the other hand the cultural differences and larger distances from the headquarters increase the cost and effort in assuring quality of the procurements.

This research improves the logistics and quality control in Damen's supply chain for a specific type of tugboat (ASD 2810) produced at Damen Shipyards Changde. The main research question is: *can the logistics and quality controlling activities in the supply chain of DSCh's tugboat ASD 2810 be improved, taking into account the increasing procurement and construction activities in Asia as well as the transparency of the Supply Chain?*

The main question is broken down into several sub-questions:

- Q.1 What trends are affecting the supply chain of DSCh's tugboat ASD 2810?
- Q.2 Who are the stakeholders in the supply chain of DSCh's tugboat ASD 2810 and what is their interest and power?
- Q.3 What are Damen's corporate policies and goals on their future supply chain?
- Q.4 What are the requirements for the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810?
- Q.5 How is the supply chain DSCh's tugboat ASD 2810 currently organized?
- Q.6 How can the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810 be improved?
- Q.7 What are the effects of the proposed improvements?

The improvements are scoped to the following topics:

- a. Who is (should be) doing the procurements?
- b. Is (should) Damen (be) applying a global- or local procurement strategy?
- c. Where are (should) Damen's warehouses (be) located?
- d. What transport modes are (should be) used?
- e. Which parties are (should be) arranging transportation?
- f. Where is (should) the quality (be) checked and by whom?

Methodology

In order to find answers to these questions, the research started with a analysis of the problem, the environment and the parties involved by interviewing stakeholders and a desktop research for trends. These findings were used to list the requirements for improvements.

In order to get to improvements, first the logistics and quality control in the current supply chain were analyzed. This was again based on interviews, and complemented with procurement data.

For the finding of improvements, the supply management theory by Kraljic (1983) was used as a basis. This theory prescribed strategies based on the value of supplies and complexity of the market.

In order to cover all subjects, it was expanded by theory on transport costs, interviews, and a desktop research. The improvements were evaluated by spreadsheet calculations.

Results

Applying Kraljic's supply management theory, as well as using information gained through interviews, got to several advises for rearranging supply flows: to shift the procurement of (part of the) high value and low complexity supplies, as well as (part of the) low value and high complexity supplies to Damen's procurement organization in Suzhou. In addition, the low value and low complexity supplies should become the responsibility of Damen Shipyards Changde. Damen shipyards Gorinchem stays responsible for the expensive and complex procurements.

When looking for suppliers in China, Damen should convince Western suppliers of important parts to start a local (Chinese) branch in order to reduce quality control costs. When looking for Chinese suppliers, special care should be taken to find suppliers both close to the yard as well as close to each other, to reduce both transport and quality control costs.

The research applies the *in-transit inventory carrying costs* when choosing a specific modality. By adjusting the ordering process to faster transport modes, costs can be saved.

The current warehouse location fits very well for the consolidation of shipments. It is however not advisable to start a warehouse in China, as the number of orders to be warehoused is limited.

By adapting the transport organization and the quality control organization to each other, additional gains are achieved in terms of reducing effort: it is proposed to transfer the responsibility for transportation to the suppliers, except when there has been no quality check to an important part.

From expert interviews, it is found that cultural differences increase the difficulty in quality control. For that reason, all Chinese supplies should be inspected twice at the supplier, in order to allow early detection of problems. The only exception is made to the very low value orders.

The advices reduce the costs on material procurements, logistics and quality inspections by about 1%. A cost reduction on the logistics and quality inspections is not significant. A vast reduction on the (chance for) disruptions through transport and customs is achieved, but emissions and energy consumption rise by about 14%.

Conclusion

This research indicates that expected gains in costs through local procurement are limited: costs reductions on logistics are low. Main benefits are to be found in the procurement costs. When implemented to all DSCh the measures would result in savings of € 280,000 to € 300,000, even up to € 380,000 to € 400,000 when the yard's production increases in the future. Local procurement however reduces fluctuations in the supply chain from transport and customs, hence indirectly reducing costs and risks.

In accordance to existing supply chain literature, this research has indicated the advantages of industry clusters to quality improvement and efficiency gains.

The conclusions of this research are applicable to any company producing standardized, but not fast moving, products in the Far East.

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1. Introduction

Damen Shipyards Gorinchem (abbreviated 'DSGo', 'Damen Shipyards' or 'Damen') is the main company in the Damen Shipyards Group (sometimes addressed to as 'Group'), one of the leading shipbuilding companies in the Netherlands. Being one of the first to implement global production, Damen currently sees opportunities to reduce both transport- and material costs, as well as transport time, by procuring an increasing number of components in Asia (Selles, 2012). These opportunities however require adaption of the supply chain organization.

For that reason, this research will look into possible improvements to Damen's global supply chain, to reduce the cost, the lead times, increase the value for the customers, while assuring the high quality, as the procurement in Asia increases.

In this research, a supply chain is defined as '*...a series of integrated enterprises that must share information and coordinate physical execution to ensure a smooth, integrated flow of goods, services, information and cash through the pipeline*' (Langley, Coyle, Gibson, Novack, & Bardi, 2008).

1.1 Complexities in improving the supply chain

There are several complexities when it comes to improving Damen's supply chain: firstly, the supply chain influences as well as gets influenced by a large number of parties and processes both outside and inside the organization. It contains interfaces between the core shipbuilding processes, the logistics, the marketing, sales, finance as well as the external suppliers and customers (Langley, Coyle, Gibson, Novack, & Bardi, 2008).

Secondly, there is an intrinsic difficulty in reducing the costs by procuring in Asia: on one hand the costs of the components potentially decrease, but on the other hand the cultural differences and larger distances from the headquarters increase the cost and effort in assuring quality of the procurements. Besides concerns on the quality, it may run up the overall costs.

1.2 Research objective and questions

The previous sketched opportunities and concerns will be researched in this report, by taking one of their mostly produced tugboats, the ASD 2810, as a business case. The subject is further limited to ships built at Damen Shipyards Changde (abbreviated DSCh), a yard that is one of the core production sites of the group. From now on, 'the supply chain' means the supply chain of tugboat ASD 2810's produced at DSCh. A more detailed reasoning for this decision is found in chapter 2.1, while both the ship type and yard are described in chapter 3.2.

The following objective for this research is derived: *to assess opportunities to improve the logistics and quality control activities in the supply chain of Damen Shipyards Gorinchem, by increasing procurement and construction activities in Asia, in order to reduce the cost and lead times while maintaining the quality level and taking into account the transparency of the Supply Chain.*

This is translated in the following main question: *can the logistics and quality controlling activities in the supply chain of DSCh's tugboat ASD 2810 be improved, taking into account the increasing procurement and construction activities in Asia as well as the transparency of the Supply Chain?*

The main question is broken down into several sub-questions:

- Q.1 What trends are affecting the supply chain of DSCh's tugboat ASD 2810?
- Q.2 Who are the stakeholders in the supply chain of DSCh's tugboat ASD 2810 and what is their interest and power?
- Q.3 What are Damen's corporate policies and goals on their future supply chain?
- Q.4 What are the requirements for the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810?
- Q.5 How is the supply chain DSCh's tugboat ASD 2810 currently organized?
- Q.6 How can the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810 be improved?
- Q.7 What are the effects of the proposed improvements?

A further elaboration on the scoping, definition and methodology that is used in this research will be given in the next chapter (chapter 2).

1.3 Structure of this report

First, this report will go into the scoping of the research' topic, providing both the boundaries and definitions used.

The report will then in chapter 3.7 find the requirements to improvements on the supply chain by first answering the first four sub-questions in an analysis of the problem environment. The concluding requirements will be the answer to the fourth sub-question.

In chapter four, the current supply chain of Damen's ASD 2810 will be analysed and the fifth sub-question will be answered. The fifth chapter will then compare the current situation to literature in order to find improvements.

These improvements will then be evaluated by comparing them to the requirements. This is done in the sixth chapter. Conclusions and recommendations then are provided in chapter seven.

The interrelations between the separate chapters, as well as the accompanying questions are visualized in the reading guide of Figure 1.1.

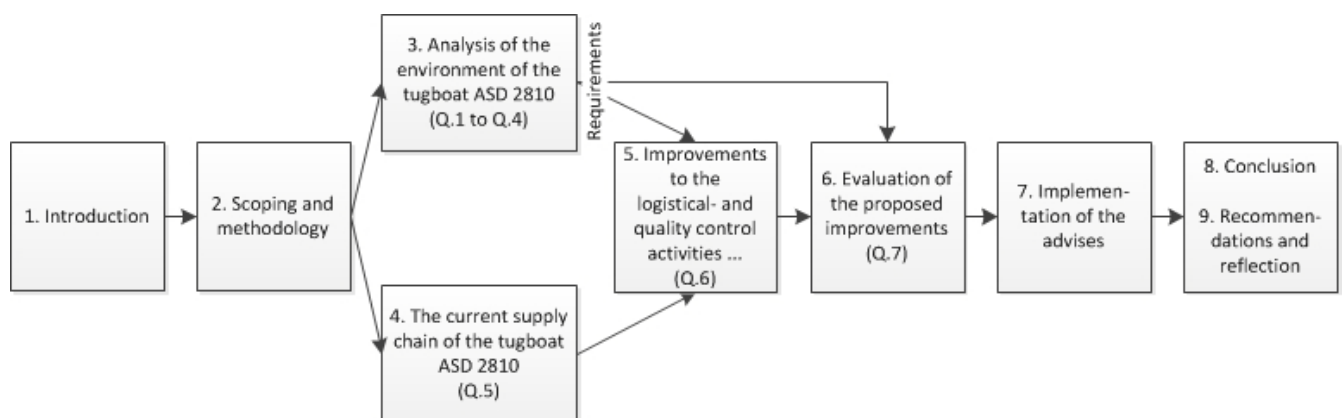


Figure 1.1 Reading guide

2. Scoping of and methodology in this research

This chapter first goes into detail on the scoping of the research, as without scoping the topic is too wide and vague to be covered in the time provided. Second, the methodologies applied and used in this research are discussed, as well as arguing why the chosen methods are suitable.

2.1 Scope of this research

When it comes to improvement of the supply chain, it is required to clarify what exactly is meant by improvement: this will be defined by the requirements of the stakeholders in chapter 3.7.2.

The analyses of the current supply chain (Q.5) as well as the improvements to the supply chain (Q.6) are researched on the following topics:

- a. Who is (should be) doing the procurements?
- b. Is (should) Damen (be) applying a global- or local procurement strategy?
- c. Where are (should) Damen's warehouses (be) located?
- d. What transport modes are (should be) used?
- e. Which parties are (should be) arranging transportation?
- f. Where is (should) the quality (be) checked and by whom?

This research is scoped at a tug boat type called 'ASD 2810' (also addressed to as 'the tugboat'): the reason for choosing this type is that it is very popular (over 100 vessels delivered until this date), so there is a large amount of historic data available. Also, the ship is produced in yards of which some located in the Far East, which makes the potential benefit of sourcing in Asia higher. A more detailed introduction to this ship type and its market will be given in chapter 3.2.

Damen is flexible in fulfilling the customers demand when it comes to the location of production. For this research to deliver results worth implementing, it is however important that the scoped yard will have a central role in the organization both now and in the future. As mentioned, a yard in the Far East will increase the potential benefit of sourcing in Asia. For these reasons, the research focuses on ASD 2810's produced in Damen Shipyards Changde (abbreviated DSCh), China. In chapter 3.1 a short introduction to this yard and Damen overall is given.

For this research, the supply chain of Damen Shipyards Gorinchem is further more considered according to the following boundaries:

- The supply chain in this research consists only of the flows that are part of tugboats of the type ASD 2810, build at Damen Shipyards Changde (DSCh). 'The supply chain' in this report refers to this scoped supply chain.
- The supply chain improvements will range from the first tier suppliers of the companies in the Damen Group to the delivery of the parts at the yard.
- The logistics at the production yard itself are considered out of scope.

2.2 Methodology

In order to achieve the objective of this research a specific set of methodologies is used. As a basis the supply management theory of Kraljic is used(Kraljic, 1983), which is used as a basic structure in the supply chain discussion throughout this document. The reason for choosing this theory, as well as a brief explanation and discussion, are found in paragraph 2.2.1.

Secondly, the methods used in the general analysis are described. These are the methodologies that finally result in the requirements for changes to the supply chain. This is found in paragraph 2.2.2.

This sub-chapter closes with the methods that will be used to map the current supply chain, as well as those used to advise on improvements. This is to be found in paragraph 2.2.3.

The overall structure of methods is visually summarized in Figure 2.2.

2.2.1 Kraljic’s theory on supply management

One of the most well-known theories on supply management and procurement relations is written by Kraljic (1983). This theory is used in this research to analyse and improve the supply chain based on the characteristics of the supplies itself. The theory’s generality makes it applicable to virtually any sort of environment in supplies or supply flows exist.

The basic idea of the theory is that it divides supplies over four types. The four types then are linked to four general focuses for strategies. Both are now discussed.

Types of supplies and supply strategies in Kraljic supply management framework

Kraljic is based on the ‘importance of purchasing’ and the ‘complexity of the supply market’ of parts.

The ‘Importance of purchasing’ is mainly considered the financial impact of the supply, or the financial risk. This is reflected by the cost of the materials.

The ‘complexity of supply market’ reflects the dependency of the company to its supplier: in a more complex market it is harder to switch to a competing supplier. The dependency depends on various characteristics, as the dependency is larger when, among others there is a monopoly within the supply market or that the supply is high tech or otherwise inflicts specific knowledge.

These two criteria result in four supply types, which are displayed in the so called ‘Kraljic Matrix’ in Figure 2.1. Kraljic defined generic strategies for all four types in his framework. A keyword summary of the generic strategies is added to the Kraljic matrix in Figure 2.1.

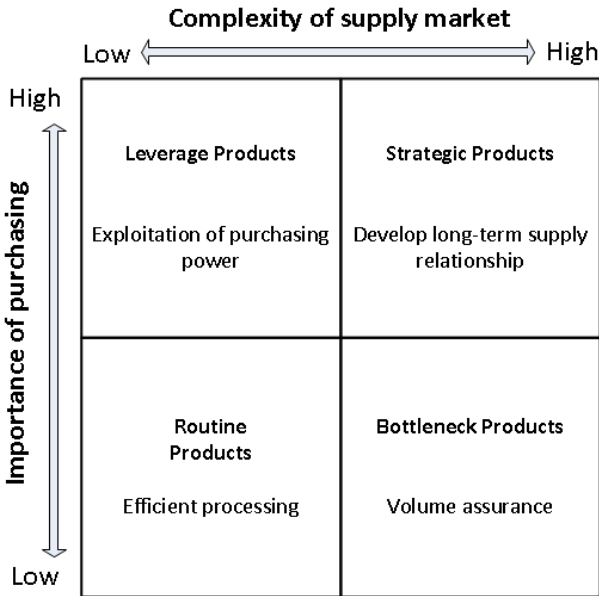


Figure 2.1 Kraljic’ framework on supply management, based on (Kraljic, 1983) and (Caniëls & Gelderman, 2005)

Operationalization of Kraljic's matrix

In order to translate and apply the method to Damen's situation the dimensions, and more important the distinctions between 'high' and 'low', should be known. Though in the original paper some examples are given the exact definition of the axes is subjective (Ramsay, 1996), especially in cases around the boundaries (Gelderman C. J., 2004).

In order to assess the importance of purchasing, the financial impact is taken. The exact distinction between 'high' and 'low' financial impact will be chosen based on the material costs of an average tugboat ASD 2810 (for a definition of the average tugboat, see paragraph 2.1.2). A quantification is provided in paragraph 4.1.1.

Defining the complexity of the supply market in practice shows to be even more variable (Gelderman C. J., 2004). The complexity, also defined as supply risk, can depend on a large number of variables. It would therefore be most specific to assess complexity on multiple criteria. However, inaccuracy comes in as the relative importance between these criteria then is required. For that reason, the complexity of the supply market is in this research brought back to the most core definition: *'the difficulty with which Damen can switch from their current supplier to another'*.

Ideally, rating the supplies would be based on consensus between experts (Gelderman C. J., 2004). As it turned out not to be possible to gather a group of procurers to discuss all items, the rating is done by sending a questionnaire to 14 of Damen's procurers (appendix C.3.1). They are asked to rate the items on a one to four scale: that way no item can be placed on the exact boundary between 'high' and 'low'. The response and outcome of the questionnaire is discussed in chapter 4.1.1.

2.2.2 Analysis of the problem: answering Q.1 to Q.4

The first four sub-questions are part of the general analysis, which aim to analyse the requirements for any supply chain improvements through the first four sub-questions. The consistency between the methods and questions for this part within the overall research is visualized in Figure 2.2.

The stakeholder analysis uses interviews with representatives of Damen's different departments and yards. The analysis itself is based on generally used techniques of stakeholder mapping based on their 'Power' and 'Interest' (for example (Hillson & Simon, 2007)). The overview of trends is based on both the interviews and a desk research. The corporate policies then are listed using a desk research.

When stating the requirements to the supply chain, the previous sub-questions come together: most demands of the most influential stakeholders are taken as need- and nice to haves, the corporate policies being one of the main interests of Damen's board. The trends influence the supply chain and therefore influence the need- and nice to haves.

2.2.3 Mapping and improving the supply chain (Q.5 to Q.6)

Before any improvements to the current situation can be made, the current status should be known. This insight into the current supply chain is mainly gained using interviews. These are used to get to know the stakeholder situation, the current flows, the current decision making trade-offs, etc. The consistency with the other methods in this research is visualized in Figure 2.2.

Insight into the flows within the supply chain will be provided by giving an overview of the costs and volumes of the flows. These will be based on Damen's procurement data. More on the data is described in paragraph 2.1.

Improvements on the transport mode are based on the overall costs, which are again based on the transport cost as well as the *in transit inventory carrying costs*. The transport mode itself will again be used as input for improvement of warehouse locations, as well as interviews with experts.

Deciding on global vs. local procurement, as well as the party responsible for procurement, is based on a Kraljic procurement matrix and interviews with Damen stakeholders. This theory was already described in detail in paragraph 2.2.1.

Last, improvements on the party responsible for arranging the transport as well as improvements on quality inspection and control will be based on scientific literature as well as interviews.

2.3 Data used in this research

To analyse the current situation, as well as to quantify decisions on improvements, data is used. The data used in each chapter is included in the visualization of Figure 2.2. This paragraph discusses the quality and limitations of the data used.

2.3.1 Lead times

When it comes to the lead times of components, Damen's Procurement Department has standard data per sort of component (Janssen, 2012). It should of course be taken into account that the lead times differ per supplier, but as the list is assembled with years of experience in the industry, it gives a true indication of the situation. This standard list is shown in Appendix C.2.

2.3.2 Procurement data

To get insight into the supplies and suppliers of the ASD 2810's build at Damen Shipyards Changde, procurement data of seven ships build is analysed (yard numbers 511540; -48; -49; -58; -59; -60; -61). This data is extracted from Damen's former ERP software (Janssen, 2012). When this chapter speaks about the 'average' ASD 2810, the average over these seven vessels is meant.

This data is not considered perfect: some prices are compensated in other classes (e.g. some parts have a symbolic price of € 0 or € 0.01, as the real costs have been accounted in another class). It is however not possible to retrace these costs, therefore causing errors in the data. The data however is considered satisfactory for getting insight in the situation and to divide the materials between high- and low value ones. However, as a result of the described inaccuracy, materials close to the boundary between high- and low value should be considered with care.

Though the ASD 2810's are standard vessels in Damen's portfolio, there are some differences between these ships. Most are minor, but two of the vessels are equipped with special fire fighting systems (De Rooij, 2012). As these are standard-options which are regularly applied to Damen vessels, it adds to the reliability of the data.

The separate parts and order-lines from the data are clustered per 'Class' in order to be analysed. This means that for example the separate parts in the rudder-propeller system are not visible, but aggregated to 'Rudder-Propeller'. These classes are standardized over the ships and are already noted in the orders lines, and thus in the procurement data. The tugboat ASD 2810 does contain 328 different classes of components.

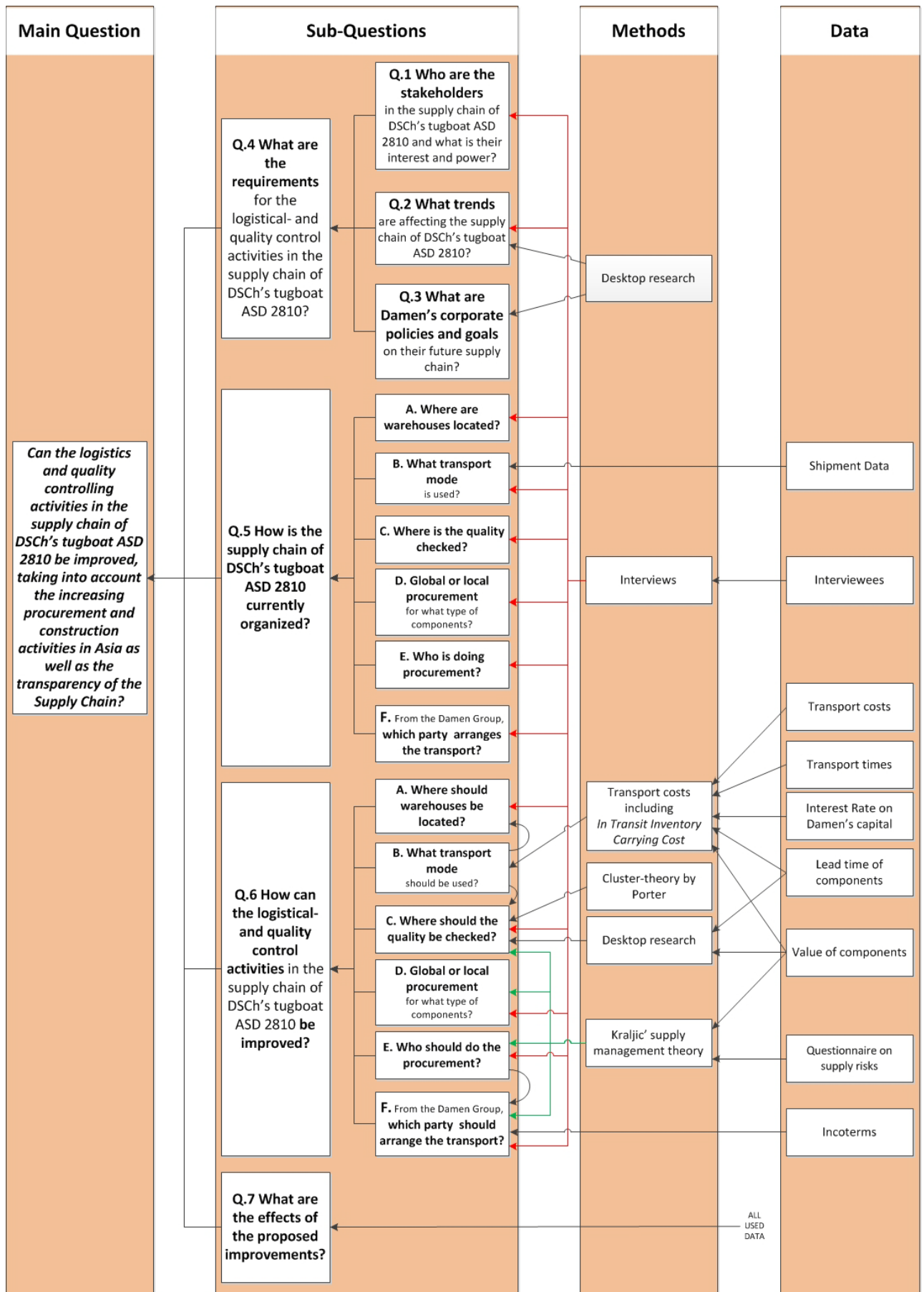


Figure 2.2 Consistency between the methods and research questions

The data on the procurements of DSCh (De Rooij, 2012) is aggregated on class level and is taken directly from the yard's accounting, specifically on the seven ships under research (the yard numbers mentioned above).

2.3.3 Flow data from DTS

Insight into the flows of DTS within the overall group turns out to be rather complicated: DSGo is the main customer to DTS, but orders for various production yards in the Damen Group. To get insight in final customer, was however not available for this research (Van Gelder, 2012). Procurements to the specific tugboats ASD 2810's in this research were available, as they are included in DSGo's dataset.

2.3.4 Transport costs and warehouse costs

Data on the transport costs are found and used in two ways: to assess the share of transport costs in the overall costs of a tugboat ASD 2810, and the way the transport costs are build up.

The first are taken from Damen's administration ((Vasie, 2012) and (Van Der Wal, 2012)), therefore being the complete costs per project for the project under research. Though this data is not detailed, it will give a good insight in the share of transport within a project's overall costs.

The warehouse costs also are taken from the administration (Van Der Wal, 2012). These global figures give insight into the warehouse's share of the costs, while more detailed insight into costs is gained by the budget of the first quarter of this year (De Bruijn, 2012). Earlier data is not accurate, as the implementation of the new ERP software too much disrupted the processes at that moment.

2.4 Sub-conclusion

This chapter has discussed the of this research, which is focussing on the following (sub-) topics:

- a. Who is (should be) doing the procurements?
- b. Is (should) Damen (be) applying a global- or local procurement strategy?
- c. Where are (should) Damen's warehouses (be) located?
- d. What transport modes are (should be) used?
- e. Which of the parties from the Damen Group are (should be) arranging transportation?
- f. Where is (should) the quality (be) checked and by whom?

The research is furthermore limited by the following restrictions:

- The supply chain in this research consists only of the flows that are part of tugboats of the type ASD 2810, build at Damen Shipyards Changde (DSCh). 'The supply chain' in this report refers to this scoped supply chain.
- The supply chain improvements will range from the first tier suppliers of the companies in the Damen Group to the delivery the parts at the yard.
- The logistics at the production yard itself is considered out of scope.

Last, the chapter has both shown and discussed the methods, as well as the data, that are used in this research. It has explained and discussed the limitations that arise from them, as well as how the methods contribute to the answering of the research questions. This was summarized by Figure 2.2.

3. Analysis of the environment of the tugboat ASD 2810

This chapter will describe the environment of the tugboats ASD 2810's supply chain in order to find the requirements for improvements to the supply chain.

The chapter will first provide an introduction to the topic by giving a brief introduction to Damen Shipyards and the Damen shipyards group (3.1); then specific to the tugboat ASD 2810 and its market (3.2); and the process of building a tugboat ASD 2810 (3.3).

Then the answer to the following sub-questions will be found: 'what trends are affecting the supply chain of DSCh's tugboat ASD 2810?' (Ch. 3.4); 'who are the stakeholders in the supply chain of DSCh's tugboat ASD 2810 and what is their interest and power?' (Ch. 3.5); 'what are Damen's corporate policies and goals on their future supply chain?' (Ch. 3.6). These answers then come together when the conclusion answers 'what are the requirements for the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810?' (Ch. 3.7.2).

The structure and overall coherency of this chapter is shown in Figure 3.1.

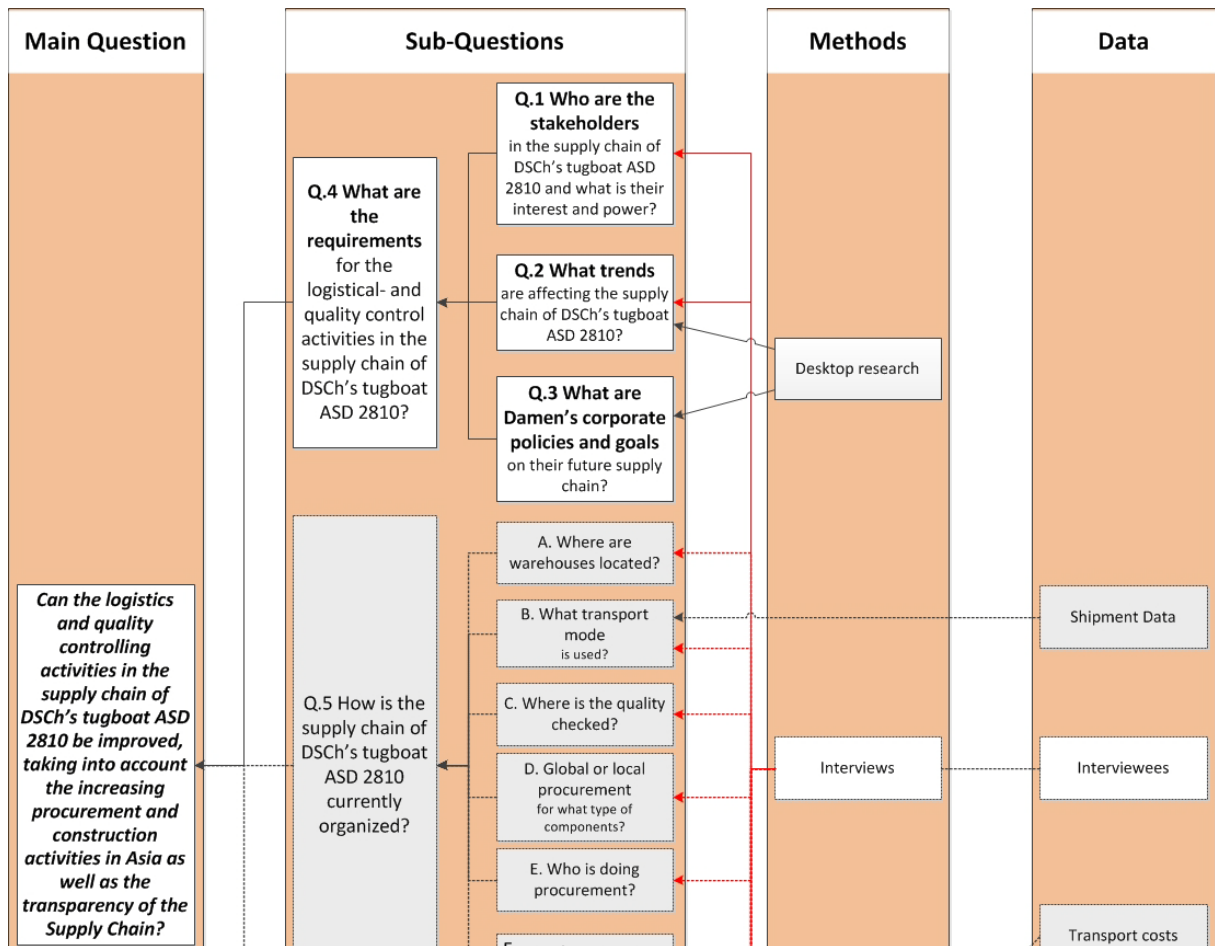


Figure 3.1 Consistency of chapter 3, its methods and data within the overall research

3.1 Introduction to Damen Shipyards Gorinchem and -Changde

Damen Shipyards Gorinchem (DSGo) has distinguished itself from the competition by recognizing the competitive advantages gained by standardized production. By using standard modules to build ships (the ‘Damen Standard’) shorter lead times, reduced costs and proven designs can be achieved (Damen Shipyards Group, 2011). DSGo is mainly active in the shipbuilding market for tugboats, workboats (of nearly all sorts), offshore and patrol vessels.

Damen Shipyards Gorinchem is the main company in the overall Damen Shipyards Group. It houses the groups headquarter and is responsible for creating synergy between several supporting services in the worldwide yards (e.g. management, procurement, logistics, ICT, etc.). Also it is doing sales and the majority of engineering. The group as a whole contains over 35 yards, of which 18 are foreign (Damen Shipyards, 2011).

The overall Damen group produces 120 to 150 ships per year, with over 150 hulls in stock (Damen Shipyards, 2011). Over half of the production consists of tug- and workboats, while a quarter are high speed craft and ferries (Damen Shipyards, 2011). The Damen Standard is still being applied, as dedicated yards produce hulls for popular ship types to stock (Damen Shipyards Group, 2011).

Currently, the company is producing over 90% of their products in a foreign country. The company for example was one of the first to start producing in Asia, with the start of Damen Shipyards Changde in China in 1994 (De Rooij, 2012). Changde is located nearly 1,000 kilometres inland of Shanghai. At this moment, the yard constructs 20 vessels per year and employs about 480 people, expecting vast growth in the coming years (see chapter 3.4) (De Rooij, 2012).

3.2 Profile of the tugboat ASD 2810 and its market

The Damen ASD 2810 is one of the most sold tugboats of Damen: over 100 are built yet. It is a multipurpose tugboat that is just over 28 meters long and 10 meters wide (hence the ‘2810’ typology). The delivery of an average tugboat ASD 2810 from DSCh costs about € 3,502,000 (Van Der Wal, 2012). A drawing of this type is shown in Figure 3.2.

The basic functions of this ship are push/ pull operations; escort towing; LNG terminal operations; and fire fighting operations. The ship’s design is highly standardized, but various options are available to optimize the vessel to perform according to the client’s needs. Standardized options contain for example fire fighting systems, different types of cooling systems, ice protection, etc.

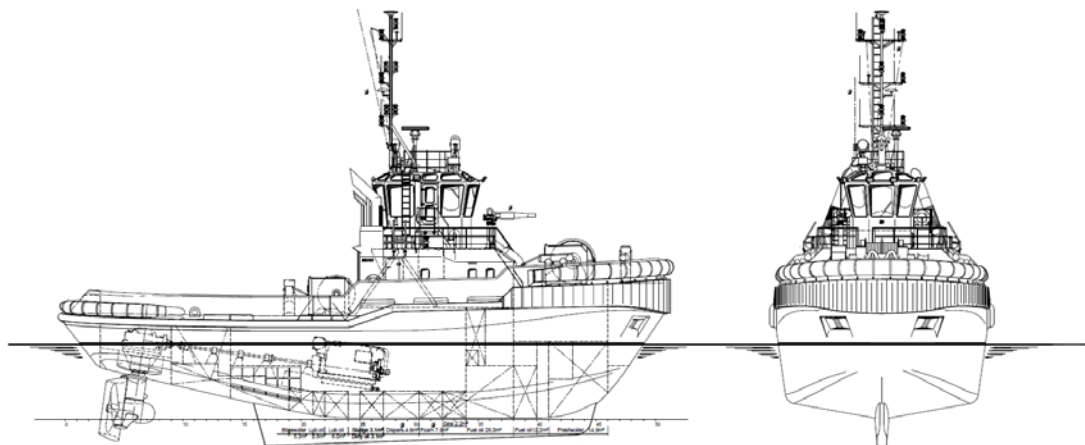


Figure 3.2 Drawing of the tugboat ASD 2810

Clients are mainly towage- and harbour service companies, but some ships are bought by (national) governments and ministries of Defence. In this market, the short lead time is of extreme importance: the towage companies order their ships only after they have been granted contracts for a new harbour. They therefore require the ships to be operational on a short term. It is thus important that Damen keeps its lead time shorter than the competition.

Secondly, Damen ships have a strong image that stands for high quality and a stable value. Damen assures this by giving warranty and to buy back old vessels (Damen Shipyards, 2011).

The client's focus on a quick lead time and high quality thus will be a major interest to a number of stakeholders.

3.3 Introduction to the shipbuilding process

The actions in the shipbuilding process are visualized in Figure 3.3, as well as the different parties that perform them. The scope of this research (flows from the first tier of suppliers to the delivery at the yard) is marked in the figure.

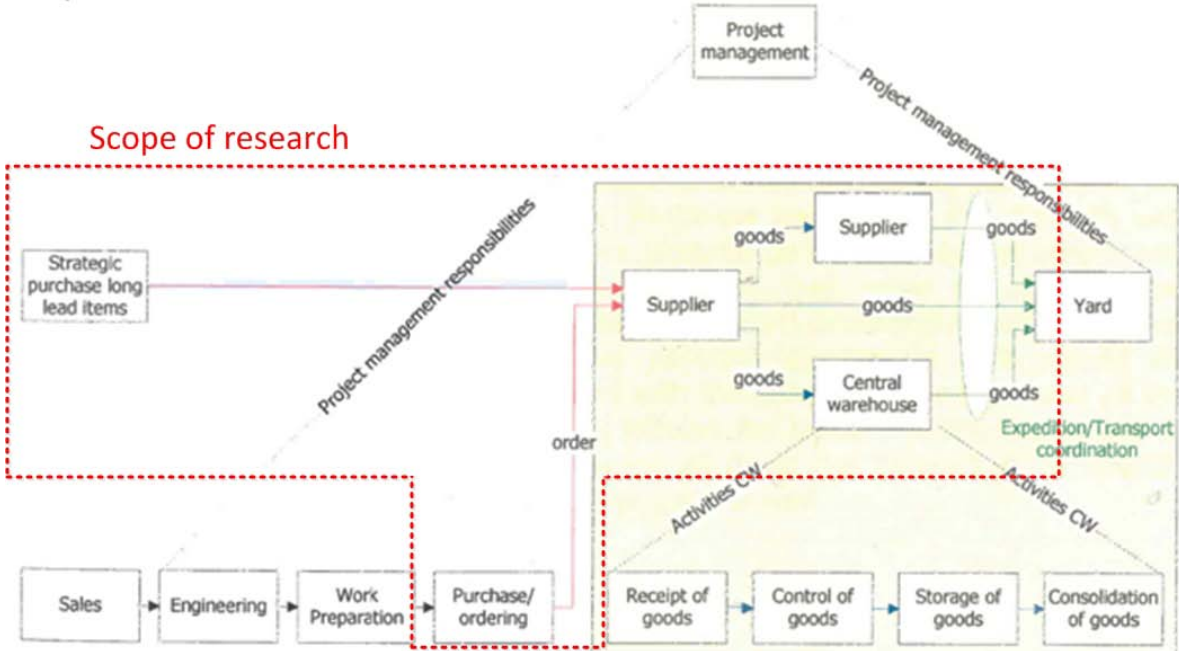


Figure 3.3 Sketch of the logistical process, circled is the scope of this research (based on (Van Dijk, 2009))

The process starts with an order. This order can originate either from an external customer or, when a ship is built to stock, an internal customer. As the most designs are standardized, the majority of the engineering work is already finished when an order comes in.

When looking at the sequencing of ship building from a time perspective, the (internal or external) order is followed by a design check on the rough design. At that time the strategic purchases are done (for parts with a very long lead time). All strategic purchases are characterized by high costs.

After this initial check, the details that are not standard are checked by engineering. At this stage also the parts engineered by suppliers are procured. When Damen’s Engineering department is finished, the detailed drawings are available. Material Coordination takes these drawings and lists from them the parts to be purchased, as well as plans them. Now also the ordered items are purchased.

The orders then are transported from the supplier to the central warehouse for consolidation, to another supplier for assembly in larger items, or delivered directly to the yard. From the central warehouse the materials are sent to the yard where the ship is produced, before it is delivered to the (internal or external) customer. If the ship is built to stock, the whole process may be started over if the final customer wants changes being done.

3.4 Trends affecting the supply chain of the tugboat ASD 2810

As some trends are, or can, influence the supply chain of Damen Shipyards and the ASD 2810 produced in Changde, this paragraph answers the sub-question: what trends are affecting the supply chain of DSCh's tugboat ASD 2810?

In general, there is a worldwide trend in transferring production to low cost areas, especially the Far East (Encorys, 2009). More technical complex projects are however still designed and produced in the West (Encorys, 2009). The founder of Damen himself expects that 50% of the shipbuilding capacity will move from Western Europe to the Far East in the coming years (Heynen, 2010).

Though exact numbers on the current status of the worldwide shipbuilding capacity in the industry is unknown, the (expected) production rate at Damen Shipyards Changde fits this worldwide pattern: the number of vessels produced in recent years has been growing, up to 20 per year at this moment, and It is expected that the production will increase to 40 vessels per year from 2012 (De Rooij, 2012).

As the production in the Far East increases, the industry in these low labour countries gains experience and develops fast. It results in more competitiveness in the shipbuilding industry, and in pressure on the prices of new build ships (Mickeviciene, 2011). The competition is increased as the financial crisis, among others, pressures cost in the shipbuilding market as well as on logistics and the supply chain (Hess, 2011). This results in an altering focus from Damen's clients, who transfer their cost pressure when buying and operating their ships.

Regarding delivery times, there is however no change in the demand of Damen's clients (Hertel, RE: veranderingen in lead times, 2012). The lead times of Damen's suppliers however gradually increase, as the crisis forces them to reduce capacity as well as being caused by the sheer growth of Damen itself (Den Boef, 2012).

However, as the wealth in the emerging countries rises, so do their wages (Malik, Niemeyer, & Ruwadi, 2011). Again, DSCh is also affected by this trend: in the past nine years, the wages nearly tripled (Chen, 2012). This rise possibly reduces the competitive advantage of producing or procuring in the Far East and as such influence the strategy of Damen.

In addition to the increasing wages a shortage of some natural resources arises, resulting in a cost increase in for example oil (U.S. Energy Information Administration, 2012). This will influence the cost of Damen's transport and logistics, but may also give advantages for products that are fuel efficient.

The current crisis has shown how volatile markets can be. In a reaction to the crisis, governments tend to react increasingly by protectionist policies, especially in China (European Central Bank, 2010). It results in higher cost, longer times and increasing regulations for importing goods in these nations. It therefore increases the supply chain cost and lead time for Damen.

In addition, the post 9/11 focus on reducing the terrorist threat has caused an increase in the strictness of the regulations by customs. It results in an increasing demand for detailed information on the shipped items and increasing limitation on the shipment of explosives and chemicals (Banks, 2008)(Thibedeau, 2007). To limit the administrative burden, customs increasingly builds on trusted partnerships (Accenture, 2010). To Damen, it results in an increasing complexity, as well as increasing costs, for the transportation to for example safety equipment and chemicals.

3.5 Stakeholders in the supply chain of the tugboat ASD 2810

To find requirements to any changes made to the supply chain, the requirements of the important stakeholders should be known. This paragraph therefore answers the sub-question: *who are the stakeholders in the supply chain of DSCh’s tugboat ASD 2810 and what is their interest and power?*

To gain insight in the stakeholders, an analysis is performed on the position of parties towards (changes to) the supply chain. It is based on the stakeholder’s power to influence changes to the supply chain for better or worse; and their level of interest in changes in the supply chain and its success or failure (Hillson & Simon, 2007).

Only powerful stakeholders have influence on (changes to) the supply chain and are therefore considered important. These are listed Table 3.1. It is seen that tension arises even from requirements of Damen itself: while on one hand the cost should be kept low, this trades-off with achieving a short lead time (quicker transport modes are more expensive) and the quality (more precise work costs more time and money). This tension is classically described as ‘Triple Constraints’ ((Meredith & Mantel, 2009) and (Project Management Institute, 2004)).

A description of all stakeholders as well as their motivations is included in Appendix A.1.

Table 3.1 List of the most important stakeholders and their criteria (in random order)

Stakeholder	Criteria
Tugs Product Group	<ul style="list-style-type: none"> • On time delivery of materials • Quality of deliveries (on specifications) • Costs reduction
General management	<ul style="list-style-type: none"> • Cost reduction • Lead time • Quality (delivery to specifications) • Sustainability • Employees’ wellbeing
Damen Shipyards Changde	<ul style="list-style-type: none"> • On-time delivery of materials • Quality of materials (materials according to specifications)
External Customers	<ul style="list-style-type: none"> • Maintain or improve cost/quality ratio • Lead time • On time delivery • Costs • Sustainability

Due to the trade-offs between these requirements (Table 3.1) they can never be completely fulfilled, but should be balanced. As the quality is considered essential for Damen to keep its attractiveness, this translates to the supply chain in such way that the quality (in this case: the delivery of components on specifications) is considered most important, followed by lead time and costs.

Satisfaction of the customer translates to the supply chain in such way that the client should not feel negative effects of changes in the supply chain: the client’s cost benefit ratio (their costs versus their

perceived quality or lead time) should at least remain equal. Summarized: the cost should be reduced, without any influence (but positive) to be noticed by the client.

From the interests of the general management, the corporate policies come into view: their implementation is one of the key requirements of the general management. These policies will be discussed in the upcoming paragraph (3.6).

3.6 Corporate policies affecting the supply chain

Due to the trends described in paragraph 3.4, Damen adapts their strategy and corporate policies on beforehand in order to stay on the competitive edge. The implementation of the policies is to be taken into account when listing requirements for the supply chain. Therefore, this paragraph answers the sub-question: *what are Damen's corporate policies and goals on their future supply chain?*

3.6.1 Product Differentiation

Damen distinguishes themselves from competitors on two unique selling points: 1) high quality vessels, with stable value; 2) short lead time. Both are achieved by the mentioned standardization and building to stock (chapter 3.1). these unique selling points therefore are to be safeguarded within any change to the supply chain.

3.6.2 Cost reduction

In the previous paragraph it is described that there is increasing competitiveness on costs. It is therefore no surprise that the company aims at increasing their competitiveness and viability by reducing material and transport cost (Van Dijk & De Bruijn, 2012). Cost reduction therefore is a must for the supply chain.

3.6.3 Outsourcing and procuring in Asia

Part of reducing the costs is the opportunity seen in increasing the amount of Asia based sourcing: it is thought to result in a reduction of material costs, logistical and transportation costs by 10.5%, as well as reducing the transportation time (Selles, 2012). A small number of supplies is already bought in China, increasing in the coming years (Slagmolen, 2012). Improvements to the supply chain should therefore take into account the increasing flow of materials from China, not only to DSCh, but to any yard in the Damen Group.

3.6.4 Increasing the transparency of the supply chain

A main focus in the current strategy is on improving the efficiency of the supply chain. For doing so, insight into the performance should be gained. Part of this policy is the implementation of new ERP software: it is the goal to cover the complete sourcing loop and all companies with the software in the future (Damen Shipyards Gorinchem, 2011). The objective to increase the insight to the supply chain should thus be a requirement, the availability of the ERP software be taken into account.

3.6.5 Four core operating companies

In their 2012 policy the general management has great focus on increasing the responsibility of four of the yards in which Damen at least has a controlling interest, of which DSCh is one. The production at these yards will be increased, clustering demand to these yards. Every yard will focus on certain ship types. The non-core yards will be used to handle peaks in demands (De Bruijn, 2012). The four core-companies will have extended responsibility, gaining their own engineering and more project management responsibilities.

The standardization of the ship types produced at DSCh, as well as the increased capabilities and responsibilities of the yard are to be considered when improving the supply chain.

3.6.6 Sustainability

The environmental impact is considered of increasing importance, both from customers as well as the company itself. The board of DSGo aims at the reduction of the environmental impact for every department (Damen Shipyards Gorinchem, 2011). One of the direct results is the aim of acquiring various standards on environment and safety (Damen Shipyards Gorinchem, 2012). An improvement of the sustainability thus is to be taken as an objective.

3.7 Sub-conclusion and requirements

The analyses in the previous paragraphs have answered the first three sub-questions. From the sub-conclusion on these questions, the requirements are selected. In this, the answer to the fourth sub-question is found.

First, the conclusions to the first three questions is discussed, followed by the conclusions on the requirements.

3.7.1 Sub-conclusion

The sub-conclusions are discussed per sub-question.

What trends are affecting Damen's supply chain?

This question is answered in Chapter 2.2. The following trends directly influence the implementation of the objectives and policies or the requirements of the stakeholders, thus being input for the requirements as well as to be taken into account when designing improvements:

- Increasing shift of production capacity to the Far East;
- The cost pressure on ships being sold;
- Increasing wages in China;
- Rising oil prices;
- Increasing protectionism of China and other countries;
- Increasing administrative effort for customs;
- Increasing limitations to the shipment of dangerous goods.

Who are the stakeholders in Damen's supply chain and what is their interest and power?

In paragraph 2.4 the main stakeholders and their requirements are found. In random order, the most important stakeholders are:

- General management;
- Tug- and Workboat Product Group (project management);
- Damen Shipyards Changde;
- External Customers.

These stakeholders have different criteria, of which the most important are:

- Customer satisfaction;
- Implementation of corporate policies;
- Cost reduction;
- Maintain or improve the current lead times;

- Maintain or improve the quality (i.e. delivery and construction to specifications);
- On time delivery of materials;
- Sustainability;

What are Damen's policies and goals on their future supply chain?

In sub-chapter 2.3 the answer to this question is found. Damen's main policy principles are:

- Distinguish from the competition on quality and lead times;
- Reduce the costs;
- Improve the sustainability;
- Expand sourcing in Asia;
- Increase the transparency of the supply chain;
- The standardization of the ship types produced in, as well as the increased capabilities and responsibilities of, DSCh;

It was concluded that the quality level and the lead times should be safeguarded, while costs are to be reduced. An increase in the volumes transported in Asia, as well as the increasing role of DSCh should be acknowledged, while the transparency should be increased.

3.7.2 Requirements

The foregoing answers result in the requirements on the supply chain for tugboat ASD 2810's, produced at Damen Changde Shipyards. The fourth sub-question thereby is answered: *what are the requirements for the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810?*

The requirements are divided in need-to-haves and nice-to-haves:

Need to have:

- Reduce the overall costs;
- Maintain or improve the current level of quality (i.e. the delivery up to specifications);
- Maintain or improve Damen's current lead time for delivering ships;
- Maintain or improve the transparency of the logistical- and quality control activities in Damen's supply chain;

Nice to have

- Improve the sustainability of Damen's supply chain;
- Reduce the impact of customs and security.

4. The current supply chain of DSCh's tugboat ASD 2810

This chapter analyses the current situation of the supply chain, in order to answer the fifth sub-question: *How is the supply chain of DSCh's tugboat ASD 2810 currently organized?*

To answer this question, this chapter first will give an overview of the values and geography in the current supply chain (chapter 4.1). This overview will then be used to define the dimensions of the Kraljic Matrix (see chapter 2.2.1) and match the supplies.

After the overview, the chapter goes into more detail on the six sub-sub-questions, which are:

- *Who is doing the procurements?* (Ch.4.2)
- *Is Damen applying a global- or local procurement strategy?* (Ch. 4.2)
- *Where are Damen's warehouses located?* (Ch. 4.3)
- *Which of the parties from the Damen Group is arranging transportation?* (Ch. 4.4.1)
- *What transport modes are used?* (Ch. 4.4.3)
- *Where is the quality checked and by whom?* (Ch. 4.5)

These findings then come together in the conclusion, answering the fifth sub-question.

The consistency of this chapter and its methods is displayed in Figure 4.1.

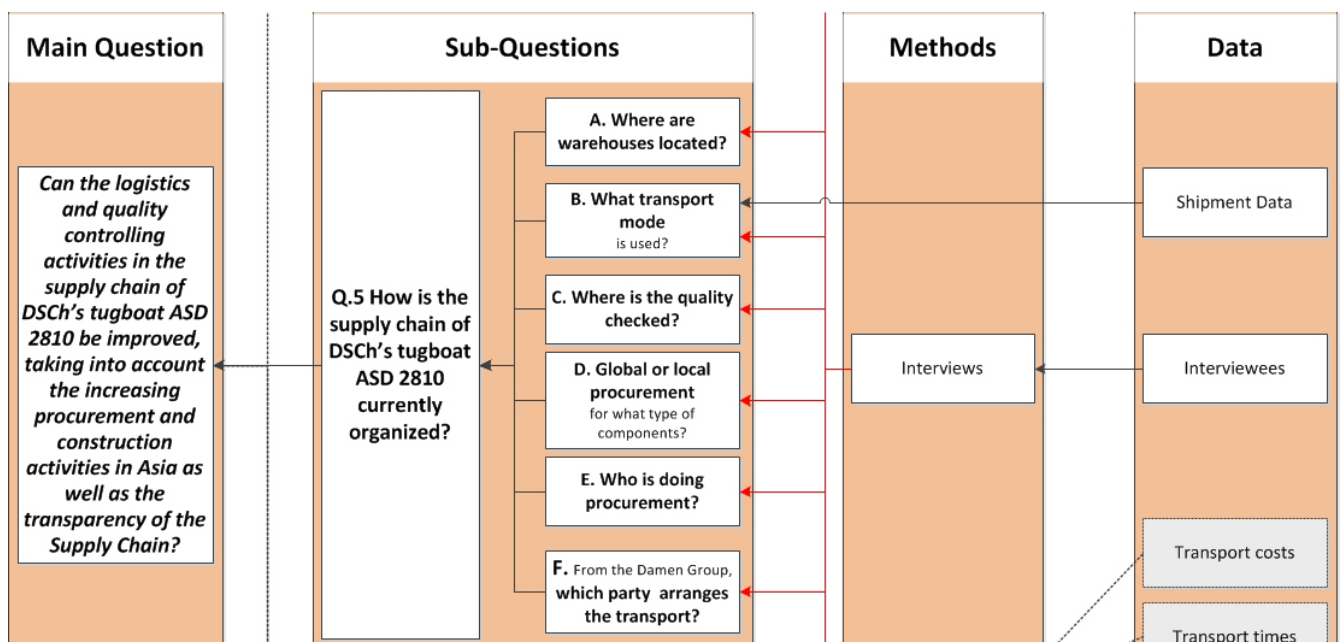


Figure 4.1 Consistency of chapter 4 and its methods and data within the overall research

4.1 Introduction to the current supply chain

To get feeling into the current situation, this paragraph briefly shows the geography, volumes, values and lead times at the supply chain of this moment.

4.1.1 Geographical mapping of the current supply chain

Currently, most of the supplies of DSGo are procured in the Netherlands. It is estimated that 80% of the suppliers is located within 50 kilometre of Gorinchem, 90% is located in the Netherlands and that 95% is located in Western Europe (Van Dijk & De Bruijn, 2012).

Inventory mainly is held at Damen's Central Warehouse in Gorinchem, where the consolidation is done. Inventory for production is held at the yard in Changde, as incoming deliveries are stored until used. Also, some components are shipped directly from the supplier to the yards.

Supplies arranged by DSCh all originate from Chinese suppliers. Most originate from East and South China, within a distance of 1,000 to 1,500 km from the yard (De Rooij, 2012).

Special notion should be made on the role of Damen Trading Suzhou (DTS): Damen's procurement company in China. The company is responsible for finding new suppliers and products, procuring items for other (Damen) companies and inspecting the quality of the procurements. DTS handles suppliers all over China, but the vast majority is located within the shipbuilding cluster in the Shanghai-Nantong-Hangzou area: a range of 300 to 400 km around Suzhou (Van Gelder, 2012).

The locations are visualized on a world map in Figure 4.2. More details on the trajectories of the flows are discussed in paragraph 4.3.

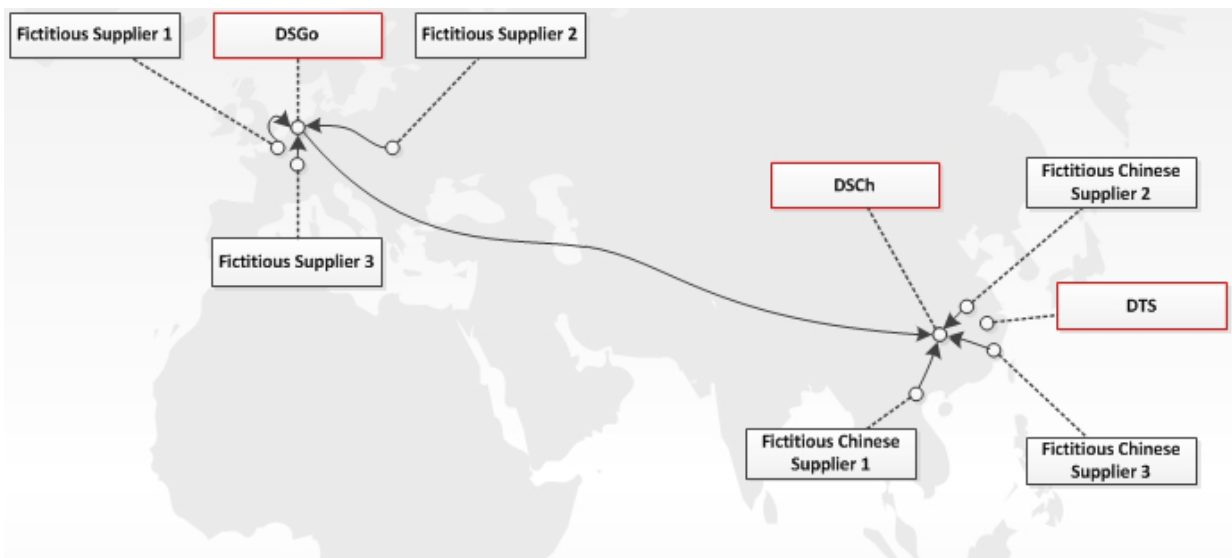


Figure 4.2 Visualization of the geographic flows in the current supply chain on a world map (supplier-to-supplier flows are not shown for the sake of readability)

4.1.2 Supply values in the current supply chain

In total, DSGO's supply chain for an average tugboat ASD 2810 build in Changde consists of 1,087 Purchase Order Lines (PO Lines). A PO line represents an order for a certain kind of product. One order may contain a larger quantity of products. All parts and order lines are divided over 356 classes in total (for a definition of a class, see paragraph 2.1.2).

On average, nearly 75% of the costs of DSCh's ASD 2810 arise from the material costs. The majority of costs are made by procurement through DSGo: on average, € 2,144,000 (82%) of the procurements. This is with 328 classes and 138 suppliers. The material costs for DSGo consists mostly of the Engines; Rudder-propeller systems, winches, electrical systems, 'miscellaneous' (containing mainly certifications) and generators (Janssen, 2012). See Table 4.1.

DSCh is responsible for € 424,000 (17%) of the procurements (€ 1 = ¥ 7.9407 (ECB, 2012)). About 5% of these are transportation costs. The majority of the material costs by DSCh are spent on steelwork, fuel, oil, paint and fenders (De Rooij, 2012). In total, they procure 28 classes. See Table 4.1.

For the ships under research, DTS has delivered six PO lines in two classes: doors and anchors. These had a value of € 9,200 (Table 4.1). Note that the orders to DTS were placed by DSGo (Janssen, 2012).

Table 4.1 Comparison of the procurements by different parties

	Procured value		No. Of classes procured
DSGo	€ 2,144,000	(82%)	328
DSCh	€ 481,000	(18%)	28
DTS	€ 9,200	(0%)	2

Looking at all the parts of the tugboat ASD 2810 together, 75% of the material costs arise from only 11 classes (Figure 4.3). On a slightly bigger scale, it is found that over 90% of the costs come from only 10% (that is, 35) classes. As this is an extensive list, it is placed in Appendix C.

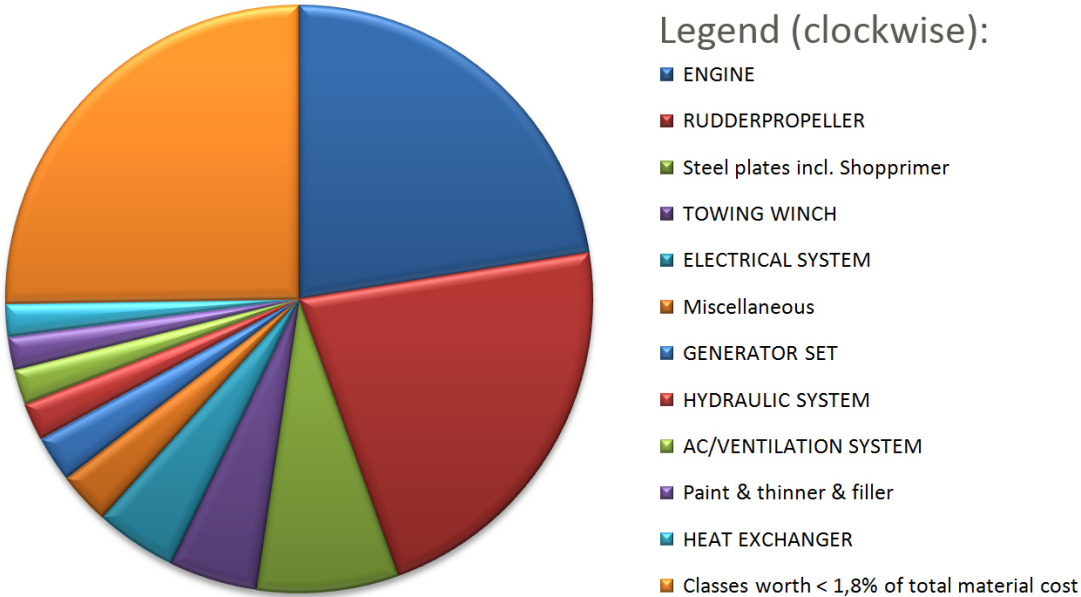


Figure 4.3 Average distribution of the cost over classes of parts, on an average tugboat ASD 2810 (for clearness, components worth <1.8% of total material costs are aggregated)

Most materials procured by DSGo on an average ASD 2810 cost between € 20 and € 50. Furthermore, 77% of the supplied volume has a value of under € 100 per unit (see Figure 4.4). This shows that the majority of the materials in the supply chain have not such a high value, while the overall costs are dominated by the high value parts (Janssen, 2012).

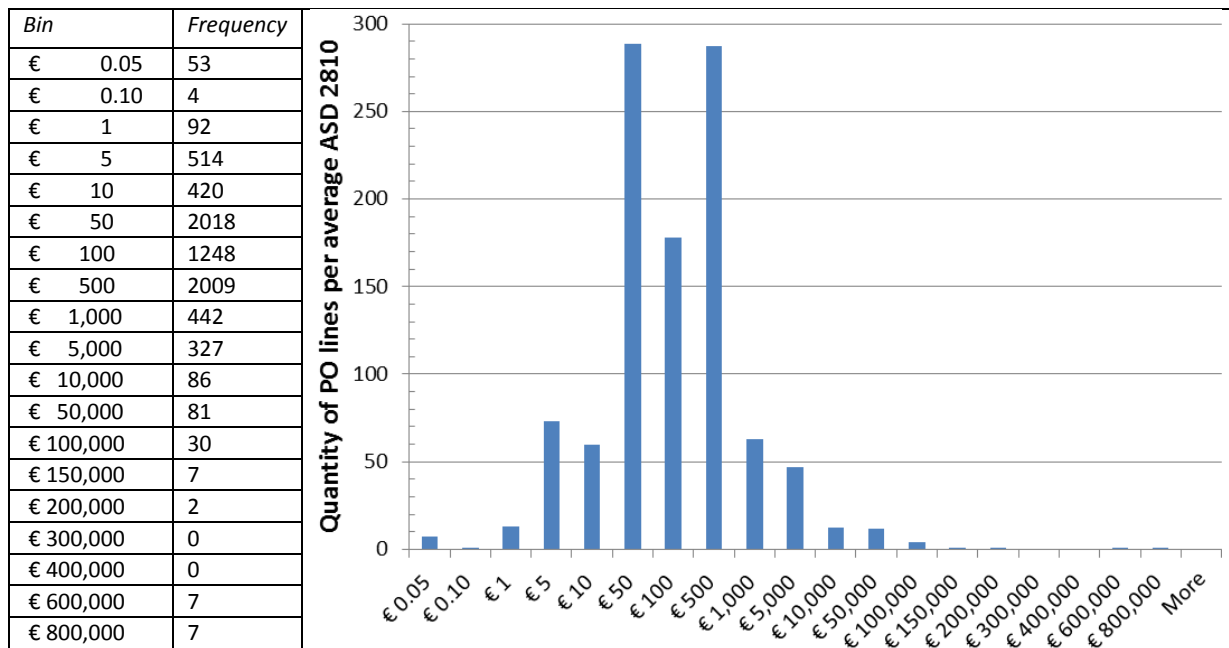


Figure 4.4 Histogram of the number of PO lines within a cost-per-part range as procured by DSGo per average ASD 2810

4.1.3 Lead times in the current supply chain

When looking at the standard lead times for components, one sees that the vast majority of parts acquired by DSGo only has a 6 week lead time until delivery in Gorinchem (Figure 4.5).

Three parts have the maximum lead time of 25 weeks: the engine; the gearboxes and couplings. The rudder-propellers have a lead time of 20 weeks, while most electric equipment arrives 16 weeks after ordering. Simple, widely available parts (e.g. mounting materials and basic safety equipment) have a lead time of six to eight weeks (Janssen, 2012). A list of all lead times is added in Annex C.2.

It must be noted that the lead times of suppliers is increasing, partially due to the crisis (suppliers cutting unnecessary capacity), but also due to Damen's increasing demand on their suppliers (Den Boef, 2012). Last, the mentioned lead times do not necessarily apply to specialised one-off supplies.

4.1.4 Defining the dimensions and boundaries in the Kraljic matrix

To apply Kraljic's theory for supply management to the supply chain of the tugboat ASD 2810, a clear definition of the dimensions is needed in order to match the products in the supply chain to the typology used in Kraljic's theory.

Defining 'high' and 'low' financial impact

Though the variable on the financial impact is straight forward to measure (the costs), the deviation between 'high' and 'low' is not. For this research, it is based on the discussed data (4.1.2).

To prevent subjective boundaries on this axis, literature advises that in most cases there is a pareto effect in the distribution of the cost (Gelderman C. J., 2004). A 80-20 rule of thumb however is not found within DSGo's supplies for the ASD 2810, but a slightly adjusted boundary is found by adjusting this rule of thumb: as described (4.1.2), the 10 % most valuable classes of supplies bring over 90% of the costs. Hence, parts within this 10% are considered of high financial impact; the other 90% is considered of low impact. The complete list of items of high impact is shown in Appendix C.1.1.

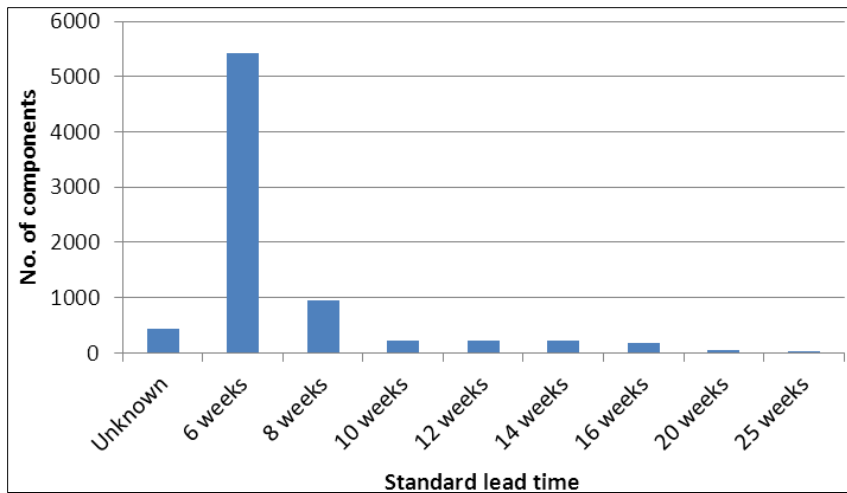


Figure 4.5 Distribution of parts over lead times for parts procured by DSGO, on average per tugboat ASD 2810

Defining 'high' and 'low' complexity

Defining the complexity is a very subjective matter. As was explained in paragraph 2.2.1, the decision on whether parts are of high or low complexity is based on a questionnaire to procurers. One exception is made, as the class 'Miscellaneous' cannot be matched at all: though it mainly consists of classifications, it is so diverse that it is not possible to rate their complexity all at once.

In the questionnaire (placed in appendix C.3.1) the complexity of 37 groups of items is regarded: the items that are currently regarded by Damen as routine items (which in the current situation are just ordered) are not taken into reviewed: these items are in essence of low complexity.

Due to this questionnaire, 16 groups of products have been rated as complex. For the sake of readability, the entire list of results is shown in appendix C.3.2. It returns in the following sub-paragraph when the different types are discussed.

It must be noted though, that this survey only takes the procurement situation into account. Sometimes, the resulting image will be incomplete: for example the steel market is not complex, but the efficient cutting and transportation indeed is.

Table 4.2 Examples for each supply type in the supply chain for DSCh's ASD 2810

<p>Leverage products 21 classes. Examples:</p> <ul style="list-style-type: none"> - steel plates - pipes - paint - fenders - Windows 	<p>Strategic Products 13 classes. Examples:</p> <ul style="list-style-type: none"> - (main) engines - rudder-propellers - gearboxes - towing winches - electrical system
<p>Routine Products 309 classes. Examples:</p> <ul style="list-style-type: none"> - Pneumatic controls - Tools - (internal) doors - sanitary tap - anchor 	<p>Bottleneck Products 5 classes:</p> <ul style="list-style-type: none"> - Radar system - Navigation equipment - valves - Ropes for lifesaving equipment - hydraulic couplings

Matching products with Kraljic's typology

The overall list of each type's products from the ASD 2810's supply chain is placed in Appendix C.4. Examples of each product type are shown in Table 4.3.

4.2 Procurement strategy and responsibility in the current supply chain

This paragraph answers the following two sub-questions: 'Who is doing the procurements?' and 'Is Damen applying a global- or local procurement strategy?'

At this moment, within Damen both a global and local procurement strategy is used: local procurement by DSCh; global procurement by DSGo; and global procurement through DTS. Before going into detail however, these terms first will be defined.

4.2.1 Definitions of local- and global procurement

In this research, the definition of global procurement is synonym to global sourcing. The definition used here, is: "the process of identifying, developing, and utilizing the best source of supply for the enterprise, regardless of location" (Kharvi, 2012). Note that global procurement thus not necessarily inflicts centralized procurement. This principle is visualized in Figure 4.6.

This report uses the following definition of local procurement: "procurement of supplies or services in the same country as the location of delivery, by other than a centralized purchasing office" (based on (Parker, 2003)). Local procurement thus in essence is decentralized. The definition is visualized in Figure 4.7.

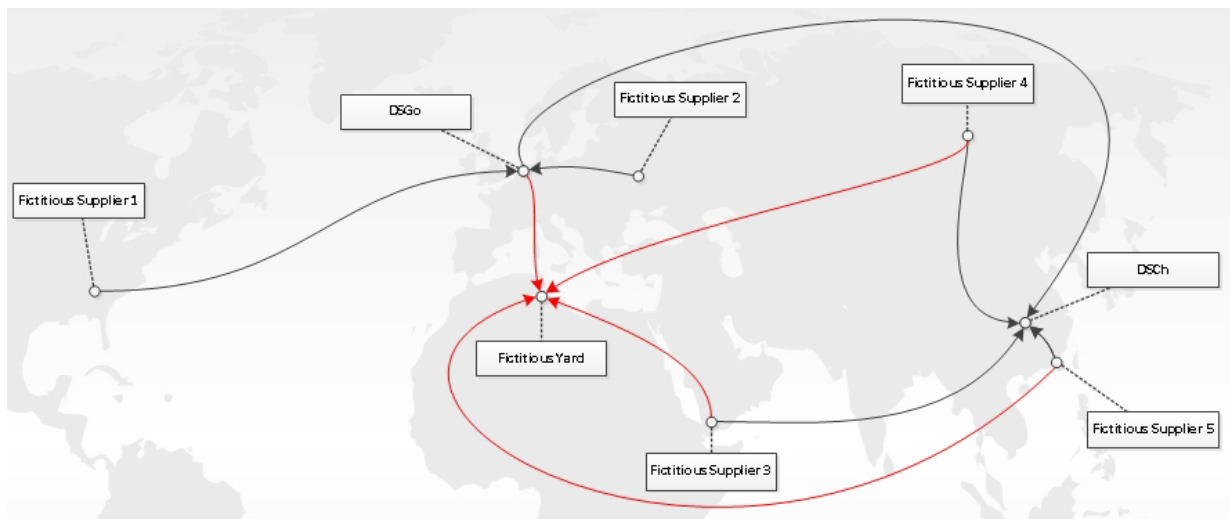


Figure 4.6 Visualization of the global sourcing principle



Figure 4.7 Visualization of the local sourcing principle

4.2.2 Global procurement by DSGo

The main flow of materials is procured by DSGo, containing both items of low- and high complexity, as well as high and low value. At the moment of writing this report, all sets (components engineered to order by suppliers) are procured by DSGo. As however will be described later (see 4.2.4), it is expected that within the near future, some sets will be procured through DTS (Van Gelder, 2012).

In theory the supply of materials to DSGo is open to contractors from any location, but currently the majority of suppliers is located close to Gorinchem in the Netherlands, nearly all being located in Western Europe (see paragraph 4.1.1). In practice the current strategy on procurement by DSGo is therefore not to be called purely global, nor is it purely local.

The procurement for DSGo is done by a dedicated procurement department.

4.2.3 Local procurement by DSCh

There is a standard demarcation that prescribes the division of procurements by DSCh and DSGo. The yard procures all its components from local suppliers, but it must be noted that 'local' in this case means a distance of 1,000 to 1,500 km from the yard (De Rooij, 2012).

As was briefly mentioned in the previous paragraph, a part of the materials are procured by DSCh: nearly 18% of the value arises from local procurements. The demarcation contains items of low complexity, such as for example: the steel plates and profiles; paint; oil and greases; fenders; and the wooden panels for the interior (De Rooij, 2012). The list of materials for which DSCh is responsible is constantly expanded when new components are found that are cheaper, but at least of similar quality as the ones from current Dutch suppliers (De Rooij, 2012).

For the procurements, DSCh has two dedicated procurement agents that visit (potential) suppliers and place the orders (De Rooij, 2012).

4.2.4 Local and Global procurement through DTS

The third procurement organization in this research is DTS. For the supply chain of DSCh, the supply through DTS is local procurement: DTS is located in the same country and is for them not a centralized procurement organization in the country. DSCh may choose to procure items using DTS or to find their own supplier (Van Gelder, 2012). To the supply chains of products and companies not producing in China, DTS is however part of a global procurement strategy.

Currently, parts for a large number of Damen vessels other than the ASD 2810 are already procured DTS, though very limited in the vessels in this research: For DSCh's tugboats ASD 2810, DTS has only been responsible for some doors and anchors. However, when looking to list of items DTS provides to other Damen yards it contains, among others: fenders; pipes and other steelwork; hatches; pyrotechnics; and winches (Slagmolen, 2012).

The current Asian supplies thus are not very complex. It is expected that in the near future the amount of procurements through DTS will rise and will include Sets (i.e. components engineered to order) ((Slagmolen, 2012) and (Van Gelder, 2012)).

4.2.5 Sub-sub-conclusion on the procurement strategy in the current supply chain

These parts looked at the sub-sub-questions: *'Who is doing the procurements?'* and *'Is Damen applying a global- or local procurement strategy?'*

At this moment, within Damen both a global and local procurement strategy is used: local procurement by DSCh; mainly global procurement by DSGo; and both through DTS. Later on, chapter 5.1 will reflect on this strategy using supply management literature.

4.3 Trajectories and warehouses in the current supply chain

This paragraph answers the following sub-question: *Where are Damen's warehouses located?* First the trajectories are described, followed by a description of the warehouse locations. By quantifying the described flows the paragraph is concluded.

4.3.1 Different trajectories within Damen's current supply chain

At this moment, there are eight trajectories within the physical supply chain towards Damen Shipyards Changde. These eight trajectories are all combined in the current supply chain:

Parts procured by DSCh and ...

1. ... shipped from supplier to supplier to DSCh
(e.g. steel plates);
2. ... shipped from supplier to DSCh
(e.g. fendering; doors).

Parts procured by DSGo and ...

3. ... shipped from supplier to supplier to DSCh
(e.g. larger propeller shafts. Not very common);
4. ... shipped from supplier to DSGo's warehouse to DSCh
(e.g. radars; safety equipment; etc.);
5. ... shipped from supplier to DSCh
(e.g. main engines; winches);
6. ... shipped from supplier to DSGo's warehouse to supplier to DSCh
(e.g. some control panels. Not very common);
7. ... Shipped from supplier to supplier to DSGo's Central Warehouse to DSCh
(e.g. control panels; fire fighting pumps);
8. ... shipped from supplier to DSGo's warehouse to supplier, over DSGo's warehouse to DSCh
(e.g. tyres for fendering).

Parts procured by DTS and

9. ... shipped from supplier to DSCh
(e.g. anchor cables).

The only return flows in the current supply chain consist of empty containers: as Damen only uses Line Owned containers towards Changde, which are returned to the shipping line once unloaded.

At all times the overall project management, and thus the management of the supply chain is performed by DSGo. The detailed management and planning of the construction activities is done by the management of Damen Shipyards Changde.

The choice of shipping directly or over a warehouse is based on the weight and volume of the materials: the rule of thumb is that an order that weights over 4 tons or is larger than 10 m³ should be shipped directly from the supplier to the yard (Peurseem, 2012). When items are purchased by DTS, transportation is always done directly. Only it is sometimes consolidated at a supplier with orders for other projects at DSCh (Van Gelder, 2012).

It must be noted that all Damen's current inventory, and even procurements, are linked to a project. There thus is currently no strategic- or safety stock.

4.3.2 Warehouse locations in the current supply chain

From the previous sub-paragraph, the following warehouse locations are found in the flows:

- At DSCh
All materials, regardless which party procured them, are stored at the yard until needed for construction. Procurements of DSCh and DTS are never warehoused other than after delivery.
- Gorinchem Central Warehouse
For part of the items procured by DSGo’s procurement department, a 6,000 m² warehouse is held in Gorinchem (the central warehouse). After delivery these items are stored in a (separate) warehouse at the yard, until needed for construction.

4.3.3 Quantification of the flows over the warehouses

The vast majority of the orders procured by DSGo are shipped over the Gorinchem warehouse, about 91%. Only 12 of orders were shipped directly, however containing 18% of the value. Though number of PO lines seems low, one should keep in mind that most of the direct deliveries are large in weight or size. The low number of order lines thus represents a large number of containers. Last, there are 'additional deliveries', which contain backorders, spares, repairs and such. This is summarized in Table 4.3.

There are no items procured by DSCh that go over a warehouse in the current situation, except for the storage at the yard itself. The same holds for supplies procured by DTS.

Table 4.3 Quantification of the different flows procured by DSGo for the average ASD 2810 build at DSCh (4% of the orders, containing 5% of the value, cannot be linked to a shipment)

	Deliveries over warehouse	Additional deliveries	Direct Deliveries
No. of PO lines	1,011 (91%)	43 (4%)	12 (1%)
Value	€ 1,639,000 (76%)	€ 14,000 (1%)	€ 378,000 (18%)

4.3.4 Warehousing Costs

Warehousing not only lowers the transport costs by consolidation, but also inflicts additional costs. These costs are shown by the direct costs, which are linked by labour hours to the specific project. The cost for the hours is set such, that it roughly covers the overall costs of the warehouse.

The direct warehousing costs per ship in this research are on average about € 19,000 (Van Der Wal, 2012). This is 1.16% of the value of the goods transported, and about 0.6 % of the overall budget per ship. Per PO line, that is € 18.95. To put this number in perspective: the average PO line warehoused has a value of € 1,621.

A reduction in the number of PO lines is however not linearly related to short term cost reductions. Looking at the warehouse’s budget and balance (Figure 4.8.), one finds that in the first quarter the majority of the warehouse’s budget (just over 80%) comes from the personnel costs (both Damen and external), followed by facility costs (nearly 15%). Any reduction in the number of PO Lines to be warehoused, would on short term only result in a reduction of the ‘other’ personnel costs, while on the long term also the other personnel as well as the fixed cost will be reduced.

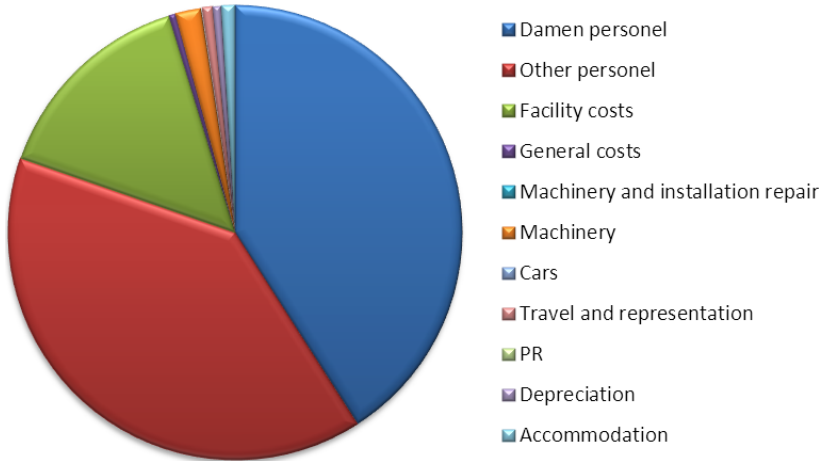


Figure 4.8 Distribution of the warehousing costs over cost centres

4.3.5 Sub-sub-conclusion on warehousing in the current supply chain

This part looked at the sub-sub-question: 'Where are Damen’s warehouses located?'

In the current supply chain, inventory only is held in Gorinchem and in Changde. From the parts acquired by DSGo, the majority goes over their warehouse (all items under 4 tons or smaller than 10 m³). Every item passes the warehouse at DSCh.

Damen only has items in its warehouse, which are linked to a (future) project.

Warehousing only represents a small amount of the costs per ship (≈0,6 %). About 80% of the costs are variable and therefore can be linked to the number of parts put through the warehouse. The current costs per PO line are € 18.95 on average. These figures can be used later on to improve the current situation, as well as to decide the impact of any improvements proposed.

4.4 Transport in the current supply chain

When looking at transport, both the party responsible as well as the transport mode chosen is important. This paragraph therefore answers the following sub-questions: 'What transport modes are used?' and 'Which parties are arranging transportation?'

4.4.1 Responsibility for, and in, transportation

Arranging transport means that the actual transport itself is outsourced to specialized transporters and logistics providers. In general, Damen arranges all transportation in house, in order to be more flexible and reduce communication distances (Flach, 2012).

For components bought by DSGo, transport is arranged by the Transport Coordination department. Only in some special cases the responsibility for transport shifts to the supplier, when a supplier delivers directly to the yard and is able to arrange transport themselves (Flach, 2012). DSGo arranges the complete transport: from the suppliers’ door up until the delivery at DSCh.

Transportation for the components that are procured by DSCh is mostly arranged by dedicated people from the yard itself, in the case of steel even for transport between sub-contractors (De Rooij, 2012) (De Rooij, 2012).

When items are procured by DTS, the transportation is always arranged by DTS itself. The reason for doing so is to keep as much control as possible: due to cultural differences, as well as scepticism of internal customers towards Chinese suppliers, they need to maximize the control (Van Gelder, 2012).

The return of empty containers is always the responsibility of the transporter, as the containers are always Line Owned. The only responsibility for DSCh is the timely unloading of the containers.

4.4.2 Incoterms

Despite the aim (Spaans, 2011) is to get the items delivered either DAP Gorinchem (meaning delivered at Damen's Central Warehouse) or FCA (meaning the risk and costs shift when the supplies are loaded on the truck), still a lot of items procured by DSGo are delivered Ex Works. This means that both the risk and the costs for the materials transfer to Damen at the supplier's doorstep, even before the parts are loaded.

DSCh always gets its supplies delivered Ex Works ((De Rooij, 2012) and (De Rooij, 2012)). The same is true for all supplies procured by DTS (Van Gelder, 2012).

4.4.3 Transport modes, costs and time

At this moment, three main modes are used: road-; sea-; and air transportation. The cheapest mode is chosen, as long as the shipment is not critical (Flach, 2012). There are no concerns on conservation of the items when choosing between these modes, but it does affect the packaging or type of container used (Dörr, 2012).

Transport within Europe and the Netherlands is done by truck. When in a hurry, Damen chooses for express couriers; or DHL when an item is small and lightweight (Flach, 2012).

Transport from Europe to China is done by sea transport. For Changde, the last part from Shanghai is done by barge, or by truck when short on time. When critical, air transport brings the components to Changsa (a 2.5 hour drive from Changde), doing the last part over the road (Flach, 2012).

At this moment, transportation costs for the parts procured by DSGo for the average ASD 2810 built in Changde are about € 75,000 ((Vasie, 2012) and (Van Der Wal, 2012)). The construction yard itself spends on average about € 23,000 on transportation (De Rooij, 2012). This is respectively 2.2% and 5.2% of their procured value. When seeing these numbers, one should take into account that in the yard's demarcation some very weighty and high volume resources (such as steel plates) are found.

The costs and transport times Damen currently achieves for their shipments are shown in Table 4.4 and Table 4.5. Return logistics (of empty containers) is included in these costs, as Damen pays a fee only when the containers are not unloaded in time.

Transport from Chinese suppliers to DSCh is always done using trucks (De Rooij, 2012).

Table 4.4 Current transport prices for shipments from DSGo to DSCh based on (Weevers, 2011) and (Flach, 2012)

Sea transport to Shanghai* and barge to Changde*	Transport: \$ 1,200 (20' container) \$ 2,000 (40' container) Taxes and fees: € 170 + \$ 308
Sea transport to Shanghai* and road transport to Changde*	Transport: \$ 250 (20' container to Shanghai) \$ 375 (40' container to Shanghai) + \$ 2,750 (Shanghai to Changde) Taxes and fees € 72.5
Air freight to Changsa**	Base tariff: € 75 Transport € 1.37 / kg (over 45 kg) € 0.97 / kg (over 100 kg) € 0.77 / kg (over 500 kg)

* Based on Full Truck Loads in line owned containers

** Air freight costs use dimensional weight, see Annex C.5

Table 4.5 Transport times and lead times for arranging transports (based on (Flach, 2012),(Flach, 2012) and (Weevers, 2011))

	Transport time after loading	Lead time for arranging shipments
Sea transport + Barge transport	+/- 81 days	2 weeks
Sea transport + road in China	+/- 53 days	2 weeks
Air freight	+/- 12 days	1 day

4.4.4 Sub-sub-conclusion on transportation in the current supply chain

This part looked at the sub-sub-questions: ‘*What transport modes are used?*’ and ‘*Which of the parties from the Damen Group is arranging transportation?*’

Damen currently arranges most transport by themselves. All modalities are used: truck (within Europe and within continental China); sea transport (Europe to Shanghai); barge (from Shanghai to Changde); and air transport (from Europe to Changsa).

Transportation takes about 12 to 81 days, depending on the modality chosen. The costs of transporting the goods using different modes have been indicated in order to be able to improve the use of different modalities later on, as well as to evaluate the effects of any improvements.

4.5 Quality inspection in the current supply chain

The final part in the analysis of the current supply chain is answering last sub-sub-question: *Where is the quality checked and by whom?*

In the current supply chain of DSCh’s tugboat ASD 2810, before delivery the quality is only checked for components procured by DTS and, as is discussed later, for DSCh. Due to cultural differences, stringent quality inspection turns out to be very important for the Chinese suppliers: it is the experience that quality drops fast when inspections are not done. As the orders of DTS are delivered ex works however, the quality needs to be checked at the site of the supplier. For that reason, DTS has quality inspectors that do an intermediate inspection, as well as a check upon delivery. During these, the inspectors measure and examine all specifications. During the intermediate inspection it can be estimated whether a supplier will deliver on costs and on time (Van Gelder, 2012)

For items procured by DSGo, at the warehouse the packaging, labelling and completeness of the orders are examined. The quality of the contents of a delivery is not inspected. A test some years ago showed that only 60% to 70% of the orders were correct on arrival (Damen Shipyards Gorinchem, 2009). The figures are thought not to have changed since then (Peurseem, 2012).

The quality of the components is thus not checked in the warehouse: this is only done through very irregular sampled checks. This is possible, as Damen has quite a long history with most suppliers. This image should be nuanced when looking outside the scope of this research: for certain procurements (such as hulls constructed by a contractor) there are multiple, very stringent quality inspections.

The lack of quality inspection sometimes has serious impact on the production process: current flaws sometimes (nearly) delay the construction of vessels, causing costly (last minute) air transportation of materials to be required (Dolman, et al., 2012).

Components procured by DSCh mostly are checked for quality at the site of the supplier. Parts that are both small and low-cost are checked after arrival at the yard only (De Rooij, 2012). These are items of which the value is lower than the costs for travelling to the supplier (De Rooij, 2012)

It must be noted that DSCh is the only shipyard and one of the very few western companies in the region. Most new suppliers thus are new to delivering to the shipbuilding industry as well as working with a Western company. Therefore most of the first deliveries are not of sufficient quality, but a steep learning curve and intensive cooperation overcome this in a short time (De Rooij, 2012).

4.5.1 Sub-sub-conclusion on quality control in the current supply chain

This part has looked into the sub-sub-question: *'Where is the quality checked and by whom?'*

In the current supply chain, the actual quality control is done at various places: after arrival at DSCh; at the supplier's site for parts procured by DTS; at the supplier's site for expensive parts procured by DSCh; and at irregular intervals at the supplier's site for parts procured by DSGo. There is an additional check on the logistical requirements, such as packaging, at DSGo's Central Warehouse.

Last, it was found that cultural differences cause more stringent quality control to be needed for Chinese suppliers.

4.6 Sub-conclusion on the analysis of the current supply chain

Now the details have been examined, the fifth sub-question can be answered. This sub-question is: *'How is the supply chain of DSCh's tugboat ASD 2810 currently organized?'*

This chapter has looked at the materials in the current supply chain, as well as various sub-sub-questions. The conclusions are discussed per topic or sub-sub-question.

Materials in the current supply chain

It was found that 90% of the material value in the supply chain arises from 10% of the classes. This was used as a boundary between the 'high value' and 'low value' parts.

From a questionnaire, the parts were labelled to originate from a complex market or not. This resulted in all supplies to be categorized in the types from the Kraljic matrix.

a. Who is doing the procurements?

There are three parties in the supply chain of DSCh's tugboat ASD 2810 that procure components. In order of value, these are:

1. Damen Shipyards Gorinchem;
2. Damen Shipyards Changde;
3. Damen Trading Suzhou.

b. Is Damen applying a global- or local procurement strategy?

Procurements done by DSGo in theory are done from a global procurement perspective, though the vast majority of the suppliers is located in Western Europe.

DSCh is procuring from a local procurement strategy, though it must be noted that 'local' in this case is only limited to China. Suppliers are located up to a distance of roughly 1,500 km.

Within the supply chain of DSCh's tugboat ASD 2810, DTS is procuring from a local perspective. For other (Damen) companies, DTS is however part of a global sourcing strategy. The suppliers are all located in China, mostly within a 400 km range.

c. Where are Damen's warehouses located?

There are two warehouses in the current supply chain: firstly, Damen's central warehouse is located in Gorinchem. Items procured by DSGo that weight under 4 tons and smaller than 10 m³ are consolidated in this warehouse. Secondly, all items procured by DSCh and DTS, as well as components procured by DSGo, are stored in a warehouse at DSCh after delivery. All inventory is linked to a (future) project.

d. What transport modes are used?

Currently, three modes of transport are used: sea transport + barge; sea transport + road transport; and air transport. The decision is currently only based on the urgency of a component, as in principle all parts are transported by the cheapest mode.

e. Which of the parties from the Damen Group are arranging transportation?

Damen in nearly all cases is responsible for arranging transportation. Only DSGo sometimes makes an exception, when a supplier delivers directly to the yard and the supplier is able to arrange their own transport. Transports for components procured by DSCh or DTS always is arranged by the respective company themselves.

f. Where is the quality be checked and by whom?

The quality is checked after arrival at DSCh. Components procured by DTS undergo both intermediate- and ex works quality inspections. DSCh's procurements are subject only to an intermediate inspection. For DSGo's purchases only irregular, sampled, inspections are done.

The next chapter (chapter 5) will look for possibilities for improvement on these topics.

5. Improvements to the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810

As the current situation is now known, improvements can be made. To achieve this, the current situation is reflected upon using literature and interviews with stakeholders. This chapter thus answers sub-question six: *How can the supply chain of DSCh's tugboat ASD 2810 be improved?*

As mentioned in chapter 2.1, this sub-question is scoped to the following sub-sub-questions:

- a. *Who should be doing the procurements?*
- b. *Should Damen apply a global- or local procurement strategy?*
- c. *Where should Damen's warehouses be located?*
- d. *What transport modes should be used?*
- e. *Which of the parties from the Damen Group should be arranging transportation?*
- f. *Where should the quality be checked and by whom?*

Each of the sub-chapter hereafter will go into detail on these questions. Any literature used is described at the start of the specific paragraph. The consistency between the data and methods used, as well as questions to be answered in this chapter is visualized in Figure 5.1.

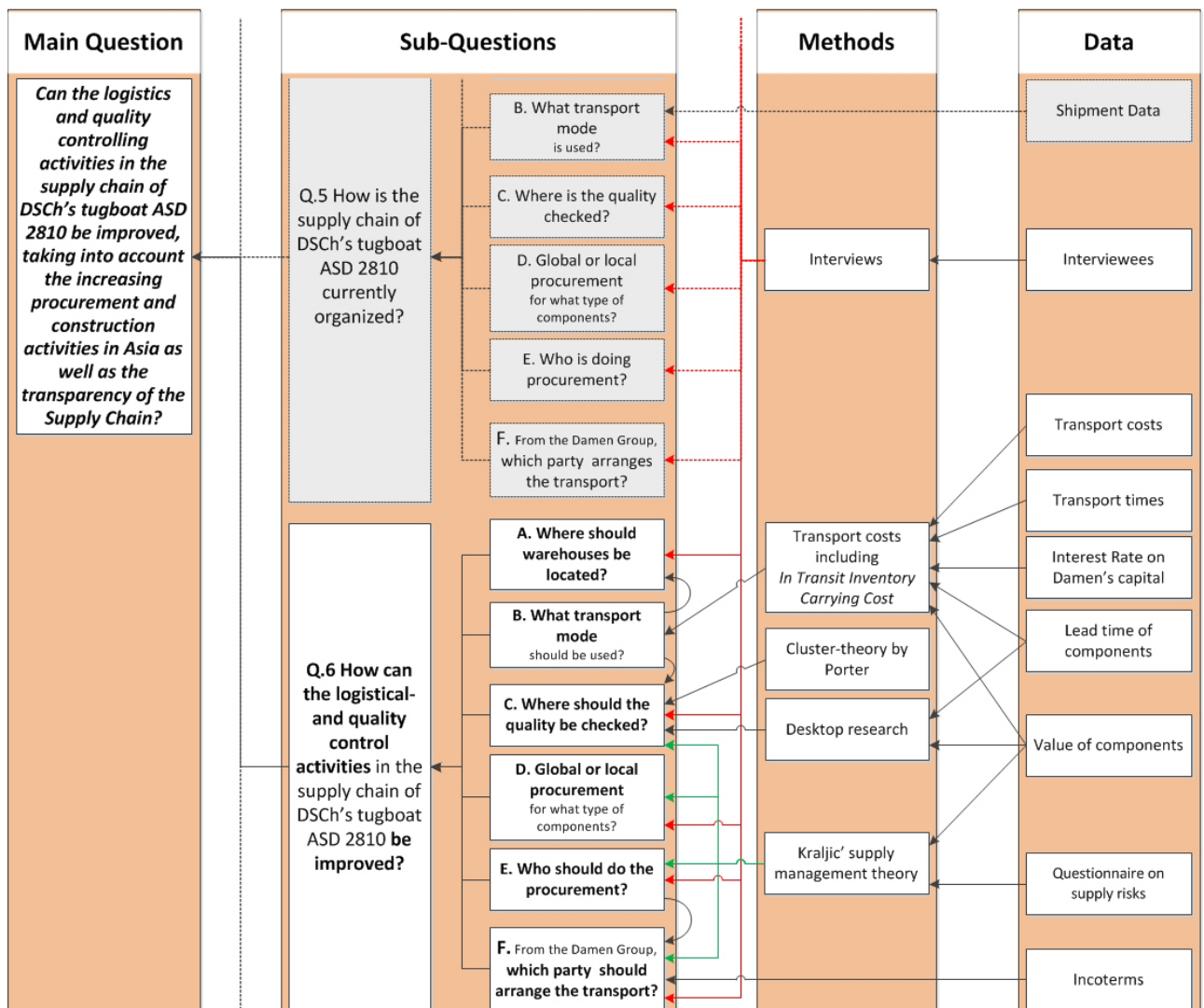


Figure 5.1 Consistency of chapter 5 and its methods and data within the overall research

5.1 Improvements on procurement responsibility and strategy

The theory of Kraljic that was described in chapter 2.2.1 is applied in this section in order to improve the procurement situation. This part therefore answers sub-sub-question 6.a: *Who should be doing the procurements?*

First, the implications of the theory to the strategy (5.1.1) and responsibility (5.1.2) are discussed. This paragraph then closes with remarks on the transparency of the status of the supply chain.

5.1.1 Implications for the procurement strategy

The implications are discussed per type of purchase. For a description of the different types, please refer to section 2.2.1.

Leverage products

For the leverage purchases (the low complexity, but high value items) Kraljic's theory advises to exploit the purchasing power available. In order to make optimal use of the possible power, one can either exploit (or create) a supplier's dependency towards Damen, or bait them with opportunity.

Therefore the focus should be on increasing the volume of the procurements. This can be done both by increasing size of the orders by standardization of components, as well as by concentrating several orders to one supplier. The concentration of orders towards one supplier should however not be exaggerated: when too much concentrated, the supplier's sense of competition may be lost.

The procurement of the leverage items might use framework contracts, but only for short term: if done so, it increases the buying power but does not cause a sense of long term assurance. Using this form of contracts at the same time allows advantage of volume, but does not force Damen to receive and pay the goods all at once.

In order to create the maximum sense of competitiveness in the supply market of these components, as well to increase the effect of bundling the orders, the leverage items should be sourced globally.

Strategic products

According to the theory, the management of the strategic products should focus on creating strategic partnerships. This is a potential threatening situation however, as there is quite some risk that Damen ends up in a locked in relationship.

Therefore there are two reasons to obtain the strategic purchases with a global procurement strategy: 1) using one procurement organization increases the chances for building the strong relationship, streamlining communication through a minimum of persons and departments; and 2) the global scope includes the maximum number of (potential) suppliers, and thus the maximum possible competitiveness between suppliers. In theory this would lower the complexity of the supply market. In theory, a part may shift a quadrant in the Kraljic matrix, becoming a leverage product.

In practice it is however more complicated than just increasing the number of suppliers: the intensive cooperation between Damen's Engineering department and some suppliers makes the company dependent to these suppliers.

Routine products

As the routine products are already of low value, and the availability is not threatened in any way, it Kraljic's theory prescribes that the focus for this type should be on reducing the procurement effort. This can be done by lowering the number of parties involved and reducing communication required.

For these reasons, the routine products can best be procured locally. Using framework contracts may reduce the negotiation effort to just ordering the parts. Furthermore, increasing the standardization within routine products will reduce the versatility of components, improving the efficiency.

Bottleneck products

Though they are of small financial impact, the bottleneck products are a risk to the continuity of the construction process as the supply depends on a very limited number of suppliers.

The flow of the products thus should, according to Kraljic's theory, be secured. This can be achieved by maximizing the number of potential suppliers by looking in the largest area possible; hence a global procurement strategy should be applied. Also, the volume may be secured by using long term contracts that implicate mutual obligations for a longer period. Using framework contracts may contribute to this as a central party can negotiate and trade with a global player, while the local yard is enabled to order the parts without additional communication layers.

In addition, the company might consider in-sourcing the production of the production of bottleneck components (Kraljic, 1983). This must however been done with the greatest care, as in-sourcing reduces the flexibility of the company: when the market decreases, it provides standing charges that cannot easily be depleted.

Exceptions from and comments to the described strategies

The previous discussed strategies are generic and apply to the supplies of the ASD 2810. Some exceptions are however in place: when for specific parts there are difficulties either in arranging transport or customs clearance, the amount of transport should be limited and when possible, custom requirements avoided. That means that, when possible, these parts should be procured locally. In the supply chain of the ASD 2810, this does at this moment not inflict exceptions to the discussed strategies: the only parts that are currently problematic in terms of customs and transportation are routine products (e.g. the fireworks, rescue equipment and paints).

When it is considered to procure a certain supply in another country, special effort should be made to recheck the local costs and market complexity. For example in production at Damen's yard in Qatar, there are nearly no specialized suppliers available: due to this, components considered routine in the Netherlands are locally very expensive and the local supply market is very complex.

5.1.2 Implication for choosing the procuring party

The previously discussed procurement strategies affect the decision for a party which is responsible for the procurement.

Routine products

When components are acquired through local purchasing, it is both straight forward as well as inevitable to grant the procurement responsibility to the local yard itself: a third party that procures items in the proximity of the yard, would only be viable when it can serve multiple parties in the

region. In the case of DSCh, it would only add complexity. The procurement of all routine products thus should be the responsibility of DSCh.

Within the overall Damen Group the procurement activities of the routine products thus are split over all production yards. As this decentralization will increase the difficulties for the headquarters for keeping insight into the procurement characteristics, special notions are made in section 5.1.3.

Bottleneck products and leverage products

When procuring globally it makes sense not to split the procurement activity over several organizations or departments. Bundling the procurement activities for a certain component is however not the same as procuring centrally: there is no reason to charge one party with the procurement of all bottleneck products and leverage products. It only would increase the complexity of the procurements, as the cultural differences and language problems would increase.

Therefore, the division of the procurement activities should be based on the location of the supplier: is the most attractive supplier found in China, the responsibility should be with DTS; when it is located in Europe or Northern America that should be DSGo.

As mentioned before, the downside of splitting the responsibility is that special care should be taken to secure and support the communication and information needed to gain transparency in processes. For the leverage products, the procuring specialists in all departments of the Damen Group should have access to the pricing information: in order to increase the cost pressure, they should be able to compare the prices of current suppliers and competitors in any other region. For the bottleneck products it is key to secure the supply volume, so the availability of competing suppliers should be known to the procuring party. Additional advises for this transparency are discussed in section 5.1.3.

Strategic products

As described in the previous section (5.1.1), the aim is to use one procuring party to improve the chances of building a strategic relationship. While for the bottleneck/leverage products the responsibility may change when switching suppliers, that does therefore not apply to strategic items.

The procurement of the strategic products must be done centrally, by one organization only, for three reasons: firstly, to increase and maintain the experience on the specific type of product; secondly, to improve and maintain the personal contact with the suppliers; and thirdly, to maximize both the insight and control from the headquarters.

For this reason the most central procurement party within the Damen Group should be granted the responsibility of procuring these items: the procurement department of the headquarters (DSGo).

5.1.3 Implications for the transparency of the supply chain

When procurement activities are performed not within DSGo, the transparency of the status and performance of the procurement activities require additional attention.

For the routine products that is not too complex: as these items are purchased locally, it is not needed to communicate over procurement negotiations. It is however needed to provide cost information systematically. In this sense the objective of DSGo's general management, to roll out the ERP software to all Damen companies fits: when DSCh can provide their costs and hours spent on the procurement, it both becomes virtually real time visible to DSGo's project managers, as well as the

registration is done at the procuring party only. Though currently separated in the ERP system, in the near future the companies will be combined in a centralized environment, lowering the barriers for further integration (Aarts, 2012).

More complex communication and information provision is required for the leverage and the bottleneck products. In case of the leverage products, the pricing information of the current supplier should be known to procurers anywhere in the Damen Group: in that way, the search for better prices can be done within the whole group.

For the bottleneck products the information provision on any available suppliers is crucial in order to secure the supply and spread any risks, most preferably accompanied by (an indication of) their prices and any particularities.

Preferably, all data on (possible) suppliers should be held in a central database. All information on pricing should be accompanied by (an estimation) of transport costs to allow comparison. For this Damen's current transport calculator (Weevers, 2011) can be used, combined with the new ERP software.

5.2 Improvements on warehousing

The warehousing can be divided into two main decisive topics: 1) which items (if any) to be kept in stock; and 2) where the stock should be located.

5.2.1 Items to be warehoused

Among others, general reasons for warehousing items are: 1) a more responsive order processing; 2) a more efficient use of transportation resources (Langley, Coyle, Gibson, Novack, & Bardi, 2008); and 3) to gain procurement advantages. The items to be inventoried will be discussed per reason.

Improve the responsiveness

The responsiveness of the order processing (and therefore the reaction speed to the customers' wishes) benefits in two ways from warehousing activities:

1. Safety stocks can be held to secure material flows, guarding against disruptions;
2. Reducing Damen's lead time by having parts on hand, being ready for shipment immediately.

The first benefit matches the focus on securing the supply flow that is advised for the bottleneck products. The second is mainly useful for supplies that have a long lead time: when these are already in stock, Damen's lead time could be reduced with some weeks. As the long lead time components however tend to be of very high value, the holding of actual stock at Damen is very expensive. Keeping the inventory at the supplier therefore may be beneficial, either with real- or virtual stocks through the agreement on low lead times in framework contracts. It will however result in higher prices, potentially reducing the insight in the actual material costs (Van Gelder, 2012).

In both cases the standardization of the parts should be considered: when a component is customary there is a very low chance it will be needed in the future, and keeping it in stock is unwise.

Keeping inventory to improve the responsiveness would mean a change to Damen's current procurement method: in order to achieve the proposed improvement, the company would no longer buy these items for a specific project.

Improve transportation efficiency

The efficient use of transportation can be improved by consolidating shipments. No reason is found during this research to change the current rule of thumb (see paragraph 4.3.1), which indicates that shipments under 4 tons or 10 m³ are to be consolidated.

This guideline should be nuanced however: consolidation is only profitable for long distance transportation. On short distances the costs of consolidating the items will be higher than the costs due to inefficiencies by small shipments. Of course, only items that are to be transported by the same transport mode should be consolidated: transporting goods in a mode of transportation higher or lower than advised will result in higher landed costs (see paragraph 5.3.2).

Gain procurement advantages

Warehousing can facilitate advantages in procurement either by strategic or opportunistic timing, or by facilitating increased procurement volumes. As with any inventory in Damen's supply chain (see '*Improve the responsiveness*'), it is only viable to use warehousing for this purpose with parts that are standardized: there is no use in buying components in advance, when there is little certainty whether there actually is a demand for them. This would however mean a change in the procurement organization, as it would require Damen not to buy parts for a specific project.

The goal of gaining procurement advantages matches the prescribed strategy for leverage products: to maximize procurement power. As these items are intrinsically of high value, the stock keeping advise is equal to the one given for the long lead time items (see '*improve the responsiveness*').

5.2.2 Warehousing locations

When discussing warehousing locations, one should distinguish two topics: a decision for centralized-versus decentralized warehousing; and the actual geographical location.

Centralized- vs. decentralized warehousing

In the previous paragraph (5.2.1), the following four types of goods are selected for warehouse activities: bottleneck products; leverage products; standard parts with a long lead time; and small components transported over long distances.

Bottleneck products are in essence low cost products. When the supply is secured (e.g. by holding safety stocks), the handling of these products should be done as efficient as possible: in a sense, they are then equal to routine items. For that reason, it is best to keep them as close as possible to the production site. The bottleneck items thus are to be held decentralized in the yard's inventory.

As discussed in the previous sub-paragraph (5.2.1), both the leverage and long lead time supplies need to be kept in stock at the supplier. This in essence is decentralized.

For the small components (that is, orders under 4 tons or smaller than 10 m³) that are to be consolidated the advice is more nuanced: on one hand, using one, central warehouse would only increase the transport costs, for the flows would meander before reaching their destination. Supplies therefore ideally would be consolidated as close to the supplier as possible. On the other hand, using too many locations would disproportionately increase the warehousing costs. A compromise for maximizing the advantage thus is to handle these parts in a regional warehouse. Please note that regional in this case refers to the region of the suppliers.

Warehouse locations

To minimize transportation effort, the regional warehouse(s) should thus be located centrally within a group of suppliers. In the current supply chain, most suppliers are located in Western Europe; around DSCh; and in China's shipbuilding cluster in Suzhou's region.

The suppliers located around DSCh do not require any consolidation, as they may ship to the yard directly. A nuance can be sought in combining transportation from multiple suppliers, but this research lacks the information required to get detailed insight into the potential of this.

The supplies from the shipbuilding cluster in DTS's region could benefit from consolidation, as the distance is quite long. However, DTS provides only (part of) the leverage and bottleneck items, of which only the latter is advised to be warehoused for other purposes than consolidation. This category consists of only a small number of orders. At the same time, part of the small group of leverage items is very voluminous, hence not in need of consolidation. Starting a warehouse for such a low number of orders thus is considered disproportional.

For the European suppliers, the current warehouse in Gorinchem is sufficient: it is located both centrally in the cluster as well as close to the Rotterdam harbour. Shipments through air-freight are efficient, with several airports close by. Being located close to the headquarters, it increases transparency and feeling of control. This warehouse also provides a broader role in the Damen Group, as it may facilitate flows to projects in Western Europe. Therefore no reason was found to change this current location.

It must be noted that besides advantages in transportation, the choosing of a location close to suppliers and competitors has substantial advantages in terms of innovation as well as 'feeling' to the (supply-) market and competition (Porter, 1998). Choosing a location within a cluster thus gives certainty towards the future, as alternative suppliers and co-makers most probably are found in the same region.

5.3 Improvements on transport modes and organization

This paragraph will discuss literature on which a modal choice can be based, followed by improvements on modal choice in the current supply chain. It will be concluded by extending the remarks to the responsibilities for, and in, transportation.

5.3.1 Literature on choosing a transport mode

All transport modes are able to transport components in the supply chain (see chapter 4.4.3). The selection of modes is therefore reduced to the financial aspect only. When deciding between modes, the cost centres to be considered are: 1) transportation costs; 2) Inventory Costs; 3) Packaging costs; 4) Warehousing costs; and 5) Costs of lost sales (Langley, Coyle, Gibson, Novack, & Bardi, 2008). Also, the criticality of the delivered component is to be taken into account, as the costs for the delay of the production and delivery need to be considered.

As Damen procures from a pull perspective, the costs of lost sales are to be disregarded. Warehousing decisions have been discussed separately (see paragraph 5.2); therefore warehousing costs are assumed to be equal in this discussion.

Looking at the packaging costs of different modes, overall there seems to be no significant difference between the packages for different modes (Dörr, 2012).

For these reasons, the decision for a specific mode is based on three arguments:

- The criticality of the component;
- Transportation costs, in € / unit;
- In transit inventory carrying costs, defined as (Kasilingam, 1998):

$$(interest\ rate\ per\ year) \times (unit\ purchase\ price) \times (yearly\ demand) \times (transit\ time\ in\ years) = \frac{iCDt}{365}$$

Note that in the third criterion the only variables (that is, for the modal choice) are the transport time and the value of the component. The interest rate changes over time, but not between components or transport modes. To choose a modality, the yearly demand can be taken as one.

5.3.2 Improvements on modal choice

The current prices Damen pays for sending their shipments are shown in Table 4.4 and the transport times can be found in Table 4.5. The interest rate Damen pays on their debts is about 3 months of Euribor plus 300 basis points, which is currently about 5% (Groninger, 2012).

This means that, for a fully loaded container, the costs in Table 5.1 are to be considered for the modalities under consideration.

Table 5.1 Costs per modality for shipping full containers (Exchange rate: \$1 = €0.8062)

	<ul style="list-style-type: none"> • Sea transport to Shanghai; • Barge to Changde 	<ul style="list-style-type: none"> • Sea transport to Shanghai; • Road transport to Changde 	<ul style="list-style-type: none"> • Air transport to Changsa
Costs (20' container)	€ 1,376	€ 2,472	€ 20,667*
Costs (40' container)	€ 2,016	€ 2,574	€ 31,024*

* Cost based on average container weight for Damen's shipments between 2007 and 2011 (20'= 8,190 kg; 40'= 12,300 kg) and standard container sizes (20'= 5.89x2.35x2,38m; 40' = 12,02x2,35x2,38m)

From these figures, it is seen that road transport in China is viable when the in transit inventory carrying costs for the difference in transport time (28 days) are larger than € 1,096 (20' container) or € 558 (40' container). Examples of such products are the engines and the rudder propellers.

Please note that when criticality occurs, for that specific component additional costs should be considered in the decision for a modality: 1) the penalty for late delivery of the ship, if the criticality is endangering the delivery date; and 2) the costs of a holdup at DSCh, which are estimated in the order of magnitude of € 1,500 per day (De Rooij, 2012). More important, it must be taken into account that a late delivery might hurt Damen's trustworthiness as a reliable shipbuilder.

5.3.3 Improvements on transport organization

Letting Damen arrange transportation, is a way of keeping control of the supplies: it gives an early notification of problems on the delivery time and quality, though the latter does not substitute a detailed quality control. It saves Damen the transportation time in the discovery of problems.

When the responsibility is shifted towards another party however, one could use the third party's expertise, as well as reduce part of their own costs. Last, it allows the company to focus on a select number of transports and products.

As for Chinese supplies a stringent control is required (see 4.5), this brings a contraposition: on one hand, one should advise that Damen should arrange transportation for all parts that not had a final inspection. On the other hand the items that not checked on quality are the most cheap orders only (see paragraph 5.4.2). On these cheap items theory advises to put in as little effort as possible, and at the same time the suppliers of most routine items are used to push their products to a customer.

The advice is therefore that for the both the routine and bottleneck items, in principle the supplier should arrange transportation. Damen should however arrange transport for Chinese supplies that did not get a final inspection, but of which the exact quality is critical to both the construction and timely delivery of the ship.

In both the leverage and the strategic procurements, there is no strong advice on whether Damen should or should not be responsible for transportation. Both need to be considered cases by case: for the leverage products it may give additional negotiating space and control on the costs. The strategic items, in theory, should be looked at which option is optimal from the overall supply chain perspective: considering experience; knowledge; and possibilities of all parties involved. In practice however, in an unbalanced relationship, Damen may be forced to the requirements of the suppliers.

For all components, unless discussed otherwise, the following holds: when Damen is responsible for arranging transportation, the company that has procured the items should also arrange transportation. That way the communication lines are kept as short as possible and the quickest reaction and feedback to the supplier is possible.

Exceptions to the discussed responsibilities

The discussed deviation of the responsibility for arranging transportation generally holds, but some exceptions are to be considered in advance.

Firstly, the complexity of goods is to be taken into account. As was mentioned in the discussion of the transportation of routine items, some products are complex in terms of transportation or customs clearance. Most suppliers of these products however are experienced in the transportation and importation of these products, therefore able to do the job using considerable less effort and finance than Damen can (Flach, 2012).

Secondly, it must be considered that transportation within the Chinese mainland should be arranged by a local party, such as for example DTS. A local party is able to get a much better price and quality than any foreign party can do, they have much better access to the market and they are much more aware of the import procedure. Also, when exporting from China, DTS is able to draw back VAT on transport (Van Gelder, 2012). At the same time the concentration to one local party will prevent the scattering of transportation when more companies from the Group start sourcing in China.

5.3.4 Advice on the Incoterms used

To simplify the risks, it is important that the right Incoterms are used in transportation. When the shipment of orders is arranged by the supplier, the responsibility of Damen should only start at the arrival at the yard: otherwise, the risk during a transport would be for Damen, while they have neither influence nor insight in how the transporter is chosen. This is especially important in China, where the experience with the conservation of materials is varying.

It is therefore essential that goods, of which transport is not arranged by Damen, are delivered DAP Changde; or DAP Gorinchem, depending on the delivery address. DAP is the acronym for “Delivered at Place” (ICC, 2010).

When Damen is arranging transport, the responsibility should shift when the parts are loaded on the truck. The reason is clearly depicted by an example: if items are delivered ex-works and Damen has not brought its own forklift, the items are loaded by the supplier, while Damen already is responsible. When in such case the supplier makes a mistake (for example dropping a valuable item), a most complex dispute may arise.

Therefore items, of which the transportation is arranged by Damen, should be done so FCA (“Free Carrier”, (ICC, 2010)).

5.4 Improvements to quality control

In the current situation, the way the quality control is done, is decided by the procuring organization. This paragraph standardizes the principles for quality control, discussing it per flow.

5.4.1 Supplies procured from western suppliers

The procurement of these parts is to be done by DSGo and will consist of strategic, leverage and bottleneck items.

Generally, trusted suppliers have proven to deliver up to expectations. The partnerships with these suppliers, both in the past and in the future, have in general proven to be a sufficient stimulus for quality assurance. It needs mentioning however that when signals are received that a (trusted) supplier is not delivering according to specifications, more regular inspections should be applied.

For all low value supplies, much less inspection effort is advisable: the costs of inspection would be disproportional in respect to the value of the goods. For that reason, bottleneck components from Western suppliers would only need inspection after delivery.

In this research, no reason is thus found to change the current strategy on quality control: to inspect the quality by irregular sampled inspections.

5.4.2 Supplies procured from Chinese suppliers

From the Chinese suppliers, four flows are to be distinguished: 1) possible strategic supplies procured globally by DSGo; 2) possible leverage products procured by DTS; 3) items bought locally by the yard; and 4) bottleneck and possible leverage items procured by DTS. These are discussed separately.

Strategic items and leverage products

The strategic items are advised to be procured globally (paragraph 5.1.1), which means that though they are not necessarily supplied by Chinese producers, the expectation is that some of them will already be in the near future (Slagmolen, 2012).

Though Kraljic’s theory prescribes the focus on a strategic partnership for the strategic products, cultural differences obstruct the trusted supplier construction that is used for the Western suppliers (Van Gelder, 2012). For that reason, in addition to the high financial impact and long lead time, it is advised to follow the method of quality inspection currently applied by DTS: to inspect the parts both

through an intermediate- and final check at least. The leverage items, which are characterized by a large value to, get the same advice.

To keep the responsibility for the quality control with the procuring party for strategic items (DSGo) would keep the communication line between quality inspectors and procurers minimized. However, it would have several disadvantages over using Chinese inspectors: 1) it would be more expensive, both as the DSGo's inspectors would need to travel a longer distance as well as have much higher wages; 2) cultural differences and language problems would unnecessary add complexity. For that reason, it is best to let the quality inspections of these products be the responsibility by DTS.

The same holds for the leverage products, though the Chinese leverage products will be the responsibility of DTS from the start: therefore, it is most logical to keep the quality inspections of these goods within the demarcation of DTS.

Routine Items

Routine items, which are both of low complexity and low value, are advised to be procured locally. In general, one would conclude that the routine items are of such low value that it is not affordable to put much effort in quality inspections before delivery. This would be in accordance to the generic advice from Kraljic's theory.

As described however, the challenges with the quality control for Chinese resources are much more stringent. In addition, the definitions of low and high value in China are different than in the Netherlands: the wages are much lower (Heynen, 2010), so quality inspection is much less costly.

It is therefore advised to maintain the current procedure as it is applied by DSCh: to do intermediate and final inspections for the (relatively) valuable routine items; while only doing inspections at the yard for the low value parts (chapter 4.5). The meaning of 'high value' and 'low value' is advised to be defined by the yard itself, as they are the only party to weigh the pros and cons in the local situation.

Bottleneck products

Though the bottleneck products do not have a large financial impact, there is however complexity in securing the availability of the parts. As it is hard to find substitutes or to re-order parts, it is important that the parts arrive in a good condition and quality. The bottleneck products therefore should be threatened like leverage products, being checked both during production as well as upon finishing. Note that this only applies to the Chinese supplies due to the mentioned cultural differences. For Western suppliers, a history of delivering good quality may be taken as a reason for reducing the intensity of the inspections.

5.4.3 Notes regarding the transparency of the supply chain's status

The quality assurance is essential not only for Damen's customers, but also to managing the supply chain: any quality problems would most certainly result in disruptions for logistics or production.

When any quality problems are discovered the sharing of information is crucial: if project management and the production yard are informed on time, the planning and logistics can be adapted in order to limit the impact on the overall performance.

Intermediate quality inspections on the important parts (i.e. the strategic-; the leverage-; and the bottleneck products) give insight into the time window as well as financial reliability of the ordered

components (Van Gelder, 2012). The earlier any discontinuities are known throughout the chain, the more possibilities for compensation within the rest of the supply chain there are. The same argument can be applied to the final inspection, though the later timing leaves fewer buffer for compensation.

For the general management, as well as the procurement department(s), the quality inspections give data on several important metrics: 1) the supplier reliability; and 2) impact (in cost and time) on logistics and production. This information is especially useful when procuring from a global procurement strategy.

As this information is useful to a wide range of parties within the company, the parties involved preferably should share the same information system. As the new ERP system is to be rolled out through the whole Damen Group (see chapter 3.6.4), this system is the most logical basis to be used to share the data on the supply chain.

5.5 Sub-conclusion on the improvements to the supply chain

This chapter has looked into the answer to sub-question six: *How can the supply chain of DSCh's tugboat ASD 2810 be improved?*

More in detail, the following aspects have been advised on:

- a. *Who should be doing the procurements?*
- b. *Should Damen apply a global- or local procurement strategy?*
- c. *Where should Damen's warehouses be located?*
- d. *What transport modes should be used?*
- e. *Which parties should be arranging transportation?*
- f. *Where should the quality be checked and by whom?*

These are here concluded on per aspect.

5.5.1 Improvements on procurement strategy and - responsibility

The advice for the improvement of the procurement strategy and responsibility is as follows:

- Strategic products are to be procured globally, by DSGo;
- Leverage and bottleneck products are to be procured globally, by a central procuring organization. For Chinese procurements that should be DTS. Framework contracts can be used, though for the leverage products they should not be long term;
- Routine products should be procured locally by DSCh.

In comparison to the current situation, this implicates a change in mainly two cases. First, to the leverage items: for example steel is currently procured locally. The advised change would result in cost reductions, as the increased procurement volume and larger supply market would lower the material costs. Secondly, to the routine items: though DSCh's current procurements for a majority exist of routine items, only a very small amount of the routine items currently is procured by DSCh.

5.5.2 Improvements on warehousing activities

The improvements for warehousing activities focussed on the location of the warehouses, both geographically as well as functionally.

In order to improve the responsiveness, standard items with a long lead time need to be put on stock. Safety stock should be held at the yard for the items of which the supply is a risk, but the value low (the bottleneck items). Long lead time items are to be kept in stock at the supplier, either real or through framework contracts.

In order to improve the transport efficiency, the orders under 4 tons or 10 m³ are to be consolidated. For Western suppliers this is to be done in Gorinchem, for the Chinese suppliers that is to be done at the supplier whenever possible.

Procurement advantages are mainly a pre for the leverage items. For their value and size, this type of inventory should be kept at the supplier: either real or virtually (through framework contracts).

5.5.3 Improvements on transport modes

The advice is that, for transport from Western Europe up to landing in China, sea transport should always be preferred. Within China itself, it is advised to consider the in transit inventory carrying costs. At this moment, this results in a decision for road transport when the difference between modalities in these costs is larger than € 1,096 (20' container) or € 558 (40' container).

When criticality occurs, the added costs for a delay (e.g. hold up of production, penalties, etc.) should be considered, as well as the potential harm to Damen's name as a reliable shipbuilder. In such case the costs differ per occurrence, so no rule of thumb is given.

5.5.4 Improvements on responsibility for transport arrangement

In the cases that Damen is advised to arrange transportation, the procuring company should do the transport.

It is advised that for both the routine and bottleneck items, in principle the supplier should arrange transportation. Damen should however arrange transport for Chinese supplies that did not get a final inspection, while the quality is critical to both the construction and timely delivery of the ship.

No preference is noted to the transportation of strategic and leverage items.

5.5.5 Improvements on quality inspections

It is advised to do a very stringent quality inspection on the items supplied in China, consisting of both intermediate and final inspections. The only exception is made for the lowest value routine items: when, for this type of supplies, the cost of inspecting are higher than the actual value itself, an inspection after arrival is sufficient.

Inspections in China should be done by DSCh (for supplies they procured), using DTS for inspecting all other Chinese components.

For Western suppliers, a sampled inspection is considered sufficient. For the low value items, all quality inspection can be done after delivery. This inspection is to be done by DSGo.

6. Evaluation of the proposed improvements

This chapter will evaluate the advising from the previous chapter by checking if the requirements are met. Meeting the requirements however demands them to be quantifiable.

First, the operationalization of the requirements is discussed. The chapter then will evaluate the advices on each of the requirements separately. Figure 6.1 shows the consistency of this chapter within the overall research.

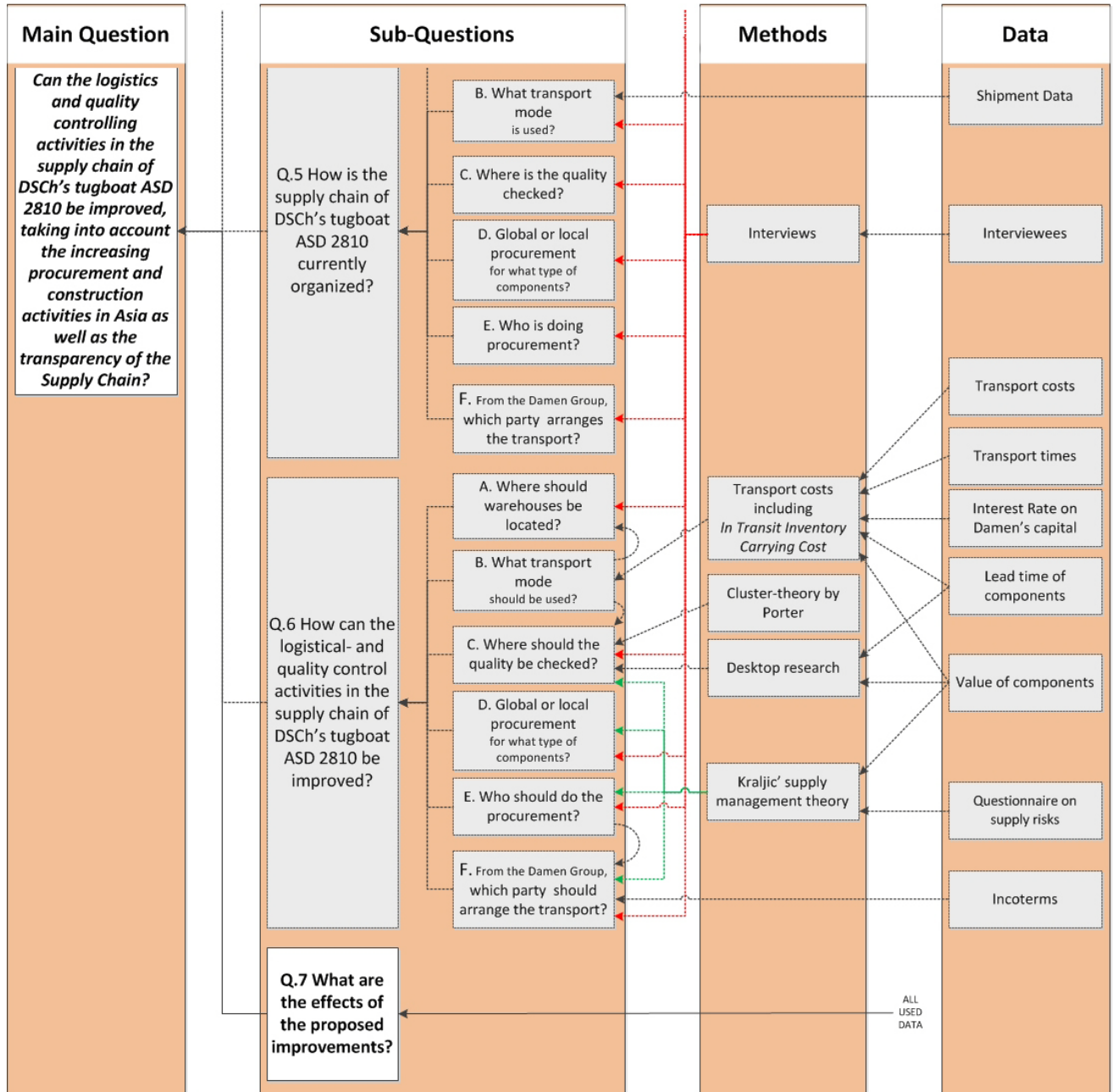


Figure 6.1 Consistency of chapter 6 and its methods and data within the overall research

6.1 Quantification of the requirements

To recap on the requirements (chapter 3.7.2), they were divided in need- and nice to have, which' quantification is discussed in the next two sub-paragraphs:

Need to have:

1. Reduce the overall costs;
2. Maintain or improve the current level of quality;
3. Maintain or improve Damen's current lead time for delivering ships;
4. Maintain or improve the transparency of Damen's supply chain;

Nice to have:

5. Improve the sustainability of Damen's supply chain;
6. Reduce the impact of customs and security.

6.1.1 Quantification of the need to have

The first need to have, '*reduce the overall costs*', can logically only be measured by a change in costs. This will give an accurate insight to the performance on this criterion.

The second, '*to maintain or improve the current level of quality*' is more complex. Microscopic Insight is not possible, so the measuring is done on a higher level. As experts conclude the cultural problems in quality achievements with Chinese suppliers, the requirement is operationalized by the percentage of Chinese items inspected. As can be concluded from the previous statement such measurement only gives an indication, as this is measuring the process towards quality, not the quality itself. Other factors of influence, such as the thoroughness of the inspections, are not taken into account.

The third, '*maintain or improve the current lead time for delivering ships*', has one component within the scope of the research: the transportation time including warehousing. This way of measuring does not regard production, but gives accurate insight into any gains within the research's scope.

The fourth, '*take into account the transparency into the supply chain*', is not quantifiable. It will however be elaborated on whether an effect on the transparency is plausible.

6.1.2 Quantification of the nice to have

The first nice-to-have, '*Improve the sustainability of Damen's supply chain*', is in terms of logistics characterized by the (amount of) transportation, which results in emissions. A comprehensive estimation of the sustainability would require an estimation of a wide variety of emitted gasses, which would be too much for this research. For that reason, this research will only evaluate the sustainability based on the most well-known greenhouse gas, carbon dioxide, giving a hint to the overall emissions by the amount of diesel fuel used.

The last criterion, '*reduce the impact of customs and security*', is partially measurable up front. Partially it is possible, by using the number of order lines that are to be imported for example. Additional changes, such as factors reducing the impact of security regulations, can only be elaborated on pros and cons.

6.2 Notes to and assumptions in the evaluation

This chapter evaluates the advices given in this research by checking the effects of applying the advice. In order to do so however, some global assumptions should be stated.

When calculating the effect of the supplies to be procured globally, this research assumes that the following products are products will be bought from suppliers in China:

- All products that currently originate from a Chinese supplier (De Rooij, 2012);
- All products that are expected to originate from Chinese suppliers in the near future by DTS (Slagmolen, 2012);

Furthermore, the following assumptions are used in all calculations:

- Purchase order lines of the class ‘miscellaneous’ is excluded from the calculations, as these contain a lot of intangible items, which cannot be transported;
- Purchase order lines of the class ‘transport’ are excluded from the calculations, as these contain (part of the) transport costs for the current situation;
- When calculating costs, the following exchange rates are used: \$ 1 = €0.7999 (ECB, 2012); and € 1 = ¥ 7.9407 (ECB, 2012).

Assumptions for specific evaluations are discussed in their respective topics.

6.3 Changes to the values and volumes in the supply chain

The proposed improvements cause a large shift in the (responsibility for) flows in the supply chain, which is seen from the values and volumes in Table 6.1.

Table 6.1 Comparison of the volumes and values in the current and advised situation, per ship, using average values

		Current situation ¹	Advised situation
Procured by DSGo			
Volume	no. Of Classes	326	27
	no. Of PO Lines ²	1,034	147
Value	total	€ 2,066,000	€ 1,870,000
	avg. per PO Line	€ 2,000	€ 13,000
Procured by DSCh			
Volume	No. Of Classes	27	314
	No. Of PO Lines ²	Unknown ³	888 ³
Value	total	€ 452,000	€ 226,000
	avg. per PO Line	Unknown ³	€ 254 ³
Procured by DTS			
Volume	No. Of Classes	2 ⁴	12
	No. Of PO Lines ¹	1 ⁴	27 ³
Value	total	€ 1,314 ⁴	€ 424,000
	avg. per PO Line	€ 1,314 ⁴	€ 15,000 ³

¹ Data originates from chapter 4.1;

² The number of PO lines is an average over 7 ships. The figure for the advised situation therefore is rounded to the nearest whole number;

³ From the orders in the current situation of DSCh only the values and classes are known. For the advised situation each class is taken as a PO Line (that is: 16 classes/PO lines for DSCh; 10 classes/PO lines for DTS);

⁴ In the current situation, the orders handled by DTS are placed by DSGo.

6.4 Costs

First, the overall costs are shown and then the accuracy of the calculations is discussed. The sub-paragraph closes by discussing the findings.

Results

In Appendix D the costs of the advised situation are estimated on different aspects. Overall, the average logistical- and quality control costs decreased by nearly 4.5% (from € 150,300 to € 143,600), but the change is well within the bandwidth of the calculations. Due to this, a addition will be done to the original advice (paragraph 6.10). The calculations involve transportation costs that are planned. Last moment air transportation to compensate for disturbances in the supplies are not considered, as these cannot be estimated in advance.

Detailed results are listed in Table 6.2, as well as visualized in Figure 6.2 and Figure 6.3.

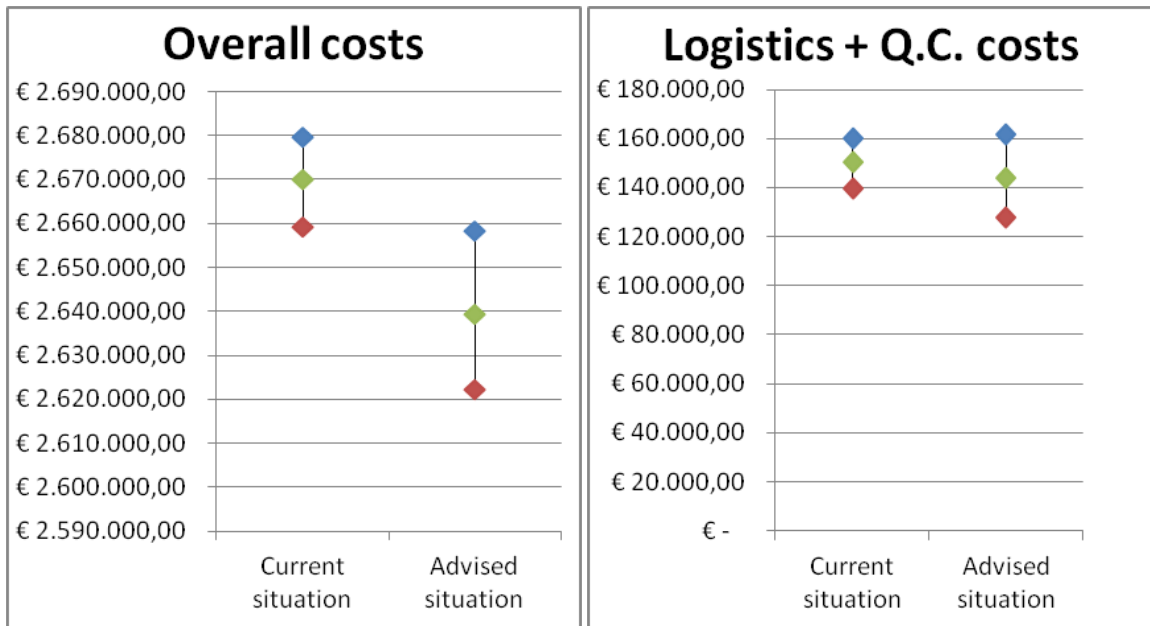


Figure 6.2 Visual comparison between the costs in the current and the advised situation (three dots showing the accuracy; left the overall costs including material procurements; right the logistics and quality control costs only)

The costs on the logistical- and quality control activities thus are not significantly reduced. Besides these cost centres however, significant improvements will be made on the material costs: sourcing materials in China will reduce the materials costs by about € 24,000 (+/- € 1,200). See appendix D.5 for more details on the earnings on the material costs.

Overall, this means a reduction of just over 1% on the logistical-, quality control- and material costs of an average ASD 2810 build in Changde. It must be noted though, that the actual cost savings will be higher: effects of higher procurement volumes have not been taken into account.

On the long term the earnings will be even higher, as also Sets will be procured in China. An estimation of the potential earnings is however not easily done, as part of the benefits in it trade off against an increase in Engineering effort on Damen's behalf. This effect is too complex to be estimated in this research.

Financial impact when extending the implementation

As the ASD 2810 is taken as a business case, the effects of greater implementation need to be considered. The calculations may only be extrapolated to DSCh, as for other yards the financial benefits on materials and transportation most probably are not equal.

Table 6.2 overview of the costs comparison between the current- and advised situation

	Current situation	Advised situation
Transport costs		
From DSGo to DSCh		
Direct shipments (truck)		€ 4,030
Direct shipments (barge)		€ 7,720
Indirect shipments		€ 1,380
Sub-total DSGo-DSCh	€ 75,480	€ 13,130
From Local Chinese Suppliers to DSCh		
Direct shipments		€ 3,150
Indirect shipments		€ 34,630
Sub-total local suppliers-DSCh	€ 22,700	€ 37,780
From DTS's suppliers to DSCh		
Direct shipments	Incl. DSGo	-
Indirect shipments	Incl. DSGo	€ 990
	Incl. DSGo	€ 990
Other local transport		
Transport of locally procured bulky materials	Incl. DSCh	€ 22,700
Total transportation costs	€ 98,180	€ 74,600
In-transit inventory carrying costs		
In transit inventory carrying costs	€ 25,080	€ 19,030
Total in-transit inventory carrying costs	€ 25,080	€ 19,030
Warehousing costs		
DSGo	€ 19,160	€ 2,460
Total warehousing costs	€ 19,160	€ 2,460
Quality inspections		
DTS	€ 410	€ 2,710
DSCh	€ 7,450	€ 44,800
Total Quality Inspection Costs	€ 7,860	€ 47,510
Material Costs		
Material costs	€ 2,520,000	€ 2,496,000
Total material costs	€ 2.520.000	€ 2,496,000
GRAND TOTAL	€ 2,768,500	€ 2,639,600

By rough estimation, the overall material- and transport costs of all yearly produces vessels at DSCh are between € 28 million and € 30 million (€ 18 to € 20 million for large vessels, € 10 million for small vessels (De Rooij, 2012)). A 1% reduction thus would roughly mean a saving of about € 280,000 to € 300,000. In the future this amount will most probably increase, as the yards production rate will grow (see 3.4). If the expected growth in the production of small vessels is achieved, this will result in about double costs, as well as savings, on the small ships. A reduction on the long term thus is roughly estimated to be between € 380,000 and € 400,000.

Discussion of the results

In retrospect, the lack of costs improvement on logistics is explainable: it was expected that the costs for quality control would increase, while this would be overly compensated by a reduction in transportation costs. The cost reduction in transportation was however not sufficient.

From the discussion of the current transport costs (see 4.4.3), it can be seen that the majority of the transport costs arise from haulage. The (relative) affordability of transport between Rotterdam and Shanghai can be explained by several arguments, such as: large competitiveness among ocean lines for a number of years ((UNESCAP, 2005), (IBM Business Consulting Services, 2005), and (Steamship Mutual, 2012); a large amount of excess capacity ((Barnard, 2011) and (Steamship Mutual, 2012); the very (cost-) efficient handling of containers in the very large container vessels (AT Kearney, 2012). As a result, a reduction in transport distance cannot be translated linearly in a cost reduction.

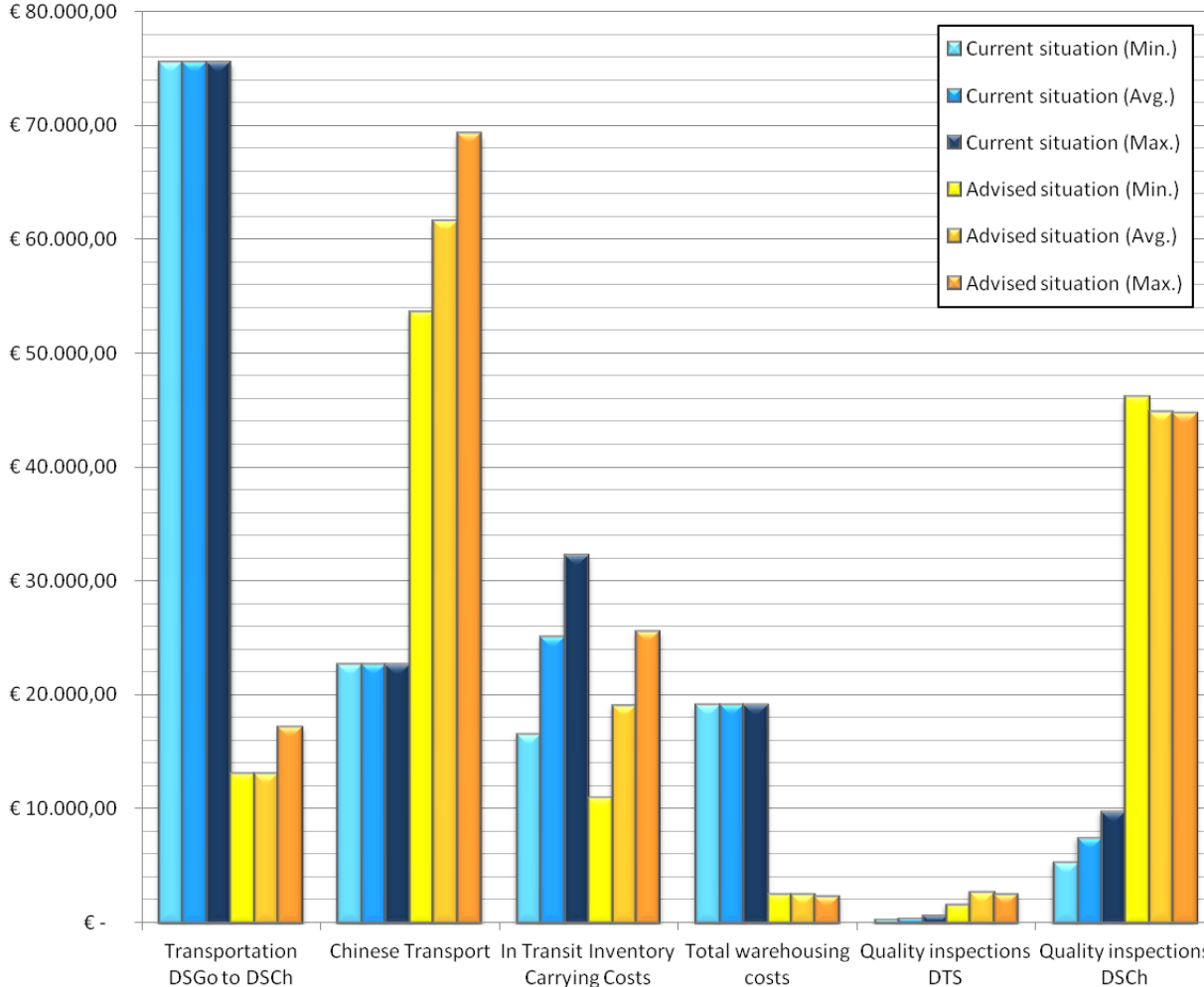


Figure 6.3 Visual comparison between the costs in the current and the advised situation, (three bars show the accuracy)

Considering this and combining it with the figures presented the foregoing chapters, the following conclusion may be drawn: when a 20' container, packed with the average 168.5 PO lines is no longer shipped from DSGo to Shanghai, it saves € 1.63 per PO line (€ 274 per container). This is such a small number, that virtually *any* increase in quality control costs or local transportation will eliminate it.

It is not to be expected that this situation will change in the near future: in general, overcapacity in the ocean liners sector keeps on existing. The fuel costs keep rising, but this will hit the barges relatively harder than the ocean liners due to the mentioned efficiency (AT Kearney, 2012).

The estimation of the improvement of the material costs are much lower than the earlier estimated 10 % (Selles, 2012): partially, this is caused by the fact that a number of items already is procured in

China, hence causing no change to the current situation; partially, it is also caused by the fact that this research does not advise to source *all* items in the Far East.

As discussed, part of the financial gains through the sourcing strategy will be traded off against an increase in engineering effort (and costs), especially for the parts that are Engineered to Order (the Sets). In addition to this, it should be known that the initial procurements will not show these advantages yet: it takes time to find the best suppliers and to fine-tune both the collaboration and quality standards.

6.5 Level of quality control

The level of quality achieved is, as explained, measured by the number of Chinese supplies inspected. Though this is not a perfectly fitting quantification, it may be used in arguing whether the control on the quality has (at least) remained equal or not.

The earlier any defects are discovered, the lesser risk there is for disruptions in the delivery of the ship though. This has not improved, as among the items inspected before arrival a reduction appears (Table 6.3): the number of DSCh’s orders checked in advance reduces from 100% to 76%. The reason is found in the lowest value routine items, which will be checked at arrival only. This is not of grave concern: late discovery of defects in this group of parts thus may not have too much impact.

Table 6.3 Comparison of the percentage of the Chinese orders inspected before delivery

Procuring party:	Orders checked before delivery -current situation	Orders checked before delivery - advised situation
DTS	100%	100%
DSCh	100%	76%

Though a share of the procurements is checked later on, all Chinese procurements are checked after arrival at the yard. In that sense there is no change compared to the current situation, and the criterion is concluded to be met.

6.6 Lead time

To assess the internal lead time of Damen, the total time is taken from the delivery by the supplier until delivery at DSCh for all trajectories. To compare both the current and advised situation, this number is multiplied by the number of PO lines in a specific trajectory. This calculation is shown in Appendix E. The results are shown in Table 6.4.

Table 6.4 Comparison of the total transportation in the current and advised situation

	Current situation [days x no. of lines]	Advised situation [days x no. of lines]
TOTAL	90,757	16,150

It can be concluded that the amount of time in transport overall decreases by over 86.5%. This is mainly caused by the enormous amount of PO lines that are within the routine items, which are cut of the long trip from Europe to China. The lead time of the overall project is however not reduced: most of the items that have a long lead time (lead time from the supplier, that is), are strategic items. These are still procured by DSGo, and the transport time for these items is not reduced. On the other hand, the lead time will not raise either.

It therefore can safely be stated that the criterion to at least maintain the lead time, is matched.

6.7 Sustainability

The sustainability of the logistics in Damen’s supply chain are characterized by the (amount of) transportation, which results in emissions and energy consumption. As discussed, the emissions are shown by the amount of carbon dioxide.

As the exact location of the suppliers is not known, and the average distances over the trajectories should be considered. That is: 1) Gorinchem-Rotterdam-Shanghai-Changde, through the Suez channel; 2) Suzhou-Changde; and 3) DSCh’s suppliers – Changde.

Based on emission data(EcoTransIT, 2012) the emission total emissions and diesel usage are estimated. The detailed outcomes are discussed in appendix F and summarized in Table 6.5.

Table 6.5 Evaluation of the carbon dioxide emission and fuel consumption (latter rounded to hundreds)

	Current situation		Advised situation	
	Energy consumption [Diesel Equivalents]	Carbon dioxide [Tonnes]	Energy consumption [Diesel Equivalents]	Carbon dioxide [Tonnes]
Grand Total	31,000	74	35,400	85

From these figures, it can be seen that the advices do not improve the sustainability of the logistics in the supply chain. Though the total transport distance decreases (appendix F), the relative increase of truck transport causes a worsening of the environmental impact: both the fuel consumption and the emission of carbon dioxide increase by about 14%.

When it comes to sustainability however, it is too narrow to only look at the impact of logistics: as the Chinese industry is not known to be very environmental friendly (for example (Hofman & Kuijs, 2007);(Kahn & Yardley, 2007); and(Pearce, 2010)), the impact of a sourcing decision is wider than logistics only. Though it is not possible to quantify this effect for the advices in this research, it is a safe statement that the effect will worsen the sustainability of the supply chain.

6.8 Amount of imports

The amount of imports, measured in PO lines, can be estimated fairly precise: the number of imports equals the number of international transport. For the supply chain of DSCh's ASD 2810, that is the number of items procured by DSGo. This number is known from paragraph 6.3 and listed in Table 6.6.

Table 6.6 Comparison of the number of PO lines transported internationally

	Current situation	Advised situation
Number of PO lines shipped internationally	1,086	204

The shown reduction of lines indicates that the overall influence by, and therefore risk from, customs procedures is reduced. More important than this global number however is the amount of difficult items that no longer will require importation: in the advised situation all difficult items (such as fireworks, paints, chemicals, etc.) are procured within China, no longer forming any risk in import.

It must be noted though that this is not importation in classical sense: Damen pays no import duties, as the parts are related to a project that is sold in a country other than China.

6.9 Transparency of the supply chain

Looking at the advices given on the separate logistical components, it shows that more orders are placed by other companies than DSGo. The role of DTS is increased. In addition, one of the advices is to integrate (part of) the order flows in companies other than DSGo.

This shattering of the order- and material flows is increasing the complexity of the supply chain. Increasing the complexity means that the insight into the performance and status will become rather more difficult.

To handle this, it is essential that the described (see 5.1.3 and 5.4.3) comments are considered. Especially the implementation of a central system that contains the logistical- and procurement information will greatly improve the insight. As currently, the information on procurements by DSCh is separated from the procurement information of DSGo, the implementation of a single, overall, system would the transparency compared to the current situation. Damen's newly implemented ERP software being rolled out group wide, is considered an excellent platform. Though currently some practical problems exist, in the near future these barriers will be removed (Aarts, 2012).

Concluding: the implementation of such a centralized system, based on Damen's new ERP system, would increase the transparency. When such a system is not created, the insight would reduce.

6.10 Improvements to the advices

As was quantified in the previous paragraphs, the advised changes to the logistical components of the supply chain do not reduce the costs on logistics and quality control, which is one of the main reason for increasing the Chinese sourcing. The increase of sourcing in china in order to reduce the costs thus is only viable when the costs of quality control are restrained. Two options are advised to reduce the costs for quality control: cooperation with current supplier; and reducing the distance towards suppliers.

Cooperation with current suppliers

Literature (Langley, Coyle, Gibson, Novack, & Bardi, 2008) describes the advantages to such problems by supply chain integration: the increased cooperation in the supply chain can counter cost increases in quality, logistics, and others in the chain. However, as described, the supply chain integration with Chinese partners is considered infeasible due to cultural differences (Van Gelder, Discussing Damen Trading Suzhou, 2012).

For that reason, the most feasible option for supply chain integration and reduction of the quality control efforts is integration with the current (western) suppliers: persuading the current suppliers in joining the increase of the Chinese activities would benefit all parties. On one hand the suppliers would benefit, as they will continue to supply to the production of Damen's Chinese yards, instead of losing them to Chinese competitors. On the other hand Damen would benefit, as the quality control would be secured by the (trusted) suppliers themselves. Currently, it happens quite often that Dutch suppliers open a branch close to a foreign Damen location. This is however a process that would not only affect DSCh's ASD 2810, but all production either in Changde or even China.

Using such construction, the effort- and costs for quality control would drop to the level currently applied to DSGo's suppliers. The downside of this would of course be that such a construction would by no means result in the same decrease of material costs as would be achieved by using Chinese

suppliers. It must be noted though, that experts already state that the costs improvements for high quality products would be limited ((Croes, 2012) and (De Rooij, 2012).

Reducing the distance to suppliers

When it is either not possible, or detrimental, to cooperate with a current supplier, it is possible to reduce the costs of the quality inspections by finding supplier in a more compact area: on one hand this would reduce the travel costs, on the other hand it would reduce the overall time needed for inspections (and thus the costs).

It must be noted however, that though the costs for inspections might be reduced, it is very hard to reduce them so much that they do not counter the reduction achieved in logistics.

6.11 Sub-conclusion on the evaluation of the proposed improvements

This chapter has quantified the (estimated) results of the advices from the previous chapter, by checking them to the initial requirements. The chapter also has brought some improvements to the original advice due to the resulting figures.

The evaluation has resulted in a positive outcome on the following requirements:

Need to have:

- Reduce the overall costs
The reduction of the logistics and quality control costs was not significant. Savings on the material procurements tipped the overall balance to a reduction of about 1% per ship.
- Maintain or improve the current level of quality;
All Chinese items are inspected on their quality level before delivery. Exceptions are the lowest value routine products, which are only inspected after delivery at the yard.
- Maintain or improve Damen's current lead time for delivering ships.
The total time in transportation was reduced, but the long-lead time components still require long distance transportation;
- Take into account the insight into the performance of the supply chain.
It is reasoned that the insight is improved when a global information system is implemented, but is worsened when no additional measures are taken.

Nice to have:

- Reduce the impact of customs and security.
The number of objects imported is reduced, and no risk imposing items require custom clearance anymore.

One nice to have however is not matched:

- Improve the sustainability of Damen's supply chain;
Both the energy consumption and emissions increased, due to the increasing use of transport by trucks.

Due to the lack of costs reduction on the quality control- and logistical activities, an addition is made to the original advice: in order to reduce the costs for quality inspections, a further integration with the suppliers is advised by requesting current Western suppliers to relocate to the Chinese mainland. When looking for Chinese suppliers, it is advised to search them close to the yard (reducing the local transport costs) and in proximity to other suppliers (increase the efficiency of quality inspections).

7. Implementation of the advised measures

In the previous chapters DSCh's ASD 2810 has been taken as a business case for improving quality control- and logistical activities, resulting in a number of advises to the logistical- and quality control. In order to achieve any of the shown advantages, the implementation must be looked at: 1) the area of implementation; 2) the organization and engagement of the parties; 3) measures considered quick wins; 4) long term measures; and 5) the possible extension of the measures.

7.1 Area of implementation

This research has taken the tugboat ASD 2810 as a business case for improvement. Within the (current) structure of the Damen Group, there is however very much interconnectedness between the Product Groups (PG's) and the yards (see Figure 7.1). Implementing the measures only for DSCh's ASD 2810 would therefore limit the impact and potentially cause confusion, as both the Tugs Product Group and DSCh will change their procedures only for part of their projects.

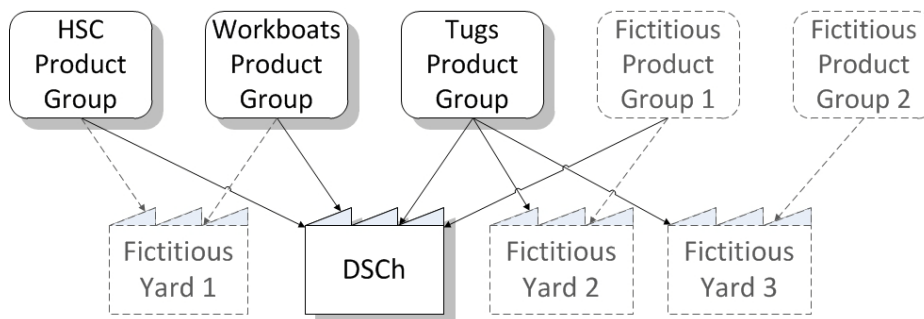


Figure 7.1 Simplified visual representation of the interdependency between yards and Product Groups

Implementation of the proposed measures for the complete Tugs PG would inflict multiple yards, thus requiring additional local markets to be assessed and multiple departments to adapt. Implementation at DSCh however would require little adaption of the PG's (a change to the applied demarcation), while the application to all production of the yard would increase transparency. The policy of 'Core Companies' (chapter 3.6.5) to let the core yards (one of which DSCh is one) focus on certain types of ships, will further add to the increase of transparency.

The measures should thus be implemented per yard.

7.2 Parties in the implementation process

For implementation purposes, the parties involved should be considered in two ways: 1) select parties which decide on the measures; and 2) the engagement of other parties. Both are based on a categorizing of stakeholders (Hillson & Simon, 2007), as shown in appendix A.2.

7.2.1 Parties to include in the deciding team

The implementation of the proposed measures is not possible without the cooperation of the powerful stakeholders (see appendix A.1 and chapter 3.5). There are four such actors, which all are considered to be supportive (see appendix A.2).

However, the external customer is in fact a diverse, large quantity of parties. They are therefore replaced by a party which' interests are aligned and which stands very close to them: the Sales department. Secondly, the Tugs Product Group will represent the other PG's that produce at DSCh: their interests are mostly aligned, while it is the major PG that constructs its ships in Change.

All actors in this team are at different branches of Damen’s corporate hierarchy (see appendix A.4) and in a dispute none of them has a final say in a decision. Therefore, a persistent controversy will involve escalating a decision to at least the COO of the Damen Group.

In addition, the COO's involvement would assure the wider perspective needed to consider group-wide implications; it assures the (preservation of) experience at the top level of the organization (increasing the chances of success during potential extension of the implementation to other yards). The COO would represent the General Management, which is a main stakeholder.

A side note must be made on this: the discussed parties can decide on the strategic choices, such as local vs. global procurement. The operationalization of global procurement (whether it results in a Chinese supplier or not) will remain the responsibility of DSGo's Procurement department.

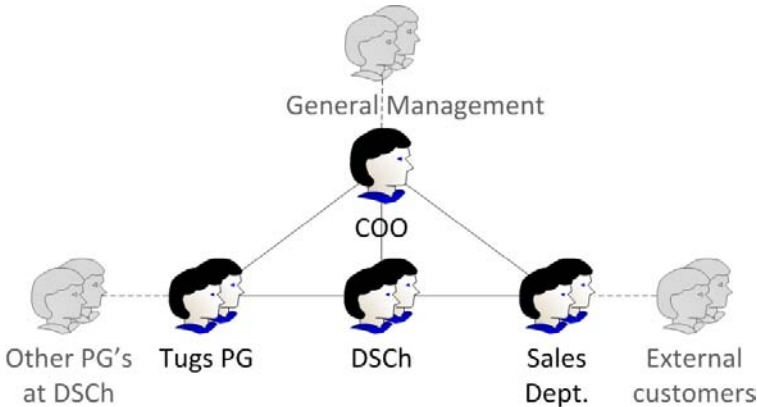


Figure 7.2 Visualization of the actors to include in the deciding team.

To conclude on the previous: the decision-making process should include (representatives of) the Tugs Product Group; Damen Shipyards Changde; DSGo’s Sales department; and the Group's COO. This is visualized in Figure 7.2.

7.2.2 Engagement of other stakeholders

For discussing the implementation, it is assumed that the four deciding parties (see 7.2.1) are problem owners. During the implementation they should cope with various other stakeholders, of which some are in favour, and some are not. The correct engagement of these parties therefore is critical for a successful implementation. For a detailed assessment of all parties, see Appendix A.2.

The largest threat to the implementation comes from the parties that are of negative attitude and (potential) high power: these are parties that can possibly withhold the implementation. These are the Engineering department, as well as potentially the external customers (see Appendix A.2).

In order to spare the attitude of the first as much as possible, the impact on them should be reduced: the department should be given sufficient time to adjust to the increase in specifications required for the ordering of components Engineered to Order. This means the implementation of the new sourcing strategy for the procurement of Sets should be uncoupled from the overall implementation.

In order to improve the attitude of the second, one should acknowledge possible concerns on the quality of Chinese made components: Damen should convince the customer that Damen delivers quality ships regardless of the choice of supplier. An example of a way to achieve this, is to give a

warranty specifically on the components from Chinese brands. It must be noted though that this specific solution will require extensive data on the reliability of the parts in order to be successful.

For most other parties, the main engagement strategy should focus on arousing their interest, or maintain them being interested. Not being a power player in the implementation of the proposed measures, the discussion of their position can be found in Appendix A.2.

The engagement (among others) is now used to decide which measures are quick wins or long term.

7.3 Quick wins

Quick wins are measures that take little effort (either in stakeholder engagement or investment) to implement, but improve the current situation. Four quick wins are distinguished and now discussed.

Modal selection is performed for every shipment again, and therefore can be changed without investments nor hurting any stakeholder. When considering the in-transit inventory carrying costs when choosing a transport mode for the engines, thrusters, and electrical system plus winch, and delaying their procurement (and payment) accordingly, some € 6,000 can be earned per ship.

The largest cost winnings (in logistics) can be made by reducing the distances for local transportation and quality inspection, especially in China. When new suppliers are sought, this should be done at a shorter distance to the yard(s) on one hand, while being closer to other suppliers on the other. By this criterion in supplier selection, a large cost- and time reduction can be induced.

The adaption of the Incoterms is mostly a formality, sometimes under negotiation during procurement. It requires no initial investment. The change will not result in a reduction of the costs, nor an improvement to the performance of the supply chain. It however will reduce the risks.

Transferring (at least) the contract negotiation from DSCh to DTS is a small organizational switch, as most of these procurements are now done in China. Such move will centralize the procurement of the most expensive (non-complex) components in China, allowing the procurement control and power to be maximized. It will however require sufficient capacity at DTS.

7.4 Measures to be implemented on the longer term

Longer term measures may or may not have a limited impact, but are always more complex to incorporate. Four such measures are distinguished and are now discussed:

The implementation of Kraljic's strategies in Damen's procurement is quite an extensive task: it inflicts a large number of orders and suppliers that need to be shifted towards local procurers. The result will be a reduction of (disturbances due to) transportation as well as shorter communication lines between the production yard and suppliers.

The implementation to the procurement of components Engineered to Order (i.e. Sets) should be implemented separately, as Damen has a high dependency to the suppliers these components. Finding new suppliers for these requires quite some adaption in the specifications Damen's Engineering department makes for the suppliers. The Engineering department is a bottleneck in this and will need sufficient time to adapt. Hence it is a long term measure.

Apart from the change in sourcing strategy, Damen should look for possibilities to engage in an intensive partnership with suppliers, so that they open up a Chinese branch. As this inflicts large

investment from the suppliers, it will be a long term decision-making process before all parties are on the same page. The benefits due of reducing quality control costs and efforts are however large.

Lastly, in order to influence the customers, Damen needs to eliminate the customers' concerns on the quality of Chinese components. To achieve this Damen might, among others, consider implementing a warranty on certain Chinese parts. This requires however detailed information on the reliability of the specific components, hence being a long term measure to implement.

7.5 Extension to other yards

As DSCh's tugboat ASD 2810 is taken as a business case, additional advantages may be found by extending the implementation to other yards: on one hand it would increase the benefits from global sourcing; on the other hand it would standardize the applied strategies in the company.

As discussed before, the implementation is advised to be done per yard. Extension would therefore mean the rolling out of the strategy to other yards than DSCh. It would make sense to start with the 'Core Companies' (chapter 3.6.5), as these yards are destined to get increasing responsibilities.

The discussed implementation structure is very well applicable to such situations, as only two actors would change: the yard, and (potentially) the Tugs PG. The other stakeholders would however retain, bringing their experience on previous implementation(s). The ability to learning towards future implementations therefore is assured.

It must be noted though that the outcome of one implementation is not to be copied bluntly to a new one: each yard has its own advantages and limitations, and each geographical area has its own possibilities. Therefore, among others, the categorization of the supplies and an estimation of the risks should be adapted to each specific situation.

7.6 Sub-conclusion on the implementation of the advised measures

This chapter has shown a strategy for the implementation of the proposed measures. The following parties should be included in the deciding team (in random order): the Tugs Product Group; Damen Shipyards Changde; DSGo's Sales department; and the COO of the Damen Group. Furthermore, it is argued to implement measures for all projects at DSCh.

It is described that the following measures can be implemented on short notice:

- Considering the in-transit-inventory carrying costs when selecting a transport mode;
- Looking for suppliers at a closer distance;
- Changing the standard Incoterms to FCA and DAP;
- Transferring the procurement responsibility of leverage items to DTS.

The following measures are to be implemented on the longer term:

- Implementation of Kraljic's strategies in procurement;
- Applying the new sourcing strategy to components Engineered to Order (the Sets);
- Partnering with current (Western) suppliers in China;
- Guarantee the quality of components.

The structure is thought to sufficiently maintain any experience, gained during the implementation, for future projects.

8. Conclusion

Damen Shipyards Gorinchem is facing increasing cost pressure, disturbances from customs and an opportunity seen in reducing costs by increasing the procurement and construction in the Far East. Reducing costs however had a danger of trading off against a reduction in the quality. This results in the following objective for this research:

"to assess opportunities to improve the logistics and quality control activities in the supply chain of Damen Shipyards Gorinchem, by increasing procurement and construction activities in Asia, in order to reduce the cost and lead times while maintaining the quality level and taking into account the transparency of the Supply Chain"

This translates in the following research question: *"can the logistics and quality controlling activities in the supply chain of DSCh's tugboat ASD 2810 be improved, taking into account the increasing procurement and construction activities in Asia as well as the transparency of the Supply Chain?"*

This is scoped to the logistical- and quality control activities in the supply chain of tugboats of the type ASD 2810, built at Damen's yard in Changde (China). This is one of Damen's most common ship types. The yard is one of the main production companies in the group.

The conclusions are discussed per sub-question.

Q.1 What trends are affecting the supply chain of DSCh's tugboat ASD 2810?

Through a desktop research and interviews the following trends were found: increasing cost pressure on ships being sold; increasing shift of production capacity to the Far East; increasing limitations to the shipment of dangerous goods; and increasing disturbances due to transport and customs. and

Q.2 Who are the stakeholders in the supply chain of DSCh's tugboat ASD 2810 and what is their interest and power?

Through interviews the most important criteria are found from six important parties: the customer's satisfaction; cost reduction; maintenance or improvement of the lead times; sustained quality level (i.e. delivery up to specifications); and sustainability of the supply chain.

Q.3 What are Damen's corporate policies and goals on their future supply chain?

By a desktop research and interviews, six major policies or objectives were found: to let Damen distinguish from competition on quality and lead time; to reduce costs; to expand sourcing in Asia; to focus on four companies; improve sustainability; and increase the supply chain's transparency.

Q.4 What are the requirements for the logistical- and quality control activities in the supply chain of DSCh's tugboat ASD 2810?

The previous three analyses resulted in the following requirements for improvements:

Need to have:

- Reduce the overall costs;
- Maintain or improve the current level of quality (i.e. the delivery up to specifications);
- Maintain or improve Damen's current lead time for delivering ships;
- Maintain or improve the transparency of the logistical- and quality control activities in Damen's supply chain;

Nice to have:

- Improve the sustainability of Damen's supply chain;
- Reduce the impact of customs and security.

Q.5 and Q.6 How can the logistical- and quality control activities supply chain of DSCh's tugboat ASD 2810 be improved?

The fifth and sixth question were focussing on six topics. This sub-conclusion is discussed per topic.

a. Who should be doing the procurements? And b. should Damen apply a global- or local procurement strategy?

Based on Kraljic supply management theory and interviews, the advice on the strategy is: to procure strategic (expensive and from a complex market) products globally through DSGo; to procure Leverage (expensive and not from a complex market) and bottleneck (inexpensive and from a complex market) products globally through DTS and DSGo; and to procure Routine (inexpensive and not from a complex market) products locally through DSCh. Framework contracts can be used to reduce the communication distance and effort between yard and suppliers.

In contrast to this advice, nearly all parts are bought currently by DSGo. Very weighty or voluminous, but not complex items are bought by DSCh. DTS only supplies some anchors and doors.

c. Where should Damen's warehouses be located?

Standardized items with a long lead time are advised to be kept in stock, as are the bottleneck items. The current rule of thumb for consolidation (orders under 4 tons or 10 m³) is advised for all materials. For leverage items, stock should be kept in case of the opportunity for procurement advantages.

As the amount of orders to Chinese suppliers requiring consolidation is low, it is not advised to use a warehouse in China. Stock keeping and (minor) consolidation activities are to be done at a supplier. Framework contracts may be used to achieve this. The central warehouse in Gorinchem is to be used in the flow from Western suppliers. This is not changing the current situation.

d. What transport modes should be used?

For transportation, the *in transit inventory carrying costs* are to be considered. Choosing a faster transport mode and delaying the delivery and payment of the supplies accordingly saves money on the interest on expensive products. The criticality is however to be taken into account.

In the current situation, all shipments from DSGo to DSCh in essence use a barge within China, as only the transport costs are considered. Faster transport modes are only used when criticality occurs.

e. Where should the quality be checked and by whom?

As a cultural problem to sustained quality control arises with Chinese suppliers, very stringent quality inspections should be done on parts sourced in China. These should consist of both intermediate and final checks to increase the early detection of problems. For routine items of which the inspection costs are higher than the value, inspection after arrival only is advised. For western suppliers a sampled inspection is sufficient. Their low value items should only be inspected after delivery.

This differs from the current situation, as DSCh now checks items only once, while DTS checks all items regardless their value.

f. Which parties should be arranging transportation?

As Chinese procurements require additional quality- and delivery control (see previous), on one hand the transport for all items that did not get a final quality inspection on delivery should be arranged by Damen. On the other hand, these are the low value items, on which procurement theory prescribes minimization of the buyer's effort.

It is advised that for both the routine and bottleneck items, in principle the supplier arranges transportation. Damen should however arrange transport for Chinese supplies that did not get a final inspection, but of which the quality is critical to both the construction and timely delivery of the ship. This will extra ensure the delivery time. It opposes the current situation, as now Damen arranges transportation in nearly all cases.

Q.7 What are the effects of the proposed improvements?

It is concluded that the described advises match all requirements, except the improvement of the sustainability: both the emissions and energy consumption rise by about 14%.

A 4.5% reduction of the costs on logistics and quality control is achieved, but this amount is not significant. Including benefits on the material costs (but not taking into account procurement advantages due to larger volumes) an overall reduction of about 1% per ship is achieved. When implemented to all DSCh this would result in savings of € 280,000 to € 300,000, even up to € 380,000 to € 400,000 when the yard's production increases in the future.

Due to this evaluation, it is concluded to be important that suppliers are sought on short distance from the yards, in order to reduce the costs for local transport; and that new suppliers are sought close to other suppliers, in order to increase the efficiency in quality inspections, as well as to increase quality due to industry clustering advantages.

Final conclusions

The outcomes of this research draw a picture applicable not only to Damen or the shipbuilding industry, but to any company producing standardized, but not fast moving, products in the Far East. It shows that the logistics and quality control activities can be improved, but that expected gains in costs on logistics through local procurement are limited: costs reductions are low. When combined with virtually any increase in quality control costs, the financial gain diminishes.

It shows that, for China-sourcing to be financially attractive, it should result in a reduction of material costs: the financial benefits in logistics and quality control are limited. In the business case of this research, the total costs are reduced by about 1%. This is less than preliminary expert expectations, due to the fact that currently part of the supplies already originate from China, as well as that not all globally procured items are thought to be procured in China.

One of the major advantages of the advised strategies can be found in a reduction of disturbances through transportation and customs clearing: the chance for fluctuations that can gravely and expensively influence production are vastly reduced.

In accordance to existing supply chain literature, this research has indicated the advantages of industry clusters to quality improvement and efficiency gains.

9. Recommendations and reflection

Though this research is performed with the greatest care, sometimes decisions had to be made in the directions of the research. Inevitably, this research therefore is not covering the broad overall topic. Therefore, this chapter will discuss the author's recommendations for further research, as well as reflect upon the decisions made in performing this research.

9.1 Recommendations

During this research, several topics, complexities or opportunities are seen, but not looked into. For some of these, the author recommends further research:

- This research has looked at the supply chain of DSCh's tugboat ASD 2810 only, removing part of the complexity, but also part of the opportunities. Including common parts over various ship types as well as flows to all yards and companies in the Damen Group, will bring up various advantages: potentially increasing buying power, procurement- and flow handling efficiency, etc. Expanding this research over these flows is recommended.
- This research only looked at the reorganization of the flows and a number of activities. It has however not looked into organizational aspects, such as in- or outsourcing activities. However, part of the costs and problems arise in transportation and warehousing, while this is not considered part of Damen's core competences. The author therefore highly recommends reviewing the core competences and -activities of the company, in order to make a substantiated decision whether a 3PL provider might be of service.
- Part of the complexity arises from the plurality of components over different vessels, and more in general over different types of vessels. Standardization will reduce the complexity and effort in procurement, transportation, warehousing as well as quality control. Therefore, it is recommended that Damen puts effort in the standardization of the components in their supply chain.
- This research repeatedly has mentioned the importance of data sharing in order to ensure the transparency of the supply chain. Though some of the existing structures and systems can be used, the quality of data in these systems is vital for the effectiveness of such system: specifications of supplies, as well as data on the repetitiveness of parts are very much needed. Therefore, it is strongly recommended that Damen pays specific attention to its Master Data Management, as well as to building and maintaining their digital Parts Catalogue.

9.2 Academic reflection

Though this research has been performed with the upmost care about the results, the author finds the following aspects might influence the outcomes as described in this report:

9.2.1 Data used

Two sources of data need to be discussed: DSGo's procurement data; and DSCh's procurement data.

DSGo's procurement data

The procurement data from Damen's former ERP software (MARS) has one main restriction: the costs of some Purchase Order (PO) lines are registered in other classes: some lines have an unrealistically low value, as the real costs are accounted in another class or PO line (see 2.1.2). The large quantity of lines makes retracing these cost displacements not possible, causing an inaccuracy. This results in an inaccuracy of the values on the level of parts and/or PO lines.

This inaccuracy is considered acceptable, as it is used on an aggregated level. The inaccuracies in the details thus fall away. In retrospect however, the research should additionally have used each ship's IDK overview (*'Integrale Directe Kostprijis'*; Integral Direct Costs). In the IDK, the financial data already is aggregated, which improves the accuracy. As it however does not include data on the volumes, these details still are to be extracted from MARS.

DSCh's procurement data

The data on DSCh's procurements is already aggregated, being specific on the values of each class. However, as the data did not include procurement volumes, the amount of orders is not accurate. This has limited impact, as volumes have not been used other than to give insight in the flows.

9.2.2 Methodology used

The using of two methods requires discussion: Kraljic's supply theory; and the stakeholder analysis.

Kraljic's supply theory

As was discussed in Chapter 2.2.1, Kraljic's supply theory is generic. Therefore, in general it is applicable to the situation found in this research. However, some limitations were found.

- Firstly, the theory does not consider *mutual* dependency. The output thus is not always applicable to the reality: for some classes the theory advises a strategic partnership, while the dependency is unilateral. Equal cooperation will thus be difficult to achieve. Literature already has acknowledged this limitation (among others (Caniëls & Gelderman, 2005) (Dubois & Pedersen, 2001) and (Gelderman & Van Weele, 2005)). Also the method is not taking into account the motivation of a supplier, in other words the attractiveness of a (future) deal from a supplier's perspective (Ramsay, 1996).
- Secondly, the theory does not take cultural differences into account. As extensively discussed in the report, former experiences with Damen have learned that partnering with Chinese suppliers requires extensive quality control. The prerequisites for a strategic partnership is preferable, therefore are not equal for Western- and Chinese suppliers.
- Thirdly, the use of questionnaires to apply the theory has increased the aggregation level of the rated classes. This adds inaccuracy: for example, part of an aggregation may be complex, while another part is not. In addition, some smaller parts, which belong to multiple classes, may get a double (contradicting) rating.

There have been scholars that have added perspectives to the original theory, especially on the mutual dependency (e.g. (Gelderman & Van Weele, 2005)). Considering the large amount of suppliers involved and the fact that the dependency may differ per supplied product, the author considers these theories to be too extensive for the subject under research.

Stakeholder analysis

Several aspects should be considered in the (outcome of the) stakeholder analysis:

- The stakeholder analysis has aggregated some parties (for example the Product Groups, which consist of a director, Design & Proposal, Project Management, etc.). Therefore, it shows a simplification of the actual problem environment.
- In general, a stakeholder analysis is considered to be a snapshot of the current situation only (for example: (Enserink, Hermans, Koppenjan, Kwakkel, & Thissen, 2008)). This is especially important to consider within DSGo, as the company's fast growth and organizational changes cause continuous rearrangement of the power ratios.
- Last, the power ratios not only consist of actual power, but also perceived power. The perception of power, and the political arena's within which they are developed, is only limitedly considered during the analysis in this research.

Though the stakeholder analysis thus has its limitations, the author considers the method suitable to get insight in both the requirements as well as implementation considerations.

9.2.3 Calculations for the evaluation

The evaluation did not consider the costs involved in the implementation of the proposed measures. Costs and effort for example for adaption of the Engineering department or the search for new suppliers are not taken into account due to the level of aggregation.

9.2.4 Robustness

No evaluation of the robustness of the proposed measures is done: the transport costs per unit, the fuel price, wages and the material costs have been considered constants. Therefore, this research cannot assess the robustness of the proposed measures to future changes.

10. References

This research has used literature and publications; interviews; e-mails; as well as electronic sources.

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10.2 Interviews

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