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Mitigating global sourcing risk in China from a country of origin perspective how the application of sourcing risk mitigation to China can be utilized for further global sourcing development: a case study at Provide B.V.

Kolp, J.M.

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Mitigating global sourcing risk in China from a country of origin perspective.

How the application of sourcing risk mitigation to China can be utilized for further global sourcing development; a case study at Prodrive B.V.

by J.M. Kolp Bsc

BSc Industrial Engineering and Management Science – TU/e 2010

Student Number 0620071

In partial fulfillment of the requirements for the degree of:

Master of Science in Innovation Management

Supervisors University of Technology Eindhoven:
Dr. Ir. W. van der Valk
Dr. J.A. Keizer

Supervisor Prodrive B.V.:
Drs. Ing. E.A.W. Zeegers
TUE School of Industrial Engineering

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Abstract

In the past decades many companies have relocated activities or source from the Far East and China in particular. This has caused China to face rapid economic development in the last decades which could influence the effectiveness of sourcing from China. With the growing economy may also come increasing cost of sourced goods. Some firms have already relocated their sourcing out of China or are struggling with quality and flexibility. In this research a risk assessment methodology is developed and carried out that anticipates on the country specific influences in global sourcing for China. This enables companies to identify appropriate measures to ensure global sourcing effectiveness. The risk assessment is carried out for four cases sourced from China provided by a high tech electronics design and production company. For these four cases risk mitigation measures are designed, anticipating on the influence of country of origin dynamics. By performing the risk assessment, the sensitivity towards and the uncertainty of country of origin dynamics is exposed. This assessment is a first step in the further understanding of country of origin effects in global sourcing.
Management Summary

Since the early 1990’s many companies have either outsourced or offshored activities to the Far East which have caused the acquisition of products to become a global activity for these companies. The main determinant for setting up these activities is that companies anticipate on achieving a strategic competitive advantage by sourcing from low cost countries. The competitive position is mainly enhanced by reducing the total costs. Given the benefits, the strategic importance of global sourcing has increased in the last years. However, achieving a decrease in total costs through global sourcing is not straightforward. While there are benefits to be obtained, some companies fail in their attempts of achieving these. Some companies have been forced to backshore their sourcing activities to Western world countries where flexibility and quality are easier to control (Kinkel, 2012). In addition, the countries to which activities were outsourced or materials sourced from have developed substantially. One clear example is China which has seen dramatic increase in direct production costs. To some low margin industries this increase has become problematic, forcing these companies to find other low cost countries as Vietnam and Indonesia (Roberts, 2008). Therefore, country specific developments add a complicating factor to global sourcing that should be looked at carefully when assessing global sourcing activities.

Given the current trends in country of origin specifics, it is questionable if sourcing from China remains profitable in the long term. Therefore, the risks that a company faces during the lifecycle of the procured or outsourced material will evolve and should as such be evaluated before a sourcing decision is made. Currently, no such methods have been developed that anticipate on the development of the country of origin in global sourcing activities. Therefore, the objective of this study is to develop an approach that allows companies to expose and mitigate risks in global sourcing, anticipating on the dynamics of the country of origin.

In order to achieve this objective, this research will be oriented towards the following main research question:

How can the uncertainty in Chinese sourcing be reduced and the lessons learned applied in further global sourcing expansion?

In order to answer this research question, a case study was performed for four cases. This case study consists of three elements. The research will firstly consist of a theoretical element. The second part of this research will consist of a practical element where theory from the first element shall be used for gathering field data by performing a risk assessment. The third part will form a solution design based on the diagnosis from the previous elements, incorporating theory and practice.

The theoretical base consists of four main elements. First, the development of global sourcing in the last years have been shown. This development has caused a rapid economic growth in China, leading to some relocation or backshoring of global sourcing activities through increasing total costs of ownership. This development has not been incorporated in current global sourcing risk assessment methodologies. As such, a new risk assessment model is developed in the second element of the theoretical base. This risk model consist of three domains; the risk context, country of origin effects and risk mitigation. For each category in the risk context a set of measurable risk elements have been identified. For the country of origin effects the same has been done where distinction was made in the risk elements between direct and indirect measurements in the third element of the theoretical base. Together, the country of origin elements and the risk context elements provide an answer to which uncertainties must be checked for assessment of global sourcing risk. The final element of the categorical risk model is risk mitigation for
which three main measures types have been identified; project measures, hybrid measures and country measures. This provides a general answer to how the uncertainty in global sourcing can be reduced. To determine which risk measures apply the best given the risk elements value in both the risk context and the country of origin context, the COORMC has been developed based upon transaction cost economics in the fourth and final element of the theoretical base.

With this theoretical base, a risk assessment methodology was developed according to Risk Diagnosing Methodology (RDM) (Keizer, Halman, & Song, 2002). This methodology was selected for the following reasons. RDM tries to overcome groupthink whereas the other considered assessment methodologies are subject to this. In addition, RDM measures risk as a social construct which fits with the requirements of this research since practitioners are predominantly involved. RDM fits with the risk definition of practitioners since it poses a risk questionnaire used to assess the likelihood of the event, the ability to influence the course of action and the relative importance of the event. Since managers see risks different than chance because they can influence the outcome, the fact this is explicitly assessed ensures RDM fits with managerial perspectives (March & Shapira, 1987). In addition, by developing a questionnaire to test the likelihood, a comparative perspective is possible which allows comparison of Chinese and Dutch suppliers. This way, different values in risk and therefore uncertainty can be observed and compared. For these reasons the RDM shall be further considered and other risk assessment methodologies shall not be treated here.

Next, the literature base was used to set up a questionnaire that would allow an RDM assessment such that the field data aspect of the study could be fulfilled. To obtain this data, for four cases the RDM process was carried out. For each case, a comparison was made between the current Chinese supplier and a possible Dutch alternative to investigate the differences in risk perception. For each case, the specifics of the case causing risk values to differ between China and the Netherlands were discussed. In line with the categorical risk model presented in the theoretical element, the product characteristics play an important role in the risk perception. However, for each case at least some risk values were found to have a large contrast with the Netherlands. As such, it is reasonable to expect an influence from the country of origin on the risk in global sourcing. It has also been shown that Prodrive and the supplier’s sometimes have different viewpoints. Therefore, next to the application of RDM within Prodrive the supplier input is useful in assessing the global sourcing risk for a case.

When all the results and interpretations from theory and practice are taken into account, it can be stated that indeed a relationship between certain sourcing risk elements and country of origin elements exist. With the case study results from Prodrive, it has been shown that some risk elements face consistently higher risks in China compared to the Netherlands, independent on supplier and product. The domains where additional risk levels are encountered are not focused in a specific domain, but scattered across six different domains: costs, human capital, IT infrastructure, logistics, product quality and supplier responsiveness. As such, risk mitigation measures will have to be oriented towards a broad set of domains. Currently, the greater risk levels in these domains can be accepted because the major benefit of cost savings obtained through Chinese sourcing is still sufficiently large. However, a change in country dynamics may have an effect in one or several of these domains and disturb the balance which currently exists.

In addition to the consistently greater risks, a few remarkable effects can be noticed. First, the effect of the supplier selection process on the risk perception is substantial. The difference in risk values between cases I and II is such that many of the differences can be contributed towards the fact that the supplier of case I has not been selected by Prodrive but by the customer. Case II faces either generally lower or no greater risk at all compared to case I when comparing Chinese and Dutch sourcing. Therefore, the
uncertainty level encountered with Chinese suppliers is greater when no supplier selection process has been completed.

Second, a European sales agent has a large effect on the perceived risk levels. The selected cases face roughly the same logistic nature; goods are produced in China and shipped to the Netherlands. However, the difference in risk perception between the PCB portfolio where a European sales agent is active and the Cables & connector portfolio where is dealt with Chinese suppliers directly, is substantial. This is reflected particularly in the communication oriented risk elements such as contracting possibilities, order updates accuracy etc. A European sales agent therefore has a clear risk mitigating effect on Chinese sourcing.

To deal with the consistently greater risks a risk mitigation strategy is required. When there is sufficient frequency, uncertainty and specificity a form of country of origin measures is effective. It is shown that the sourcing in China cannot be called an incident, and as such the frequency of Chinese sourcing is sufficiently high. In terms of uncertainty in the country of origin values, it became clear that quite some variables identified by Kolp (2012) as country of origin elements have seen dramatic fluctuations in recent years for China. Therefore, the uncertainty in country of origin elements is such that some form of country of origin risk mitigation measures seems justified. Lastly, in terms of specificity it has been shown that there is quite some sensitivity to country of origin elements by showing the conceptual relationship between consistently high six risk domains and country of origin elements.

From this conceptual relationship, the following risk mitigation measures are designed. First, a distribution office should function as a separate company within Prodrive Holding by sourcing from several suppliers in the Asia region. This way, the distribution company can focus completely on optimizing the information, material and cash flows from Prodrive to their Chinese suppliers. In addition, setting up a distribution office will allow Prodrive to have one single focus point instead of managing individual Chinese suppliers. This consolidation is not just for information, but also for goods. Setting up a distribution office will allow for transport consolidation from China to Prodrive, thereby reducing the transportation costs. Next to the optimization of separate flows, having a distribution point for the Chinese suppliers will allow Prodrive to have initial quality checks carried out, making return flows to the supplier easier and the chances of defects arriving in the Netherlands smaller. By setting up the distribution office within the Prodrive Holding in a tax friendly country, additional financial gain can be obtained as well as a presence for future sales opportunities. In addition, communication oriented risk elements such as contracting possibilities, order updates accuracy will face substantially lower risk values.

Next to setting up a distribution office, Prodrive needs to reconsider its selection and auditing processes when it comes to Chinese suppliers. In a more general sense, it is probably best to deviate the specifics of supplier selection dependent on the country of origin and its appliance. This will allow selection and evaluation of suppliers based on the likely risks in that country. This way, Prodrive will reassure itself its suppliers are well equipped against possible changes in the country of origin. The changes should at least be expanded with a financial health check, employee development plans, health and safety measures in place and environmental proactiveness. Taking the largest risk exposures in to account by differentiating to a certain country creates a more robust selection and auditing policy.

Several recommendations can be made with regard to the implementation of the results of this research. First, the proposed solutions to set up a distribution channel and change the supplier selection and evaluation procedures should be implemented. Next, it should be rechecked to see how the risk exposure levels have developed. The solutions have been designed based on the findings of this study and are therefore likely to positively affect the risk exposure. However, this expectation should be validated after the implementation. In this research it has been shown that some differences may exist between the
supplier and Prodrive. Therefore, it is important to incorporate the supplier in this validation as well. Second, the solutions have been designed based on a part of the entire supply base of Prodrive present in China. It should be checked if the proposed solutions are also applicable to the remainder of the supply base in China and if these suppliers would also benefit. Given the results of the current study, it is expected that the influence of setting up the distribution channel will also contribute in the remaining custom component categories that are directly procured from Chinese suppliers. Third, the proposed solution contains a guideline for implementation. However, at the current point in time there is too much uncertainty to develop a complete business case required for obtaining resources. Although the most important aspects have been noted, additional research should be performed to analyze how the new business should function and operate, which requirements exist for this and how these can be fulfilled. An important note is to define clear goals in the implementation planning of the business case such that progress and evaluation can be performed effectively. Fourth, with the further expansion of Prodrive’s global sourcing activities, assessing the country specific risk and how it may affect Prodrive’s sourcing effectiveness will bring insight which measures are applicable to mitigate risk. In addition, in the event of changing country of origin dynamics or sensitivity towards these dynamics, assessing the COORMC position can help Prodrive identify if and when to backshore or reposition their sourcing activities from the country of origin.

In addition to the recommendations, several contributions are made by this study. First, a set of risk elements has been collected based on the work of other scholars in the global sourcing risk field. These elements are distributed over a set of categories and are logically related. The most important contribution however is that these elements are measurable and can be used for performing a risk assessment. Current sourcing risk models are typically oriented towards a specific category such as disruption likelihood or dyadic effects. Second, a new methodology for assessing global sourcing risk in a specific country of origin has been developed. By using a comparative approach in an RDM methodology, the benefits of RDM can be utilized while at the same time having a measure for where different risk levels can be observed in the country of origin compared to the reference country. Third, the country of origin risk mitigation continuum (COORMC) has been formulated based on transaction cost economics that helps in explaining why and when backshoring may occur. Based on the frequency of transactions in the country, the sensitivity towards country dynamics and the uncertainty entailed with the developments of the country, a general feel for which risk measures are effective for the company is created. Fourth, this research has performed a process that will create awareness amongst practitioners on the dynamics brought forward by the country of origin. As such, which risk mitigation measures to take given the specifics of the supply chain in the country can be determined by applying the approach used in this study.

With the contributions of this study in place, an answer to the main research question can now be formulated. In order to reduce the uncertainty in Chinese sourcing, companies will have to assess their risk exposure in China. This risk exposure will be composed of a risk context element and a country of origin element. With this assessment, the position of the company on the COORMC can be determined that will allow for designing effective uncertainty reducing measures. These can be either focused to project specifics, country specifics or hybrid measures. The lessons that can be obtained from China are that companies need to anticipate and estimate how their sourcing will be affected by dynamics of the country. In addition, designing effective risk mitigation measures will depend on three elements that may differ from firm to firm and from project to project: frequency of sourcing, uncertainty in country dynamics and sensitivity towards changes in country dynamics. Finally, the effect of an intermediary on communication uncertainty is such that significantly lower uncertainty is observed when an intermediary is placed between the producing supplier and the sourcing customer.
Preface

Before you lays the most visible result of my seven year endeavor to become an engineer. Although this document is in itself an achievement that I will proudly look back towards for years to come, it is what it represents what I consider my true achievement. This is the final chapter to what has been a seven year long journey. I did not make this journey alone, and some of the people who have helped me along the way I would like to thank.

First of all I would like to thank my supervisors who have helped me with this final project. My gratitude goes out to Wendy van der Valk who has, despite her transfer to another university, supported me throughout the project. Her feedback was essential for my progress and my criticism towards own work. Next, my gratitude goes out to Jimme Keizer who was willing to supervise the project, despite the risks in the project with a supervisor at distance and my job on the side. My special gratitude goes out to my colleague and supervisor from Prodrive; Erik Zeegers. Many thanks for the fruitful and fun discussions we have had amongst all sorts of topics of which some found a place in this thesis. The lessons I learned will continue to help me for years to come in my professional career. In addition, I would like to thank all my colleagues at Prodrive who have given their input, feedback and cooperation towards this research.

During my seven year study, many people have helped and supported me of which some I would like to thank in particular. First and foremost my gratitude goes out to my parents and sister for their continuous and unconditional support over the years. Furthermore, I would like to thank all my friends for the fun times we shared and those still to come. In particular I want to thank the ‘Anates Volantes’ and ‘Kijk wel ff’ who have managed to make a Frisian feel at home in Brabant.

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Eindhoven, April 2013
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1. Introduction

Since the early 1990’s many companies have either outsourced or offshored activities to the Far East which have caused the acquisition of products to become a global activity for these companies. The main determinant for setting up these activities is that “companies want to ameliorate their competitive position and a global sourcing strategy is seen as a major tool to reach this goal” (Quintens, 2006, p. 33). The competitive position is mainly enhanced by reducing the total costs. In order to achieve these benefits, companies must develop skills in global sourcing (Trent & Monczka, 2003). Given the benefits, the importance of global sourcing has increased in the last years. The clearest example is reflected in China, which has seen a significant outsourcing boom in the early 1990’s.

Achieving a decrease in total costs through global sourcing is not straightforward. While there are benefits to be obtained, some companies fail in their attempts of achieving these. The countries to which activities were outsourced or materials sourced from have developed substantially. China has seen dramatic increase in direct production costs. To some low margin industries this increase has become problematic, forcing these companies to find other low cost countries as Vietnam and Indonesia (Roberts, 2008). Clearly, the production costs of China in the early 1990’s no longer exist. Therefore, country specific developments add a complicating factor to global sourcing that should be looked at carefully when assessing global sourcing activities.

Because of the rapid development these countries are facing, the conditions under which is sourced from these countries evolve during the lifecycle of the product. Since the lifecycles of these products extend over many years, the developments of the country during the lifecycle are relevant to global sourcing. Given the current trends in country of origin specifics, it is questionable if sourcing from China remains profitable in the long term. For example, the current trend in minimum wages in China is such that it will be twice as high in 2015 as it was in 2009. Therefore, the risks that a company faces during the lifecycle of the procured or outsourced material will evolve and should as such be evaluated before a sourcing decision is made. After the initial decision, monitoring procedures for changes in the country that might influence sourcing effectiveness should be in place. In order to properly respond to the risks when sourcing from developing countries, a risk assessment provides a methodology for analyzing country of origin developments. With a correct risk assessment, a company will be able to develop effective risk mitigating measures, decreasing their risk exposure. In the current academic literature such an approach has not been developed.

The dynamic environment in China creates even greater complexity in an already difficult context. Many examples can be found of companies that abandon their sourcing activities from the far eastern sourcing because of difficulties with quality and flexibility (Kinkel, 2012). Recent examples include speculation of Google’s planned production of the Google Glass project in the United States. In fact, many companies are relocating their production activities back to the United States (Neil, 2013). While the scale of the backshoring trend compared to those still offshore is miniscule, a reversing trend is nevertheless emerging. Either because increasing production costs, difficulties in quality or flexibility or additional motives, companies struggle to make sourcing from China effective. For companies who are currently building or considering to build up a supply base in China, the question rises if this is the right way forward and will be profitable. In addition, the effectiveness of global sourcing in a broader sense is questionable given the recent backshoring trend from China. Given the Chinese developments, which lessons can be learned from it for companies in their further global sourcing activities. The answers to these questions is not present in the current academic literature.

For companies currently investigating to start sourcing from China or to expand sourcing activities there, this study will bring forward results that will allow companies to test if, when and how to do so. In addition,
some findings of Chinese sourcing development can be utilized by companies who are currently expanding their global sourcing activities to other countries.

To show companies how to investigate and improve Chinese sourcing effectiveness, a risk mitigation approach is adopted. Through risk mitigation measures the effectiveness of Chinese sourcing can be safeguarded, reducing the risk in disturbance. In addition, in this research a relation is placed between country specific developments and the sourcing strategy put in place through risk mitigation. By putting in place risk mitigation measures the effects from country developments such as climbing wages may be reduced or possibly eliminated. This will not only benefit practitioners, but is also a contribution to the academic literature.

This study will continue by firstly define more thoroughly the problem companies are facing in Chapter 2. In addition, the assignment from the company where the research is executed shall be outline. With the problem description and assignment in place, a theoretical base for the remainder of this study is build up in Chapter 3. This base shall consist of the development of a conceptual global sourcing risk model which will be utilized for execution of a risk assessment. In addition, risk mitigation measures to decrease global sourcing risk will be designed. The risk assessment is carried out for 4 different cases at the researched company and the results from the assessment will be presented in Chapter 4. The analysis and diagnosis will be based upon these results and brought forward in Chapter 5. With a diagnosis in place, a solution design is build up and presented in Chapter 6, as well as an implementation plan for the company where the research is executed. Finally, the results are discussed, and some limitations and recommendations are presented.
2. Problem definition

This research will be oriented towards improving the quality of sourcing from China. In addition, the current economic developments of China require an additional perspective on global sourcing which anticipates on the countries development. In this chapter, an description is presented of the current shortfalls and how it applies to the company of study. First, the objective of the study is formalized which will help to understand the structure of the remainder of this study. Next, the assignment as presented by the company of study is presented which will help to achieve the objective of this study. Finally, an approach is presented how to fulfill the assignment of the company and meeting the objective of this study.

2.1 Objective of the study

As described by Quintens (2006), successful global sourcing still helps companies achieve a competitive advantage. With the dynamics of global sourcing countries such as China and the problems with them, an approach is required which helps companies expose the causes for these problems. This way, the competitive advantage obtained with global sourcing can be kept. With the challenges at hand, companies need a methodology for anticipating on the problems that originate from global sourcing, where this study will focus on China. In this research, an attempt is made to develop a methodology for exposing the risks companies are facing in global sourcing. A vital element in this methodology is incorporation of the developments that take place in the country of origin. Therefore, the objective of this study is to develop an approach that allows companies to expose and mitigate risks in global sourcing, anticipating on the dynamics of the country of origin.

2.2 Assignment

To meet the objective of this study, the company Prodrive B.V. will serve as a base for research. Prodrive B.V. is an electronics design and manufacturing company based in Son, the Netherlands. Prodrive has been sourcing from China for several years and has encountered some difficulties with it. In addition, Prodrive has the ambition to further develop their supply base on a global level, reaping the benefits entailed with successful global sourcing. However, through the current experience with sourcing from China and lack of control on the situation in China, uncertainty to further expansion exists. This problem shall be further explained in Prodrives context in the next section, after which a formal problem definition is presented. From this problem definition a research question is derived for which the methods shall be explained afterwards.

2.2.1 Problem Context

Prodrive is an electronics design and manufacturing company based in Son, the Netherlands. Prodrive was founded in 1993 at the technical university of Eindhoven by its two owners and current directors. Over the years, Prodrive has been a prosperous company with an average turnover growth rate of 25% per year. Currently, their activities have expanded from designing high tech power electronics to designing, developing and producing full electronic system solutions, including mechanics, software and cables. To make this expansion possible, several activities have been added to their main activities allowing for full system solutions to their customers. This started by producing electronics in an automated production line in 1999, followed by module assembly. Recently, activities have been expanded vertically through the integration of mechanics and cables assembly.
In addition to the expanded activities, the customers have become international rather than locally based. However, it should be mentioned that the biggest customers at this point in time are still located in the region. These customers are nevertheless globally operating companies. The same trend can be found for Prodrive’s sourcing activities. Where their main sourcing requirements are still fulfilled by local component manufacturers and distributors, international suppliers are becoming increasingly important. The focus is specifically based on Asian suppliers, reflected in the recent opening of a representative office in Hong Kong.

Prodrive’s growth thus far was established by fulfilling increasingly complex customer needs in technological terms. Therefore, Prodrive has a great deal of knowledge for designing, developing and producing high tech electronic systems. However, for several reasons which extend the current scope Prodrive is expanding its activities to technologically less complex systems but in far greater numbers, specifically consumer products. The origin of the materials required for these products are mainly China. Therefore the sourcing volume from China has grown substantially in the last two years.

To support its sourcing activities, Prodrive makes the following categorization in sourced materials:

- Standard Components
- Custom Components
- Remaining Components
- Non Product Related (NPR) Components

Standard components are standard electronics, often produced by multi billion euro companies such as Intel, Xilinx, TDK etc. This category holds the largest part of the sourcing volume and is mainly procured through European distributing parties. The real production sites are scattered across the world. Custom components are parts that are specifically designed and produced for Prodrive. For example coils, mechanics and printed circuit boards (PCB) can be produced according to a design specifically for Prodrive. The remaining and NPR components are small in volume but hold many different suppliers. However, their added value to Prodrive’s products is relatively low. For every category a further definition is made through portfolio’s. Every portfolio groups a set of purchased materials based on its technology or function.

In light of the current problem context, the relevant material category is that of custom components since these are the most important to Prodrive competitive advantage. The production of standard components is highly automated and is produced by highly advanced companies. Therefore, the impact of country dynamics such as increasing labor costs is not significant for standard components. The remaining and NPR components do not add sufficient value to Prodrive’s competitiveness to be of importance for this study.

The custom components consist of four main product portfolio’s: PCB’s, Magnetics, Mechanics and cable & connector assemblies. For PCB’s the materials are often produced in China but are sourced through distribution parties that operate in Europe. PCB’s are a vital component in every product that Prodrive produces. For magnetics the material supply is currently European based but is under investigation for Chinese or other globally oriented alternatives. For mechanics some sourcing activities are already in place in China and expanding. For cable & connector assemblies some purchasing activities take place with Far-Eastern companies, specifically for standard cable types and further expansion is under investigation.

2.2.2 Problem Definition

As mentioned before, Prodrive has started a representative office in Hong Kong. However, it has been shown that Prodrive is struggling with making this work effectively. Over the last years, different people
with different skills have operated in Hong Kong with different tasks and responsibilities. However, to the current point in time Prodrive is not satisfied with the way of working between Prodrive Son and Hong Kong. Until a clear approach and strategy is present of what is required to make the representative office work, management has seized to invest resources in it. Nevertheless, management acknowledges the potential of global sourcing. In addition, to have a presence in the Far East is also appreciated by Prodrive’s international customers. These customers encourage further globalization of Prodrive’s activities such that not only sourcing becomes more effective, but also aftersales processes provided by Prodrive can be provided closer to their customers. Therefore, Prodrive is aware of some of the benefits of being present in China but, given their previous attempts, struggle to make it work effectively. As such Prodrive is not sure what exactly the additional complexities and uncertainties are that sourcing from China brings and how to deal with them. This prohibits Prodrive from further expansion of global activities to other counties, which would sustain their competitive advantage and is encouraged by their customers.

Given the expanding product portfolio of Prodrive, being able to source effectively on a global level is regarded essential to Prodrive’s future competitive advantage. Therefore, it is required that sourcing from China gets controlled and managed. However, Prodrive also observes the current backshoring trend of activities out of China by some firms to Western countries where control is easier. Therefore, the durability of Chinese sourcing is questionable. A methodology for assessing where and how Prodrive is sensitive to China’s changing economy is therefore also required. The different sourcing risk levels of Chinese sourcing will be influenced by the developments in China.

Therefore, Prodrive faces some difficulties. On the one hand does it acknowledge that a global presence will provide future competitive advantage and is regarded as a plus by their customers. On the other hand, current experiences with China have seen difficulties with quality and flexibility. There is more uncertainty to where problems may exist with Chinese sourcing as is a methodology how to deal with them. In addition, the attempts made to make Prodrive’s representative in Hong Kong work and deal with the Chinese sourcing uncertainty have not been successful thus far. Lastly, Prodrive observes the changes which China has faced the last years, among which are a steep increase in minimum income which may threaten the sourcing attractiveness of China. Therefore, the following problem statement can be formulated:

*The current sourcing activities in China are not efficient and face additional uncertainty through country dynamics. As such, the effectiveness of these activities in further global sourcing expansion is unknown.*

For this problem statement research questions shall be formulated next.

**2.2.3 Research Questions**

In order to solve the problem statement, this research will be oriented towards answering research questions. The following main research question is formulated:

*How can the uncertainty in Chinese sourcing be reduced and the lessons learned applied in further global sourcing expansion?*

From this main research question several sub research questions are formulated:

- Which uncertainties are relevant in global sourcing?
- How can these uncertainties be measured?
- What are the current uncertainties for Chinese sourcing?
- How can the uncertainties in Chinese sourcing be reduced?
- Which lessons can be learned from China for further global sourcing expansion?
The approach used to answer these questions shall be explained in the next section.

### 2.3 Research design and methods

This research is oriented towards solving a business problem. To do so, an approach needs to be developed which fulfills the objective of this study. In this chapter, the process that will be followed and the design that was used to conduct the research is presented.

#### 2.3.1 Research strategy

This research will be set up in several steps. These steps are inspired upon the regulative cycle by Van Strien (1997) but do not follow this strictly. The main difference exists in that this research will not be able to implement the provided solution to the problem. Therefore, the first steps of the regulative cycle are translated into a linear approach that will provide structure towards solving the problem. The current chapter has been devoted towards defining the problem at hand.

The remainder of this research will be set up according to the schematic presentation in Figure 1 and consists of three elements. The research will firstly consist of a theoretical element. This theory aspect consists of the current problem definition and the following chapter. In the current chapter a methodology for measuring uncertainties in global sourcing shall be presented. In the following chapter a theoretical base for the remainder of this study is presented. This will provide insight to which uncertainties exist in global sourcing, and which elements need to be tested. In addition, some remarks are made on how the uncertainty can be reduced through risk mitigation measures. This will allow answering, which uncertainties exist in global sourcing, how these uncertainties can be measured and how the uncertainty levels can be reduced in a general sense.

The second part of this research will consist of a practical element where theory shall be used for gathering field data by performing a risk assessment. The data of this risk assessment is presented in Chapter 4, after which the results shall be analyzed to form a diagnosis in Chapter 5. From these chapters, the answer to what the level of uncertainty is for the current Chinese sourcing can be formulated.

The third part will form a solution design in Chapter 6 based on the diagnosis from the previous chapters, incorporating theory and practice. At this point, the already obtained general answer to how uncertainty levels can be reduced shall be further explained based on the results from practice. Finally, the results of this study shall be discussed in Chapter 7 where an answer shall be provided to the main research question, as well as an answer to which lessons can be learned to further global sourcing activities.

![Schematic presentation of research](image-url)
As mentioned before, the current research will involve the study of several cases. The selection methodology used for these cases and the motives are explained next.

### 2.3.2 Case selection

This research will use case studies to analyze and design a solution to the problem. Through case studies, ‘how’ and ‘why’ questions about a contemporary set of events over which the researcher has little control are the most appropriate method of study (Yin, 2003). In the current research, there is uncertainty towards sourcing in China. The uncertainties that exist for Prodrive may be similar in some but different in other aspects. Therefore, in order to improve the sourcing from China for Prodrive only cases are selected from within Prodrive.

When taking the context of Prodrive in to account, the custom component category will apply the most for further case study. A schematic representation of the case selection is presented in Figure 2. Given the past, the quality problems that occur in this component category are the most frequent. In addition, the process for fabrication of such components is generally labor intensive, and given the lower labor costs in China these are popular candidates for sourcing from China. Because of the labor intensity a greater exposure to country of origin developments is expected. As such two portfolio’s are selected to provide the cases from the custom component category, represented by the horizontal shapes in Figure 2. These are the Cables & Connectors and the PCB portfolio. Given the expansion of Prodrive’s product portfolio, particularly for low cost/high volume items sourcing from China for these portfolio’s is frequent.

In order to investigate the specifics of the uncertainties that sourcing from China brings, a comparison is made towards Dutch substitute suppliers. By comparing the cases between China and the Netherlands, the specifics of Chinese uncertainties can be determined. This is represented in Figure 2 by a case being provided by a current Chinese supplier, which is compared to an alternative Dutch supplier for the same case. To investigate the specifics of supplier dependent variables, two cases are selected for both portfolio’s such that within portfolio comparisons can be made. By comparing within portfolio uncertainties that may originate from the specific supplier of the case can be exposed. For this reason, two within portfolio cases are selected but also two portfolio’s are selected. This way, through comparison of the cases an understanding for general uncertainties in China can be found across suppliers and across product portfolio’s. Because of resource limitation to this research, further case selection is not possible.

![Figure 2 Schematic overview of case selection](image-url)
The cases that are selected within a portfolio will have the same appliance: high volume low cost products as is the case for consumer electronics. This choice is made such that specific uncertainties that may originate from the appliance of the components do not disturb the uncertainty measurement. The selected cases will therefore involve four different suppliers, categorized in two portfolio's, providing four different components which are all applied in consumer electronics products and are sourced from China.

2.3.3 Data collection

In order to obtain data for the uncertainties of the selected cases, a risk management perspective is adopted. Risk is commonly described as the uncertainty involved around an expected outcome March & Shapira (1987). In order to find uncertainties involved with Chinese sourcing, appliance of a risk management perspective will allow finding the amount of uncertainty involved with an expected outcome. This research will require comparing risk values between countries and across cases. In order to do so, a methodology is required that rely on the knowledge harnessed in the practitioners since a current scenario will have to be compared with a hypothetical alternative. It may be that this alternative has been a supplier for that product in the past, or is merely an alternative supplier located in the Netherlands. As such, a level of experience is required to compare the current supplier with a possible alternative. Since experience may also cause prejudice because of a negative experience in the past, a combined approach is required that captures the knowledge and perspectives of both experienced and relatively new practitioners.

To find a suitable risk assessment method that fits with these requirements, the line of reasoning of Ruytenberg (2011) is followed. In Ruytenberg (2011) the following classical managerial risk assessment methods are compared after a literature study; failure mode and effect analysis (FMEA), database type analysis, matrix type analysis, and risk diagnosing methodology (RDM). Many of the risk assessment methodologies are a slight variation of one or a combination of these types. The line of reasoning of Ruytenberg (2011) is followed, who indicates that RDM tries to overcome groupthink whereas the other assessment methodologies are subject to this. This is relevant given the balance that is required between experienced and new practitioners. In addition, RDM measures risk as a social construct which fits with the requirements of this research. In RDM, it is emphasized to investigate why there is no consensus amongst the assessed persons (Keizer, Halman, & Song, 2002). Furthermore, the process of prioritization is not separated from the risk elements but integrated in a total approach (Keizer, Halman, & Song, 2002). The RDM methodology also fits with the risk definition of practitioners since it poses a risk questionnaire used to assess the likelihood of the event, the ability to influence the course of action and the relative importance of the event. Since managers see risks different than chance because they can influence the outcome, the fact this is explicitly assessed ensures RDM fits with managerial perspectives (March & Shapira, 1987). In addition, by developing a questionnaire to test the likelihood, a comparative perspective is possible which allows comparison of Chinese and Dutch suppliers. This way, different values in risk and therefore uncertainty can be observed and compared. For these reasons the RDM shall be further considered and other risk assessment methodologies shall not be treated here.

To develop the risk questionnaire, an initial set of risk elements is derived from a literature study. This literature review will be presented in the next chapter. From the initial risk elements an approved risk elements set was found after checks by a senior practitioner at Prodrive for relevance. From this list a risk questionnaire was formulated corresponding to RDM methodological principles. These are that the questions should be formulated as positive statements, conforming to prospect theory. For each element three separate questions are answered on a five point scale. These questions are: the level of certainty that the statement is true, the level of influence you have on the statement and the relative importance of the statement. For the first two questions a 1 score indicates a ‘very low’ answer and 5 is a ‘very high’ answer. For the third question a 1 score indicates a ‘very high’ answer and a 5 indicates a ‘very low’ answer. Through this numbering, the reference list of RDM can be used for indicating on a 5 point scale
how large the risk element is to be perceived. In short, the more low scores are given on each question, the higher the perceived risk. For each question at each risk element based upon the distribution of the responding answers either a '0', 'm', '*' or '?' is assigned to the question. A '0', 'm' or '*' indicate there is consensus amongst the respondents for the specific question at that element where '0' is a low risk, 'm' is a medium risk and a '*' indicates a high risk. For every element a combination of three risk indications is therefore present, one for each question. This combination is then checked against the reference list of RDM to find a risk score for that element. It may consist of S, L, M, H, F; safe, low, medium, high, fatal respectively. A '?' is assigned to questions where consensus is absent amongst the respondents. These may result in a range of risk values and should be discussed in the risk management session which is part of RDM. An application of this methodology is presented in the following example.

Example

One element that was on the reference list is ‘process change likelihood’ in the industrial category. Translating this element to an element conforming with RDM and prospect theory results in ‘The supplier has stable production processes’ since if this statement were true, it indicates a low risk for this element. Assuming the following hypothetical respondents distribution to the question, see Table 1, the respective assigned elements would be '0' for level of certainty, '*' for ability to influence outcome and '*' for relative importance. This would result in a high risk value for the risk element after checking the RDM reference table, see Appendix I.

<table>
<thead>
<tr>
<th>Risk question</th>
<th>Level of certainty</th>
<th>Ability to influence</th>
<th>Relative importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supplier will change his processes often</td>
<td>1 2 3 4 5</td>
<td>3 2 1</td>
<td>5 1</td>
</tr>
</tbody>
</table>

Table 1 Respondents example I

The following three elements ‘lack of effective system integration’ and ‘lack of compatibility with IT’ are grouped in to one risk element for the RDM questionnaire: ‘the supplier has high quality IT systems’. Assuming the following respondents distribution to the question, see Table 2, the respective assigned elements would be '*' for certainty, '?' for the ability to influence outcome and 'm' for relative importance. This would result in a medium to high risk value for the risk element after checking the RDM reference table in Appendix I. For most outcomes if a '?' is involved in the outcome, it results in a risk spread rather than a definitive value.

<table>
<thead>
<tr>
<th>Risk question</th>
<th>Level of certainty</th>
<th>Ability to influence</th>
<th>Relative importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supplier has high quality IT systems</td>
<td>3 2 1 4 5</td>
<td>2 2 2</td>
<td>1 4 1</td>
</tr>
</tbody>
</table>

Table 2 Respondents example II

End of example

Next to the question for the current scenario where the Chinese supplier is concerned, for each element a hypothetical scenario is formulated where the respondents are asked what the answers to the three questions would be if the part were to be sourced from the reference country, in this case the Netherlands. This will allow for checking if indeed a difference exists between the current scenario where the part is sourced from China, compared to if the part were to be sourced from a Dutch alternative supplier.
2.3.4 Respondents

The questionnaire will be developed based upon the risk elements for several respondents. The majority of the respondents are Prodrive employees. In total six respondents are selected for every case: the supply chain manager, two senior purchasers who control the portfolios of the respective components, a senior project purchaser who has significant experience with project sourcing, the purchase engineer for the respective component and the operational purchaser for the respective components. The internal focus is in line with RDM. These respondents are chosen for their mixing level in experience with the country of origin (China) and their different perspectives, from operational to strategic. This should allow for a broad perspective covering multiple viewpoints. If there is consensus in their responses to the questionnaire, it is very likely that it is a good representation of the acquired knowledge within the company. The questionnaire developed based upon the risk elements for internal assessment can be found in Appendix III: Questionnaire Prodrive. However, in the current context the activities of the supplier play a substantial role, formulated particularly in the dyadic effects category of the previously presented theoretical framework. Therefore, the supplier company is included in the questionnaire audience where the different perspectives can be used for validity checks between Prodrive and their suppliers. For suppliers a single measure shall be used to test for contrasts between the Prodrive view and the supplier for those questions. The questionnaire for the suppliers based on the relevant risk elements can be found in Appendix IV: Questionnaire Suppliers. Available system data is used for further assessing quantifiable questionnaire elements. If inconsistencies are found with the questionnaire data these shall be discussed with a senior purchaser.

2.3.5 Risk management session

After the initial questionnaire has been filled out, the inconsistencies in the respondent’s answers shall be discussed in a risk management session, in line with RDM. The goal for the risk management session is to achieve consensus on the disputed elements after discussion where the risk facilitator will serve as a discussion leader and is attended by all Prodrive respondents. The discussion points which will be brought forward are the points where at least a high or fatal value is found in the range resulting from the RDM for the current situation or the hypothetical Dutch alternative. For instance, the previously mentioned example (see Table 2) resulted in a high to fatal range for risk score. This would be included in the risk management session since it contains at least a high value. All results which will be discussed in the risk management session are highlighted in Appendix I: RDM classification list. The motive for this selection is that the goal of this study is to design risk mitigation strategies and therefore the highest perceived risks are considered the most interesting.

For the risk management session the following ‘rules of engagement’ are adopted from RDM, see Figure 3.

- Every one’s viewpoint is valid!
- No holding back – Say what’s worrying you!
- No management hierarchy
- The things we don’t like to hear are probably the key issues
- Explain from your area of expertise

Figure 3 RDM risk management session rules of engagement

10
The agenda for the risk management session will be build up as follows:

- Opening with objectives and goals
- Explaining the rules of engagement
- Present results for Case I
- Discuss inconsistent scenario’s for Case I
- Present results for Case II
- Discuss inconsistent scenario’s for Case II
- Present results for Case III
- Discuss inconsistent scenario’s for Case III
- Present results for Case IV
- Discuss inconsistent scenario’s for Case IV

It is to be expected that during the discussion additional points of interest may be brought forward. In order to stimulate this, it is the goal to involve as much people in the discussion session as possible and to get everyone’s view on the inconsistency at hand. The arguments used for bringing consensus may be of interest in interpreting the results. The transcript of the risk management session will be validated by a participant for errors.

### 2.3.6 Research quality

Given the case selection and the data collection methodology, this research is subject to some quality norms. These norms shall be treated individually next. As defined by van Aken, Berends, & van der Bij (2007) controllability, reliability and validity are quality measures for empirical research. However, the most common measures of research quality are construct validity, internal validity, external validity and reliability of which the primary elements shall be addressed briefly. For a complete list of measures please find Table 3. Construct validity is safeguarded predominately by applying triangulation towards the data collection. In addition, through the discussion session a qualitative re-check on the observed data from the questionnaires is executed. For internal validity the use of findings from previous studies are incorporated in to this research. The developed questionnaire was developed based upon a previously executed literature study. In addition, the conclusions drawn from the collected data are checked by two tutors as well as a company supervisor. The external validity is troublesome since risk is dependent on its context. However, the process that is developed in this study should help other companies as well and is applicable in other contexts. The reliability of the study is aided by having a clear case selection strategy as well as a clear methodology for developing the questionnaire and discussion session held for data collection.
<table>
<thead>
<tr>
<th>Type of Validity</th>
<th>Measures of addressing this in the research</th>
</tr>
</thead>
</table>
| Construct validity               | • Triangulation is in place through using questionnaires, discussion data and data from databases  
  • Triangulation through integrating multiple perspectives through; 1. The supplier versus the companies’ side and 2. Multiple intercompany perspectives  
  • Risk assessment methodology derived from studying academic literature  
  • Allow discussion on the initial result questionnaire results in a risk management discussion  
  • The transcript of the discussion session is validated by another participant.                                                                                                        |
| Internal validity                | • Use of framework derived from literature to guide questionnaire composition  
  • Use of risk assessment methodology derived from literature  
  • The internal validity in deriving conclusions from the data is supervised by two tutors as well as a company supervisor                                                                                                           |
| External validity                | • Fixating risk categories allows for finding real country of origin effects valid across products sourced from China by comparing cases  
  • Case sampling limited to country, company and industry context which would give too much disturbance in data  
  • Generalizability is low but given the risk definition this is logical for risk assessments since they are context dependent.                                                                                                       |
| Reliability                      | • Case definition used to counter biases originating from separate risk categories  
  • Risk elements by Kolp (2012) shall be used to compose the risk questionnaire, standardizing the methods of data collection  
  • Quantitative data available will be used to guide the discussion, increasing the reliability of the study                                                                                                                                  |

Table 3 Measures to ensure research quality, based on Yin (2003) and Gibber et al. (2008)
3. Theoretical framework

As was presented in the previous problem definition chapter, a literature research is required in order to find which uncertainties may apply to sourcing from China. To do so, first a definition of why companies want to start global sourcing and how this has developed is required for understanding the uncertainties. This will be brought forward in the first section. Next, a translation to a risk management perspective is made such that the uncertainties involved in global sourcing can be found. This will be presented in the second section. These uncertainties will serve as a base for developing the RDM questionnaire, as explained in the previous chapter. This will be brought forward in the third section. This questionnaire shall serve as a base for the case data collection for the next chapter. Finally, in order to reduce the uncertainty levels with sourcing in China a risk mitigation section is set up. In this section some measures shall be presented that have been applied for uncertainty reduction by other scholars.

3.1 Global Sourcing

The role of purchasing within organizations has changed substantially over the years. It has evolved from a locally oriented out-of-catalog ordering activity to a strategic business process involving multiple activities such as contracting, supplier selection and negotiation on a global scale (Trent & Monczka, 2003). Sourcing is no longer managing a strict buyer-seller relationship but should be placed in the total value chain of the company. Therefore, the entire supply chain from raw goods to end customer should be evaluated when performing sourcing activities.

3.1.1 Sourcing development

The development of sourcing can be explained in two developments. First, sourcing has developed from a locally oriented administrative business process to a global value adding business process. Second, the context in which these sourcing activities take place has developed from a strict locally oriented buyer-seller relationship to a globally oriented total value chain approach. What is common in both trends is the internationalization aspect of sourcing. Several models and frameworks exist for explaining or conceptualizing the development of global sourcing. Examples are the global sourcing antecedents model by Quintens et al. (2006) or global sourcing development by Trent & Monczka (2003). However, the transition to global sourcing is not straightforward. Some companies are recalling their global sourcing decisions, backshoring their sourcing activities to Western world countries where flexibility and quality are easier to control, especially in the current economic climate (Kinkel, 2012). When companies fail to overcome the challenges of global sourcing, ultimately the initial decision to source from low cost countries may be reversed. From research it shows that about 20% of the offshoring decisions are reversed after 4 to 5 years (Kinkel & Maloca, 2009). Companies struggle most with the inflexibility of foreign partners and lack of quality performance (Kinkel & Maloca, 2009). The available conceptual development models for global sourcing do not explicitly provide an explanation how this backshoring trend might have emerged. The development models are only progressive and motives for backshoring are absent in these development models. In more recent developments the effects of the financial crises are becoming clearer for global sourcing, with figures of backshoring increasing while offshoring decisions are halted (Kinkel, 2012). Strikingly, lack of quality and flexibility performance by the supplier is not explicitly mentioned by for instance Quintens et al. (2006) antecedent. Therefore, a critical view is required when interpreting the antecedents of global sourcing in light of most recent developments.

To assess the uncertainties companies face in their transition from local to global sourcing a new perspective is required. The conditions to global sourcing must be met, but since the dynamics of the
environment influence sourcing effectiveness, a continuous view is required to check if the conditions will remain to be met. Current models do not offer such a continuous view but are only based on the current situation. To make an appropriate assessment, a view is required that takes developments of the environment into account. Since sourcing decisions require an initial investment of resources, a return on investment is mandatory for effective global sourcing. If a valid business case exists at the present day, it can’t simply be extrapolated to the future, assuming the profitability in today’s conditions. An example is the current financial crises and the backshoring decisions made because of it (Kinkel, 2012). It can be argued that if an assessment had been made towards the global sourcing decisions risk in financial fluctuations, a different initial sourcing decision was made. The new view should therefore incorporate both the present day as well as the expected developments of the environment. To do so, a risk assessment has been developed that explicitly takes the development of the environment into account (Kolp, 2012). The risk model will allow companies to develop a method that finds where a gap exists between required and acquired knowledge concerning global sourcing uncertainty. Next, the knowledge may be enhanced which reduces the uncertainty concerned in global sourcing. After this process the risk model may be used again to find remaining or possibly new gaps between acquired and required knowledge. This cycle can be repeated and allows for the continuous perspective which is required for durable global sourcing.

3.1.2 Country of Origin development

With the development of global sourcing, significant changes have occurred in the countries of origin. The economic and social developments observed in China cause for a risk analysis to not only look to current situation, but also to expected developments in the country of origin. One clear example is the minimum wage developments in China, see Figure 4. Since the primary motive for sourcing is to reduce total costs, climbing minimum wages will most likely lead to increased costs in production processes. This may pose a threat to global sourcing profitability and should therefore be incorporated in a global sourcing risk assessment. In the current situation it is uncertain what the sensitivity towards changes in wage development is. This is one example of a factor which needs to be assessed for a given case to check global sourcing durability. Current sourcing risk models do not take this developing perspective into account.

![Figure 4 Minimum wage trend China (stats.gov.cn)](image)

In a similar fashion, the rapid increase of sourcing goods for China has made raw material prices volatile. This will also have a direct effect on the costs of sourcing goods from China. Raw material prices are a core element in the producing of goods and are exposed to steep fluctuations, depending on the current economic state, see Figure 5. Therefore, the two main cost elements of a product; labor and raw materials, are instable through time and have seen volatile changes. For the development of a global sourcing risk framework, country of origin developments have to be taken into account as will be explained in the next section.
3.2 Global Sourcing Risk Framework

To allow companies to identify values for the global sourcing uncertainties, the sensitivity to certain elements has to be measured. In order to do so, a risk framework will be developed which will serve as input for the RDM questionnaire used for data collection. In addition, the developments of the environment as brought forward in the previous section are explicitly taken into account. The framework consists of three aspects; global sourcing risk elements, country of origin elements and risk mitigation elements. First, a general perception of risk in relation to uncertainty is presented. Next, a conceptual risk model is brought forward which consists of categories. For these categories, risk elements of the risk context are presented next. The country of origin effects and risk mitigation shall be explained in further sections.

3.2.1 Risk

Risk can be explained by many definitions and from different viewpoints. Risk definitions range from mathematical definitions in terms of standard deviations, beta’s etc. to conceptual social definitions. Depending on the field of study, a definition of risk is chosen. Since some form of risk is relevant in a wide array of studies, a clear single definition is absent. This absence of a definition is also represented in a difference between academics and practitioners’ point of view (March & Shapira, 1987). Management practitioners perceive risk with negative outcome; the possible positive outcomes in a risky scenario are not associated with risk. In addition, risk is not a probability concept in managerial practice. Finally, managers show little desire to reduce risk to a single quantifiable construct but they wish it were that simple (March & Shapira, 1987). Risk is seen as a crucial element in decision making. In hindsight, risky choices that turn out badly are seen as mistakes whereas in academic or mathematical terms equally risky decisions that turn out good are seen as successful. In terms of this research, a methodology is required that applies both to practitioners’ perspectives as well as academics’.

The risk definition should allow for explaining differences between companies, even if they pursue the same activity. In a mathematical manor risk is often identified as the likelihood a deviation occurs from an expected outcome. However, this clarification does not provide an answer to why the same activity may have different deviations depending on the company pursuing the activity. As such, measuring the deviations from company to company becomes a problem. To deal with these problems, the following definition from a discussion with Keizer is formulated; every time within a project or activity when a gap exists between required and acquired knowledge a risk may exist. Since knowledge depends on the people involved in the project or activity, risk becomes a social construct which can be measured by analyzing the delta between acquired and required knowledge of the persons involved. This allows for
explaining why different companies pursuing the same activity or project may face different risk levels; the acquired knowledge levels of the people involved of the respective companies differ.

In this study the goal is to assess the uncertainty to Chinese sourcing. Given the definitions of risk, it is to be expected that a high uncertain value will be associated with a risky decision in managerial terms. In terms of the presented definition, high uncertainty is expected with elements where the company has little or no experience and knowledge. As such, assessing the knowledge levels will give a reasonable approximation of the uncertainty involved with the sourcing activity. To make such an assessment, a reference list is required for developing a risk questionnaire. This reference list will be build up according to risk elements’ distribution over several conceptual categories. The categories used in this study will be presented next.

### 3.2.2 Categorical risk Model

When the global sourcing risk elements, country of origin risk elements and risk mitigation strategies are combined, the categorical risk model can be formulated. The categorical risk model is depicted in Figure 6. Given the importance of the country of origin dynamics to global sourcing uncertainty and effectiveness, it is expected this plays a mediating role. Indeed, by moving the same activity to a different country general lower uncertainty is observed (Kinkel, 2012). Therefore, changing the country of origin will present different risk values for what may be the same risk context. The specific measured elements of the country of origin shall be presented in section 3.3. Next to the country of origin elements, a company may have put in place risk mitigation measures that reduce the uncertainty level of sourcing from that particular country. These measures also mediate the exposed uncertainty level. More details towards risk mitigation and country of origin dynamics are presented in the section 3.4. The last element of the categorical risk model is the risk context. The risk context is divided in to four categories; industrial, organizational, dyadic and product. The methodology used for selecting the elements to measure the risk context are presented in section 3.2.3. The categories have been determined by a literature study to global sourcing risk. These models are often oriented to a or a couple of the mentioned categories. However, to explain and find the risk elements that may cause uncertainty in sourcing from China, a broader approach is required. Therefore, a new categorization has been made.

![Figure 6 Categorical Risk Model (Kolp, 2012)](image)

Based upon several research papers in supply chain risk management and global sourcing risk management the categories have been defined. Initially a long list of research papers containing a conceptual model or empirical assessment of risk was set up. From this list, 8 papers have been selected
that contribute or emphasize global sourcing risk in concrete elements of risk measurement. These were often distributed in to categories already. This categorization was then reconfigured in to that of the current paper. The eight papers eventually used are Tumalla & Schoenherr (2011), Lockamy & McCormack (2012), Chopra & Sodhi (2004), Rao & Goldsby (2009), Munaj & Mentzer (2008), Blos et al. (2009) and Hallikas et al. (2002). These papers have some overlap in terms of focal points but in general describe risky events associated with global sourcing. The risk categories that have been formulated are the following; industrial, organizational, dyadic and product categories. For these categories, risk elements that can be measured were determined and are described next.

### 3.2.3 Risk elements

The categorical risk model presented is not suitable for risk assessment. Although a rough definition of the context has been made, a more fine grained set of elements is required to be able to develop a questionnaire based upon it. The 8 papers mentioned before in total brought 220 risk elements for assessment, distributed over the 4 categories. Each element on its own may contain a risk where a higher level of knowledge is required than what is present, and as such involve uncertainty. This initial set was distributed over the correct category. Some risk elements were applicable in multiple categories and were initially assigned to all categories relevant. Obviously there is a lot of overlap between these risk elements. Therefore the duplicates or near-duplicates are removed from the initial list per category. A near-duplicate is a risk element which has a different name but is used to measure the same construct. These assessments are quite arbitrary but the following rules were kept to as close as possible in the reduction process: If a risk factor is a clear example of another risk factor and no reasonably other examples can be thought of for the general risk factor, the general term is omitted. When more examples can be thought of under the general term, the exemplar risk factor is omitted. When a broad risk factor is found that explains one or several other risk assessment criteria but is hard to measure, the broad risk factor is omitted since the goal is to find clear risk elements usable for measurement. By following this process, the initial set of 220 risk elements were reduced to a set of 56 risk elements. The risk elements set is presented in Appendix II: Risk elements list.

### 3.3 Country of origin effects

As was explained in the development of the country of origin section, the relevance to take country of origin effects in to account with global sourcing is high. Current sourcing models have not been able to explain why companies have started to backshore some of their activities out of China. Given that the motives for backshoring are increasing total cost of ownership and the additional effort required for Chinese sourcing, a set of factors shall now be presented that are based on these motives. The factors are distinguished from Kolp (2012) and separated in direct and indirect effects which are presented next.

#### 3.3.1 Direct effects

The direct effects are effects which will immediately change the current efficiency and attractiveness of sourcing from China. As already mentioned, labor costs and raw material prices will directly influence the price of the sourced goods. Next to these main two components of a product, another direct measure is present through currency and inflation risk. If a country is subject to a fluctuating currency exchange, the attractiveness of sourcing from that country is partly dependent on what the exchange rate is. An example is represented by the current devaluation of the Japanese Yen. Such monetary policies are in effect to make a country have a better position for exports. Indeed, it has been speculated that the Chinese have kept their currency low such that export volume would not be disrupted. Although there is a risk for
inflation in the long term, in the short term the export position will be profitable. In global sourcing terms, such monetary policies of the country of origin will have a direct on the sourcing attractiveness. Next to the direct elements of labor costs, raw materials and currency exchange there are some indirect effects which are explained next.

3.3.2 Indirect effects

Next to the direct effects, a set of contextual effects can be identified for explaining how country of origin effects may lead to eventually backshoring. These effects will also help to take the dynamics of the environment into account when assessing global sourcing uncertainties. A brief overview of these contextual effects will be brought forward.

First, there is the distance to the country of origin. The distance to the country of origin influences the prices of the transport. Since the goods need to be transported from the country of origin to the reference country, a transportation cost may influence the sourcing effectiveness since it influences total costs. While the distance itself will not change, the costs of moving goods will be interacting with this distance through for example the transportation costs. Second, the governmental regulations have an indirect effect since a change in governmental regulations may affect the supplying company. For instance, a change in environmental laws may force the supplier to revise his production, lowering or halting production of the products. The likeliness of this event to occur will influence the uncertainty level that is observed for sourcing from that country. For China it is known that quite some policies are changing. As such, it is relevant to take this into account for assessing the global sourcing elements. Third, the infrastructure efficiency may influence the effectiveness in many ways, one of which is the IT infrastructure. A good IT infrastructure will allow for more efficient communication, which influences the delivery reliability. In this case, the infrastructure is a facilitating aspect in global sourcing since a high quality will lower the uncertainty amongst communication in global sourcing. However, if the infrastructure is not continuously developed, it may become a cause for lower effectiveness towards the future. Fourth, the export rating of the country influences the attractiveness of transporters focusing on the specific country. If a company has diminishing exports, the prices of the transport may go up, as well as longer transport times since the transporter will be less likely to optimize for the country. Fifth, the Purchasing Managers Index (PMI) of the country of origin will give some insight into fluctuations. This will give some prediction in for instance the raw material price development. In Figure 7 a steep decline in the PMI is visible at the end of 2008. The steep decline is represented in the steep decline of material prices in 2009, see Figure 5. A similar predicting value is found for the country’s export rating, GDP development etc. Sixth, the likelihood of a country being affected by environmental hazard can be predicted by the history of environmental hazards of that country (Blos et al.,2009, Chopra & Sodhi, 2004, Rao & Goldsby, 2009). An environmental hazard obviously poses a risk since it may shut down the producing supplier completely. The seventh and final indirect measure is that of cultural alignment. It poses a risk since it may cause miscommunication through a greater likelihood of communication errors and therefore influence the risk in material availability.
Through direct and indirect effects the environment will influence the uncertainty levels to which a company is exposed in global sourcing. To benefit from global sourcing, companies must assess and take this influence into account in their sourcing strategies to insure future durability. Although it has been shown that these developments are quite drastic in China, the assessment itself will be relevant in global sourcing in general. In the next section, the elements which will be influenced by the country of origin dynamics are brought forward.

3.4 Risk Mitigation

In order for the uncertainty in global sourcing to be reduced, a risk mitigation strategy is required. This is the last element of the categorical risk model as presented earlier. This risk mitigation strategy can be oriented towards a specific case or be more focused on general contextual aspects such as the country of origin. This section shall describe firstly an guideline for applying risk mitigation to specific projects. Next hybrid measures and measures oriented towards the country are presented. This is done such that in the last section a methodology can be developed to determine how to determine which type of measures to take, given the uncertainty in a specific country.

3.4.1 Project Measures

To have successful and effective risk mitigation, it needs to be designed such that it fits and is designed to the context in which it is applied (Christopher et al., 2011). The lowest abstraction level of the context is the specific product sourced from that supplier. By designing risk mitigation measures directly towards a specific component sourced from that supplier very specific risk elements can be reduced. For instance, if a component has volatile lead times, a different source for that component can be selected beforehand. This way, a specific risk for that component at that supplier can be reduced by having a second source on stand-by that can be contacted in case of calamities. Other project specific measures may depend on certain product characteristics. For instance, if a product has a high toxic production process, specific measures may be required to reduce the uncertainty originating from this production process. General measures on a country level would not help reduction of this uncertainty since it is specific for the production process. For any type of project risk, increasing flexibility in terms of having multiple suppliers on standby will reduce the chance of supplier specific risks escalating in to incidents (Sodhi & Tang, 2012). Which project measures are required shall be decided in the solution design after the diagnosis of the cases in Chapter 6.

3.4.2 Hybrid Measures

Next to project specific risk, hybrid measures can be formulated. These are measures which would affect the uncertainty of multiple projects. If for example the toxic production process required for PCB’s of the previous example is generic for all PCB suppliers, a measure may be required that affects all PCB suppliers. One way to increase focus on the quality of the toxic production process and the environmental protection of that supplier during is changing the supplier selection process. This will reduce the uncertainty towards environmental risk. All suppliers selected for that kind of component (PCB’s) will be more critically assessed during supplier selection, enhancing the knowledge of how the supplier handles its toxic production process. Since this affects multiple suppliers but is not dependent on the country of origin, this is a hybrid measure. This is an example of a hybrid measure since it covers multiple suppliers, but is not specifically designed towards a country dynamic or influence. Another example is by grouping several suppliers’ communication with one intermediary company. This intermediary will take care of order processing, logistic handling etc. This measure is a hybrid measures since it would affect multiple suppliers but does not specifically target country of origin dependent risk. Like with project measures, which specific form of hybrid measures may be required depends on the specific diagnosis.
3.4.3 Country measures

The final form of risk mitigation measures in global sourcing is oriented towards country specifics. It is assumed that if a supplier faces a common greater risk value across products and suppliers, a measure may be required that will benefit all suppliers in that country. For example if all suppliers face difficulties with instable long lead times, a measure may be required. This can be done by enabling a third party logistics provider that will coordinate the transports from the gate of the supplier in China to receiving company in the domestic country. This way, the transportation time will have more certainty since it is controlled by one party. This will reduce the uncertainty in lead times. Enabling one third party logistics provider for all transports from China may be a costly measure, but all components sourced from China will profit by greater certainty in transportation times. Which country specific measure may be required will depend on the diagnosis as is the case for hybrid and project measures. To determine which measure is efficient given a set of risk values a methodology is described next.

3.4.4 COORMC

The three previously mentioned risk mitigation types form a spectrum of measurements. This ranges from project specific measures to country specific measures, with hybrid measures in between. To have a general idea which measures are effective in what circumstances, a transaction cost perspective is adopted. Transaction cost economics (TCE) has been a groundbreaking and widely researched topic in the economics sciences. The primary goal of transaction cost economics is to explain a certain governance structure both between and within companies (Williamson, 2008). The governance structure is a continuum that can range from fully obtained from the market to completely within-firm functions, see Figure 8. A classic example is the make-or-buy decision of a particular component. A make decision relates to a within-firm governance structure and a buy decision relates to a market governance structure. TCE helps in understanding why effective strategies employed by one company may be catastrophic for other companies. The proper governance structure is determined from the context in which the transaction is applied. Since governance structures can also serve as a risk mitigation form and moreover is context and thus company specific, analyzing a relationship between TCE and risk mitigation may be useful in designing effective risk mitigation. In a sense, understanding the dynamics behind TCE will help understanding the dynamics behind risk mitigation in general, and global sourcing in particular.

![Figure 8 Transaction Cost Economics Governance Structures (Williamson, 2008)]

Transaction costs theory describes that a firm will be striving to minimize the costs incurred with each transaction made and will adjust the governance structure to do so (Williamson, 2008). Although it is beyond the scope of this research to describe in depth the choices in the governance structures that a firm faces and which choices a firm should make in what conditions, its applicability to risk mitigation measures is evident. The primary goal is obtaining a governance structure of the firm ranging from within the firm to procured from market. Also hybrid forms such as strategic partnerships are possible. To determine what governance structure incurs the lowest transaction cost to the firm, three dimensions are considered for every transaction; asset specificity, uncertainty and frequency. Asset specificity describes
a measure of redeployability and can take forms as cash, humans, brand image etc. Uncertainty indicates the amount of disturbances to which the transactions are subject. Frequency indicates the rate in which the transaction occurs. These three dimensions shape the continuum of governance structure. Important to mention is that these three dimensions are not stable through time, but continuously change and therefore may require adaptation from the firm. If the dimensions change in value, a different governance structure may be required for optimal transaction costs. The firm will be more likely to obtain a within-firm governance structure when asset specificity is high. High asset specificity indicates that a firm has much to lose in case of disruptions of the transaction. An example is presented for a component that requires a certain production technology. If this technology is fairly simple, there will be wide availability in the market and the firm is likely to be able to obtain this from the market. Wide availability means low prices in the market. In addition procurement from market incurs no within-firm bureaucracy costs. Therefore the optimal governance structure is to procure from the market. In the case of very specialized technologies, asset specificity is high. This means the balance between market prices and bureaucracy costs asks for a more within-firm type of governance structure. Similarly, if the uncertainty in the transaction is low, the firm will search for market governance where as if the uncertainty is high, the firm will search for within-firm governance. Lastly, for low frequency transactions the firm will look for market governance and look for within-firm governance for high frequency transactions.

A conceptual relationship with risk management in global sourcing can be made. The dimensions in TCE can be translated to the context of risk mitigation in global sourcing. The frequency aspect can be measured by the number of suppliers in a specific country of origin. With few suppliers, firms will focus upon those suppliers and not on the country of origin. Therefore risk mitigation strategies will be focused at the supplier and not at the country of origin. When there are many suppliers in a specific country of origin, a firm will be more likely to incorporate a country of origin aspect in their risk mitigation strategies. The uncertainty dimension can be translated to a global sourcing risk perspective in terms of the stability in country of origin variables. When a firm operates in a country where the country of origin variables are instable, a firm will be more likely to adjust their risk mitigation measures based on the expected dynamics in the country of origin. For stable values, a disruption in transaction costs from a change in the country of origin is not likely and therefore risk mitigation will not be designed to the country of origin. The final asset specificity dimension can be related to sensitivity to country of origin variables. Where technological complexity of a component is an example of asset specificity where low values will cause a firm to obtain it from the market, if there is no sensitivity of a specific supplier providing a component towards the country of origin elements there will be no risk mitigation measures designed to the country of origin. Although absolute measures in sensitivity to country of origin variables are unlikely, it is reasonable that a relationship exists between sensitivity and governance structure in risk mitigation measures. If a supplier providing a component is more sensitive to changing country of origin elements, a risk mitigation strategy will be more designed towards the country of origin elements. The spread in governance modes in global sourcing risk mitigation can range from case specific, meaning supplier providing a component, at one end of the continuum to country of origin measures at the other side of the continuum. Hybrid measures in TCE such as strategic partnerships are also possible in the global sourcing risk mitigation perspective through, for example, designing measures through intermediary parties. These hybrid measures will have an effect across multiple projects, but are not directly focused upon the country of origin. A visualization of the country of origin risk mitigation continuum (COORMC) is presented in Figure 9. The continuum represents two ends of risk mitigation perspectives, similar to the governance structures of TCE. On the one end of the continuum are project measures and on the other end are country of origin measures. Depending on the variables a position of the firm designing risk mitigation in the continuum is determined. Like with TCE, the COORMC variables are not stable through time and may cause a firm to adjust its mitigation measures to the changing variable values. When sensitivity, instability and frequency are sufficiently high the ultimate COO measure is by avoiding the COO, relocating or backshoring the activity out of the country.
3.5 Chapter review

In this chapter, the development of global sourcing in the last years have been shown. This development has caused a rapid economic growth in China, leading to some relocation or backshoring of global sourcing activities through increasing total costs of ownership. This development has not been incorporated in current global sourcing risk assessment methodologies. As such, a new risk assessment model has been developed. This categorical risk model consist of three domains; the risk context, country of origin effects and risk mitigation. For each category in the risk context a set of measurable risk elements have been identified. For the country of origin effects the same has been done where distinction was made in the risk elements between direct and indirect measurements. Together, the country of origin elements and the risk context elements provide an answer to which uncertainties must be checked for global sourcing. The final element of the categorical risk model is risk mitigation for which three main measures types have been identified; project measures, hybrid measures and country measures. This provides a general answer to how the uncertainty in global sourcing can be reduced. To determine which risk measures apply the best given the risk elements value in both the risk context and the country of origin context, the COORMC has been developed based upon transaction cost economics. In the next chapter the risk elements of the risk context shall be used to develop and perform a RDM. The COORMC shall be used in Chapter 5 to analyze to which extend a risk mitigation should be designed towards project, hybrid or country measures based on the results from the RDM.
4. Case Data

In the previous chapters a problem description and theoretical base have been developed. With this information a case study has been performed. Using the risk elements for the categorical risk framework developed in chapter 2, an RDM questionnaire is developed in the first section. With this questionnaire, a RDM methodology has been performed for the four selected cases. For every case, the questionnaires were filled by selected respondents and the supplier. After this, the responses were processed in to an initial RDM results which can be found in Appendix V: Initial RDM results. The suppliers’ replies can be found in Appendix VI: Responses from Suppliers. With these inputs, a RDM risk management session was held with the Prodrive practitioners of which the transcript is made available in Appendix VII: Risk Management Session transcript. After the risk management session, the final RDM results could be set up and are made available in Appendix VIII: Final RDM Results. This chapter will continue by describing the methodology used for developing the RDM questionnaire. Next, the relevant results for each case are discussed. This will start with a short case description, followed by the presentation of the final results of the RDM process for that case. Some relevant aspects of the process towards these results shall be treated here as well. Cases III & IV will be discussed at the same time, since they have identical risk values which shall be explained in section 4.3.

4.1 RDM Questionnaire

Given the risk elements from the previous chapter, a risk questionnaire can be developed that will be used for data collection in the RDM process for the selected cases. In order to fulfill the requirements of the RDM questionnaire, a further reduction of the risk elements is required. Some risk elements exist over multiple categories but can be formulated in to one general question for the questionnaire. This way, the risk questionnaire does not contain duplicate entries. In addition, since the perception of risk is such that each individual risk element may pose a fatal element to global sourcing effectiveness, the categorization of risk elements is omitted. One general risk questionnaire has been developed consisting of 44 statements through application of the following rules: The questionnaire is set up with ‘positive’ statements such that respondents can confirm or deny the current statement. For each statement, three questions have to be answered describing the level of uncertainty involved with the statement, the amount of influence the company has to change the current statement value and the level of importance that is assigned to the statement. A distinction was made of the final questionnaire if it should be filled by Prodrive respondents, the supplier, system data or a combination of these. This decision was made through the perspective of the element. If this has to be validated by more parties than Prodrive or a more reliable data source is present, both Prodrive and the supplier or system data is used for data collection. For instance, the risk element of supplier/company alignment is translated to the statement ‘The supplier understands Prodrive’s position and strategy’. This statement is checked best by obtaining values from both Prodrive and the supplier since it concerns both parties. Another example is presented in the risk element of delivery reliability. This is translated to the statement ‘the supplier has a high delivery reliability’. However, this element can be measured through quantifiable system data and is more reliable than the perception of the respondents. As such, for this statement the data collection shall come from available system data. The resulting questionnaires for Prodrive and the suppliers of the cases can be found in Appendix III: Questionnaire Prodrive and Appendix IV: Questionnaire Suppliers. The Prodrive questionnaire consists of 36 statements, the supplier questionnaire 16 statements and 3 statements shall be validated by system data. For processing the questionnaire responses, the RDM process has been followed for the selected cases of which the results are presented in the following sections.
4.2 Case I

The first case is a component selected from the Cables & Connectors portfolio. A picture of the component is presented in Figure 10. This component is sourced for a consumer product directly from the Chinese supplier. This component has the largest purchasing volume of all components sourced from China. It accounts for about 20% of the entire purchasing spend of Prodrive in China. This component is used on a product for which the customer has performed part of the supplier selection. For some key items of the product, the customer has already made a supplier selection. Since this component is a key item of the product, this component is sourced from a supplier which was new to Prodrive at the time. How this is relevant shall be explained with the results from the risk assessment, which is discussed next.

![Figure 10 Picture of Case I](image)

### 4.2.1 Results from risk assessment

For Case I the RDM process has been completed. Initially, a conclusive answer was found for 7 statements based on the questionnaire responses. This means that the remaining 29 questionnaire statements have inconclusive values containing a spread in risk values. Of these values, 24 statements had a high or fatal value in its range and have been treated in the risk management session. The complete results shall be discussed next by firstly mentioning the results from Prodrive, followed by the results from the supplier and system data.

#### 4.2.1.1 RDM values

In Table 4 the results of the RDM process for Case I are presented. For each statement, the values observed for China and the Netherlands are displayed. Only those statements which have contrasting values for China and the Netherlands are displayed. The values that have no difference between the Netherlands and the Chinese case are not displayed in this table. What was a consistent argument behind the equal values for this case was that the product specifics determine many risk values. This means that for most of the equal values the observed risk exposure is determined by the product. Since this product is the same for both the Netherlands and China, the observed risk levels are equal as well. For instance, the product value was considered identically fatal, since it is such an important component on the product on which it is used. This is the case for both China and the Netherlands and is therefore not influenced by the country from which it is sourced. Another example is presented in the ability of the supplier to synchronize their IT systems with Prodrive’s. It showed that the method of communication is regarded irrelevant as long as it is accurate. As such, for both China and the Netherlands an equal value is observed.

Next to the equal values, there are also different values observed. For these differences, the relevant argumentation from the risk management session is discussed. The largest differences are observed between the quality of IT systems, the likelihood of HR problems, Health and safety measures, IT
resilience, contracting flexibility and the supplier’s understanding of Prodrive’s position. The quality of the IT systems held by the supplier is troublesome in China. In addition, because the supplier has been selected by the customer, Prodrive figures it has very limited influence on the supplier to invest in their IT. Dutch suppliers have proven to be flexible in their IT possibilities and have a higher standard than what is experienced in China. When it comes to HR problems, because Dutch supplier’s will make use of qualified personnel and are likely to be further automated in their production processes, a risk difference is observed. The HR problems in China have some form of structural nature, according to the participants of the discussion session. Currently, it is not certain to what extend Prodrive will be affected by HR disturbances at the supplier. For the health and safety measures, a similar shortage of knowledge has become visible. Prodrive has little to no knowledge on the policies the supplier follows for maintaining the health and safety of its employees. For IT resilience similar reasons as with IT quality apply. The influence Prodrive has for IT resilience is expected to be little to none in China. In addition, it turned out that Prodrive has no knowledge on this for the supplier in China or the Netherlands but its importance is classified as crucial. As such, high risk values are observed. On contracting aspects, it is considered impossible to engage in effective contracting when based in Europe for Chinese suppliers. Communication has to be clear and efficient, which is troublesome for Chinese suppliers. For the Netherlands this has proven to be no problem. Lastly, the understanding of Prodrive’s requests is observed to be problematic for the Chinese supplier. For the Dutch alternative this is not observed as any problem. From experience it showed that although the Chinese supplier does respond to Prodrive's request, often a mismatch exists between what is communicated through systems and what is really the case. This uncertainty causes for a greater risk value that is also visible in the element of effectiveness of communication with the supplier.

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>COO*</th>
<th>RDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supplier is able to quickly adjust available capacity</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier is capable of fulfilling demand</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier is able to offer high service and responds quickly</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier has high quality IT systems</td>
<td>C</td>
<td>F</td>
</tr>
<tr>
<td>HR issues are not likely to occur at the supplier</td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>The supplier provides insurance of transport</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier is resistant for IT breakdowns (back-up scenario)</td>
<td>C</td>
<td>F</td>
</tr>
<tr>
<td>There are long term contracts with the customer and short term contracts with the supplier</td>
<td>C</td>
<td>F</td>
</tr>
<tr>
<td>The requested quantities are stable through time</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The lead time from the supplier is short</td>
<td>C</td>
<td>N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>COO*</th>
<th>RDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The forecast that is presented for this component is reliable</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier has good health and safety measures</td>
<td>C</td>
<td>F</td>
</tr>
<tr>
<td>The lead times provided by the supplier are stable through time</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The transportation costs aspect of the total costs are limited</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier is able to provide sufficient stable product quality</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier is able to communicate effectively</td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>The supplier understands Prodrive’s position and strategy</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The supplier understands Prodrives requests, order updates and</td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>The inventory ownership can be shared with supplier and customer</td>
<td>C</td>
<td>L</td>
</tr>
<tr>
<td>The culture between Prodrive and the supplier is similar</td>
<td>C</td>
<td>L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COO*</th>
<th>RDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Netherlands</td>
</tr>
<tr>
<td>N</td>
<td>Safe</td>
</tr>
<tr>
<td>L</td>
<td>Low</td>
</tr>
<tr>
<td>M</td>
<td>Medium</td>
</tr>
<tr>
<td>H</td>
<td>High</td>
</tr>
<tr>
<td>F</td>
<td>Fatal</td>
</tr>
</tbody>
</table>

Table 4 RDM results Case I

Next to the large differences, some smaller risk differences are observed where China poses a greater risk for the capacity of alternative suppliers to respond quickly, the supplier’s capability of fulfilling demand, if the supplier provides insurance for transport, the reliability of the forecast, stability in lead time, the fraction of transportation costs in the total costs. In addition, a slightly positive risk difference is observed for China for inventory sharing and cultural similarity. A consistent pattern for the greater China
risks is that more uncertainty exists in what the Chinese supplier or it’s alternatives are capable of doing and what can reasonably be expected. Despite the supplier being capable to quickly help out in case of calamities, in general the supplier requires ‘more work’ for the purchasing department. Therefore, despite the fact that the supplier is capable of solving the issues, the issues are more likely to occur. Next to the additional work required for managing the supplier, the product in which it is used is quite volatile and faces rapid changes. This affects the uncertainty in the long term forecast, which is likely to increase the amount of corrective actions required. For cultural similarity it was noted that the national culture is not so important, as long as it is known how to deal with the person at hand. The alternative Dutch supplier is known to have a different company culture than Prodrive, as such a positive difference exists for China. For inventory keeping it was noted that this is harder in China, but also less important than in the Netherlands.

Next to the differences that can be observed from Prodrive RDM data, a perspective from the supplier and available system data has been researched. This is discussed next.

4.2.1.2 Supplier opinion & system data
For Case I, the supplier shows to have great differences with Prodrive’s viewpoints. Where Prodrive declares a fatal health and safety risk and the supplier, the supplier states that this is perfectly controlled and monitored. As such a greater contrast could not be observed. A similar difference is noted for the quality of IT systems. Prodrive states this is a fatal risk where the supplier states their suppliers are of high quality. The same holds for IT calamity plans and HR issue likelihood.

Prodrive also indicates that the supplier is able to fulfill demand and quickly respond. However, from the data quite a dramatic delivery reliability can be observed of only 35%. When the purchaser is asked about this difference, the difficulty with mismatches in transports and orders is the primary cause for system errors as was already mentioned with the large difference in the understanding of Prodrive’s requests. As such, the observed delivery reliability from the system is claimed not to be representative of the reality.

4.3 Case II
The second case is similar to case I, and also exists in the Cables & Connectors portfolio. A picture of the component is presented in Figure 11. This component is, like Case I, sourced for a consumer product directly from the Chinese supplier and bought in significant quantities. In contrast to case I, this component is more a standard component and better available by multiple parties. In addition, the supplier providing the component is selected by Prodrive itself. This has its effect on some of the observed risk values as shall be explained with the results from the risk assessment.

Figure 11 Picture of Case II
4.3.1 Results from risk assessment

For Case II the RDM process has been completed. Initially, a conclusive answer was found for 13 statements based on the questionnaire responses. This means that the remaining 23 questionnaire statements have inconclusive values containing a spread in risk values. Of these values, 14 statements had a high or fatal value in its range and have been treated in the risk management session. The complete results shall be discussed next by firstly mentioning the results from Prodrive, followed by the results from the supplier and system data.

4.3.1.1 RDM values

In Table 5 the results of the RDM process for Case I are presented. Similar to Case I, only the differing RDM values for China and the Netherlands are displayed. In total, 19 differing statements can be observed and therefore 17 statements have equal risk values for China and the Netherlands. Some similar arguments to Case I were brought forward as for example the IT synchronization statement. The methodology used for communication is regarded irrelevant as long as it is accurate. This was also found for Case II. However, in contrast to Case I the current case has been selected by Prodrive. This results in overall generally better risk perception which is reflected some statements values. These values now have a smaller difference between China and the Netherlands or have become equal. For example, in case I a greater risk value was observed for the insurance of transport. For Case II however, this value is equally low for both the Chinese as well as the Dutch supplier. One motive for selection of the supplier is because it is willing to provide insurance for transport. Another example is resembled in if the supplier is able to communicate effectively. For Case I, this was a high value for China and a low value for the Netherlands. For Case II however, the communication in China is still harder than the Netherlands (medium compared to low), but the difference has decreased. Again, an explanation is presented that during the supplier selection process this supplier has proved to be capable of reasonably effective communication and as such a lower risk value is observed.

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>COO*</th>
<th>RDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The suppliers' processes are stable through time</td>
<td>C</td>
<td>L</td>
</tr>
<tr>
<td>The governmental regulations are stable through time</td>
<td>C</td>
<td>L-M</td>
</tr>
<tr>
<td>The supplier has high quality IT systems</td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>The supplier is resistant for IT breakdowns (back-up scenario)</td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>There are long term contracts with the customer and short term contracts with the supplier</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The liability level is stable through time</td>
<td>C</td>
<td>M</td>
</tr>
<tr>
<td>The lead time from the supplier is short</td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>The forecast that is presented for this component is reliable</td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>The supplier has good health and safety measures</td>
<td>C</td>
<td>F</td>
</tr>
</tbody>
</table>

Table 5 RDM results Case II

However, like with Case I, some significant differences in risk values can be observed as well. More precisely the lead time length and the reliability of the forecast is problematic for the Chinese supplier compared to Dutch alternatives. These two factors are likely to influence each other as well. Since the forecast is reliable in the short term but uncertain in the long term and the lead time is long, the quantities which are bought are ordered at a point in time where demand is still uncertain. For this case it is more problematic than Case I since it has a different logistical set up, which increases the exposure to fluctuations in lead times and forecast quantities. It should be noted that the current experience has shown the supplier is capable of solving issues in the short term, but requires additional communication.
Some smaller differences are observed as well. A slightly greater risk is observed for the liability level, transportation costs fraction, communication effectiveness and inventory ownership. In contrast to case I, this part is far cheaper and better available in the market. This causes the component to have a lower liability level in the Netherlands than in China, also because of the long lead time. Because of the cheaper component, the fraction of the transportation costs also plays more of a role for the Chinese supplier than the Dutch supplier. Communication effectiveness is more uncertain with the Chinese supplier than with Dutch alternatives, but still manageable because of the amount of influence Prodrive has with the supplier. Lastly, inventory ownership can be shared more easily with Dutch alternatives because of the widespread availability of this component. Prodrive’s Dutch distributors are likely to be willing to hold inventory of this part, where this is more troublesome for the Chinese supplier. A positive difference for China is noted in the product value which also fits with the observed lower total cost motives mentioned by academics.

Next to the differences that can be observed from Prodrive RDM data, a perspective from the supplier and available system data has been researched. This is discussed next.

4.3.1.2 Supplier opinion & system data

The supplier for Case II aligns with Prodrive’s viewpoints. However, some contrasts are also observed. In the case of HR issues, Prodrive does not expect these to occur or have a great risk where the supplier states these are quite common. Also, the supplier indicates it doesn’t really understand Prodrive’s position and strategy. Prodrive observes a fatal risk in the health and safety measures of the supplier, and this is confirmed by the supplier data. In addition, Prodrive indicates the supplier is able to quickly adjust capacity but the supplier states that its suppliers are not able to respond that quickly.

Prodrive indicates that the supplier is able to fulfill demand and quickly respond. However, from the data a low delivery reliability can be observed of 57%. When the purchaser was asked about the difference, the same motives as with Case I are relevant for explaining this mismatch.

4.4 Case III & Case IV

The cases III and IV are selected from a different portfolio than cases I and II. The selected portfolio is that of PCB’s. An exemplary PCB is depicted in Figure 12. The application of the selected PCB’s are the same as with case I and II, both for consumer electronics. The PCB is always almost a key item in a product, and this is also true for cases III and IV. In contrast to cases I and II, cases III and IV are produced in China, but the communication for sourcing of these parts runs through a European located sales agent. This sales agent represents the manufacturers of cases III and IV. As such, a similar logistical chain exists as cases I and II but a different communication chain exists. Cases III and IV shall be discussed at the same time because it turns out the communication party is considered decisive for the risk perception. This shall be explained in more detail next.

Figure 12 Example picture of Case III & IV
4.4.1 Results from risk assessment

As was already mentioned, the risk values observed from cases III and IV from the questionnaire response were identical. During the discussion session it showed that Prodrive experiences risk through whoever the communication party is. For PCB’s sometimes it is not known precisely where the PCB’s are manufactured. As such, the risk perception is based upon whoever the communication runs through. Or, as was mentioned in the risk management session “Often we don’t even know where it is produced, but we know who we pay”. Therefore, since the manufacturers of cases III and IV share the same sales representative, it is not a coincidence that identical risk values are observed. During the risk management session the inconsistent findings were discussed in parallel for cases III and IV. This consisted of 10 discussion elements. Initially, 15 risk statements had consistent values and of the 21 differing risk values, only 10 had a high or fatal risk value in it’s spread. After the discussion it showed that in total 8 differing risk elements were observed for cases III and IV, as shall be discussed next, followed by the supplier perspective and system data.

4.4.1.1 RDM values
The 8 differing risk values that are observed from the RDM process are displayed in Table 6. As already mentioned, the same motives apply for cases III and IV in explaining the risk values. Since only 8 different risk values are observed, many risk values have an equal risk value for the Netherlands and China. One aspect that was reflected during the discussion session is that the equal risk values can be predominantly to the product characteristics. PCB’s have a toxic production process that is the same in the Netherlands as well as China. As such, equally high risk values are observed for health and safety measures and governmental regulations. Governmental regulations will restrict the use and applications of the chemicals required to produce PCB’s, which are equally likely in China as well as the Netherlands. In fact, from the discussion it showed that because of governmental policies entire factories have been moved in China because the production process was not allowed to close to populated areas. The other consistently important aspect is the risk mitigating effect of a European sales agent. In general, the feel and understanding with the supplier is better and communication is more effective. This is for example reflected in the contracting possibilities. Because of the more effective communication, the contracting possibilities with Dutch alternative suppliers or the European sales agent of the PCB manufacturers is considered equal. As such, equal risk values are observed.

Only one larger risk difference value is observed from the discussion session, the aspect of transportation cost. Since PCB’s can be quite heavy and the cases considered are relatively cheap, the costs for shipment to the Netherlands is quite large in terms of the total costs. There is some influence through transport mode selection, but only limited. For the Dutch suppliers this is obviously less of an issue. A large positive difference value is observed in the product value. Prodrive faces substantially better conditions in China than it would in the Netherlands, fitting with the theoretical global sourcing motives.

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>COO*</th>
<th>RDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The materials used are durable in their lifecycle (long lifecycle)</td>
<td>C N</td>
<td>L-M H</td>
</tr>
<tr>
<td>The costs of holding inventory are low</td>
<td>C N</td>
<td>L-M M</td>
</tr>
<tr>
<td>The lead time from the supplier is short</td>
<td>C N</td>
<td>L-M L</td>
</tr>
<tr>
<td>The transportation costs aspect of the total costs are limited</td>
<td>C N</td>
<td>L-M L</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>COO*</th>
<th>RDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The value of the product is low</td>
<td>C N</td>
<td>M-H</td>
</tr>
<tr>
<td>The supplier produces relatively small sized products</td>
<td>C N</td>
<td>L-S</td>
</tr>
<tr>
<td>The supplier is able to integrate or synchronize their IT systems with Prodrive’s</td>
<td>C N</td>
<td>M-L</td>
</tr>
<tr>
<td>The relation with the customer is durable</td>
<td>C N</td>
<td>L-M</td>
</tr>
</tbody>
</table>

Table 6 RDM results cases III & IV

Some smaller differences can be observed as well. A slightly greater risk is observed for the ability to synchronize IT systems in China than the Netherlands. Prodrive expects the sales agent to have decent
IT systems which could, if required, be synchronized to that of Prodrive. For Dutch alternatives there is no uncertainty in this possibility. The difference in product size is considered negligible.

Next to the differences that can be observed from Prodrive RDM data, a perspective from the European representative of the manufacturers and available system data has been researched. This is discussed next.

4.4.1.2 Supplier opinion & system data
The supplier for cases III and IV aligns best with Prodrive’s viewpoints of all cases concerned. The only contrast observable is in inventory keeping and HR issue likelihood. The supplier indicates that the costs of holding inventory are quite high for them, where Prodrive doesn’t expect this. In addition, the HR issues likelihood is underestimated by Prodrive since they rely on the supplier’s flexibility while he indicates it is not that large. In terms of data no contrast is observed. The delivery reliability is an adequate 75%.

4.5 Chapter review
In this chapter the data gathered from the cases has been selected. For each case a comparison was made between the current Chinese supplier and a possible Dutch alternative to investigate the differences in risk perception. For each case, the specifics of the case causing to differing risk values between China and the Netherlands have been discussed. In line with the categorical risk model presented in chapter 2, the product characteristics play an important role in the risk perception. However, for each case at least some risk values were found to have a large contrast with the Netherlands. As such, it is still reasonable to expect an influence from the country of origin on the risk in global sourcing. It has also been shown that Prodrive and the supplier’s sometimes have different viewpoints. Therefore, next to the application of RDM within Prodrive the supplier input is useful in assessing the global sourcing risk for a case. In addition, the role of a European sales agent of the general risk perception is substantial. Some other remarkable differences can be observed across cases as well. This shall be further researched and explained in the next chapter.
5. Risk Diagnosis

In the previous chapters, the problem definition and a theoretical base have been formulated. With this theoretical base, a RDM questionnaire has been developed of which the results have been presented in the previous chapter. These results shall be further analyzed in this chapter. First, the approach which shall be used will be formulated. Next, an analysis is performed within and across portfolio's after which a formal diagnosis is formulated in which Prodrive’s position on the COORMC shall be determined. This shall be used to design a solution in the next chapter.

5.1 Approach

For interpreting the results and the differences between cases the risk scores are translated to a numerical scale for easy comparison, see Table 7. The values range between 0 and 10, where a greater value is assigned to high and fatal risk values such that these will be more prominent in the analysis. The difference between a medium and low risk value will numerically turn out at 2 with this method, but the difference from high to medium will turn out at 3. Through this method, a risk mitigation approach can be designed that is more focused at high and fatal risk values. Applying this method to the full RDM results are presented in Appendix IX: RDM Delta Analysis.

<table>
<thead>
<tr>
<th>RDM Value</th>
<th>RDM Numerical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>0</td>
</tr>
<tr>
<td>S-L</td>
<td>1</td>
</tr>
<tr>
<td>L</td>
<td>2</td>
</tr>
<tr>
<td>S-M</td>
<td>3</td>
</tr>
<tr>
<td>L-M</td>
<td>3</td>
</tr>
<tr>
<td>M</td>
<td>4</td>
</tr>
<tr>
<td>H</td>
<td>7</td>
</tr>
<tr>
<td>F</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 7 RDM numerical values

The diagnosis for the cases shall be brought forward through 3 sections, as is depicted in Figure 13. First, the cases from the Cables & Connectors portfolio shall be compared. This means that the differences observed between China and the Netherlands for the two cases shall be analyzed. Second, the same is performed for cases III and IV in the PCB portfolio. At this point, a within portfolio analysis is completed for explaining differences in risk between China and the Netherlands. Third, an across portfolio analysis is performed to find consistent differences between China and the Netherlands across portfolio's and cases. Next, from these analyses a diagnosis shall be formulated.

Figure 13 Approach for Diagnosis
5.2 Cables & Connectors portfolio

In comparing cases I and II, the risk exposure levels obtained from the risk assessment methodology, supplier data and system data are compared. To help the comparison, all differing risk values are graphically represented in Table 8. In this table, only the differing values are displayed in a descending order. This means the largest differences between the observed values for China and the Netherlands are mentioned first. The identical values for China and the Netherlands for both cases are omitted since they are not applicable to finding uncertainty in Chinese sourcing. For both cases the differing values between China and the Netherlands are depicted in a graphical bar. A dark bar indicates a greater risk in China where a light bar indicates a greater risk in the Netherlands. The size of the bar is proportional to the difference which is observed from the risk assessment data after numerical translation of the risk values. First, the differences between cases shall be discussed followed by the similarities.

5.2.1 Differences between cases I & II

Comparing the risk values, it can be observed that Case I has more values than Case II where China sourcing has a greater risk value and in addition the observed difference tend to be larger. Several explanations are possible for this. One different property between these two cases is the fact that Case I has not been selected by Prodrive but is preferred by the customer. Therefore, the supplier selection methods used for either supplier may play a role in explaining the differences in risk values observed. First, this is for reflected in the difference in contracting possibilities Prodrive experiences with these suppliers. Case I has a fatal risk value for this element, indicating that Prodrive sees no possibility to undergo any form of contracting with this supplier. In contrast, Case II only has a medium risk value for the Chinese supplier. The observed delta is therefore much smaller with Dutch alternatives for Case II than Case I. It is likely that Prodrive has experienced a certain ease of dealing with contracts and contact with supplier of case II, whereas the supplier of Case I was forced to Prodrive by the customer. However, a country effect seems at play as well, since both Case I and II have a greater risk value than the Dutch alternative supplier would have. This is a low risk value, observed for both cases.

Second, the aspect of a missing supplier selection can also be used for explaining the difference in communication efficiency and if the supplier applies insurance for transport. Prodrive observes a high and medium risk value for supplier efficiency in communication for Case I and II respectively. For insurance of transport medium and low values are observed. Again, in the supplier selection it may have been observed that supplier of Case II has some more difficulty in communication compared to a Dutch supplier, but still efficient enough. This is also reflected from the discussion session where it showed that the supplier was able to respond to Prodrive’s needs with some additional communication. For case I however, clearly this is more problematic. For transportation insurance it showed from the discussion that one of the motives to select the supplier of Case II was that they do provide insurance for transport, in contrast to what was expected of Chinese suppliers. The importance of transport for Chinese sources is underlined in the fact that the fraction of the transportation costs has a higher value than that of the Dutch alternative for both cases.

Third, the absence of supplier selection by Prodrive is also visible in the understanding of the supplier to Prodrive’s requested order updates. Clearly for Case I Prodrive sees this as little to none, given the high risk value. A distinct difference exists with Case II where only a low value is observed. A similar reasoning as with the contracting case may apply; in the selection process Prodrive has experienced firsthand that the supplier understands Prodrive’s position and as such experiences a lower risk value. This is not the case for the supplier of Case I. It seems as this element is therefore not country dependent but is relevant to risk mitigation of Case I.
A large risk difference is observed for HR issue likelihood between Case I and Case II. The alternative Dutch supplier has low risk values for both cases, but Case I has a high value and Case II has a safe to medium value. The arguments brought forward in the discussion session indicated that in general the likelihood of HR issues is greater in China than in the Netherlands, although the full extent is unknown at Prodrive. Given the arguments and the consensus on case I, it is expected that the risk value of HR issues is too positive for Case II. This is also reflected in the reply from the supplier, who indicates there is quite a risk for Case II in HR problems. Therefore, it is a factor that may be dependent on the country of origin since it is consistent on both cases.

In the discussion session it also showed that the general feel for the supplier of Case I is more negative than that of Case II. This negative feel to the supplier of Case I can be explained by the higher risk values for Case I than Case II for the ability of the supplier to fulfill demand, the ability of the supplier to provide stable product quality, the ability provide high service and responds quickly. These values all have a greater risk value than that of the Dutch alternative for Case I where Case II observes the same or nearly the same values as the Dutch alternative. The negativity has grown to such an extent that Prodrive is currently searching for an own selected supplier that would replace the supplier of Case I.

Another element where a large difference is observed between the Dutch alternative and the values for Case I and Case II is that of the health and safety measures of the employees. This element has fatal values for both cases compared to low to medium values to that of the Dutch alternative. From the discussion it also showed that Prodrive doesn’t have a proven record of health and safety measures despite the selection process of the supplier for Case II.

There are some differences that are remarkable. For instance the difference in culture between Prodrive and the supplier has a lower risk value for Case I for the Chinese supplier than the Dutch alternative. For Case II no difference is found in this value. In the discussion session, the mentioned Dutch alternative for Case I has proven to be in an ‘order out of catalog’ business, which does not fit with Prodrive. In addition, a lower risk value was observed for the Chinese supplier for Case I when it comes to inventory ownership

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Case I</th>
<th>RDM Δ</th>
<th>RDM Δ</th>
<th>Case II</th>
<th>RDM Δ</th>
<th>RDM Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supplier has good health and safety measures</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>There are long term contracts with the customer and short term contracts with the supplier</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier has high quality IT systems</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier is able to communicate effectively</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>HR issues are not likely to occur at the supplier</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier is resistant for IT breakdowns (back-up scenario)</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The lead time from the supplier is short</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The forecast that is presented for this component is reliable</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The transportation costs aspect of the total costs are limited</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier understands Prodrive’s position and strategy</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The lead times provided by the supplier are stable through time</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The governmental regulations are stable through time</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier understands Prodrive’s requests, order updates and meets these</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The requested quantities are stable through time</td>
<td>C</td>
<td>NL</td>
<td></td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
</tbody>
</table>
sharing. The same line of reasoning can be applied since the alternative Dutch supplier is unlikely to share inventory since it does not own customer specific inventory. The Chinese supplier on the other hand is more of a solution provider similar to Prodrive, and therefore more focused on specific customers. For Case II, a lower risk is observed for product value in China than for the Dutch alternative. The primary motive for sourcing from China therefore becomes apparent, since the costs are significantly lower in China than in the Netherlands. For Case I however, a fatal value is observed for both countries. The value of Case I therefore plays a crucial role in the product but changing the country of origin will not influence this risk level.

5.2.1.1 Supplier responses
The findings that can be observed from the supplier data and the system data are such that particularly between the supplier of Case I and Prodrive’s view large differences exists. One example is that of IT quality. As mentioned before, Prodrive observes this as a fatal risk for the current Chinese supplier. However, the supplier indicates that they acknowledge this importance and indeed own high quality IT systems. The same is the case for IT resilience, HR issue likelihood and health and safety measures. Since the request to the supplier to fill the questionnaire was send from Prodrive, it may be that the supplier is trying to represent itself more positive than it actually is. However, given the supplier’s response on component lifecycle durability it shows that the supplier has also proven to be critical towards their own performance. This particular aspect is not regarded as a high risk at Prodrive and is observed to be independent on the country of origin. The data from Prodrive shows a low delivery reliability of the supplier for Case I. This is somewhat confirmed by the data from the risk assessment, where a medium risk is observed for the supplier’s ability to fulfill demand. When asked, the purchasers at Prodrive indicate that a cause for this low delivery reliability lies in an ineffective way of dealing with the shipments from China which cause for a low delivery reliability in Prodrive’s system.

As mentioned before, the supplier for Case II confirms a high risk in HR issue likelihood as was also observed in the discussion session. In addition, the supplier’s suppliers’ capacity utilization is quite high and may therefore pose a risk that is currently neglected by Prodrive since a low value is expected for the supplier’s ability to adjust capacity. The supplier confirms Prodrive’s worries to health and safety measures, confirming that in Prodrive’s selection strategy this is not predominant. An additional risk is exposed by the supplier who confirms that the financial position of the supplier is not excellent. Prodrive observes a medium risk for this supplier although from the discussion it showed that receiving reliable financial data for Chinese suppliers was not straightforward and should be looked into more thorough than is currently the case. Like with Case I, the delivery reliability data of the supplier for Case II is quite low but the same difficulty with dealing with the shipments exist and cause for disturbed data.

5.2.2 Similarities between cases I & II
Despite the many differences between cases I and II, there are also constant values to be observed. The IT systems quality of the supplier has significantly higher risk values than that of the Dutch alternatives, with a fatal value for Case I and a high value for case II. Also for IT breakdown resilience a consistently higher risk value is observed for the Chinese suppliers. Clearly there is a risk here that is not anticipated or neglected in the supplier selection process. It is therefore possible that the country of origin may play a role in the IT quality and resilience.

Another similarity that is observed for both cases I and II is the effect of longer lead times for components sourced from China. This is reflected in greater risk values for the Chinese supplier compared to the Dutch alternative for the lead time length, the reliability of the forecast and the stability of the lead time. Because of lead time fluctuations, the forecast presented to the supplier is also more volatile. Given that the forecast that is present for both Case I and II has a relatively short window, the lead time required for
these components causes Prodrive to relatively order components earlier than for Dutch alternatives. Any changes that might occur during this time cannot be taken into account anymore for the ordered goods.

After taking the supplier responses into account, HR problems and health and safety measures may also be accounted as similar findings for cases I & II.

5.3 PCB portfolio

In comparing cases III & IV, the risk exposures shall be compared resulting from the data through the RDM assessment as well as supplier and system data. A striking result is observed in comparing the values of cases III & IV. The observed risk levels are identical to each other, as depicted in Table 9. Like with cases I & II, a larger risk in China is depicted by a dark colored bar and a light bar depicts a larger risk in the Netherlands. Again, the size of the bar is proportional to the risk delta observed. Since there are no differences to be observed between cases III and IV, only similar findings shall be discussed.

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Coo</th>
<th>RDM Δ</th>
<th>RDM Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>The transportation costs aspect of the total costs are limited</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The lead time from the supplier is short</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier produces relatively small sized products</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier is able to integrate or synchronize their IT systems with Prodrive’s</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier is able to quickly adjust available capacity</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The supplier is able to provide sufficient stable product quality</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The alternatives for the supplier are able to quickly respond</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The costs of holding inventory are low</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The relation with the customer is durable</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The value of the product is low</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
<tr>
<td>The materials used are durable in their lifecycle (long lifecycle)</td>
<td>C</td>
<td>NL</td>
<td></td>
</tr>
</tbody>
</table>

Table 9 RDM Delta Case III & IV

5.3.1 Similarities between cases III & IV

When further researching the motives for the identical risk perception, it turns out that the same contact person from the distributing party supplies for both cases. This means that while the manufacturers of the parts are different companies, the communication for Prodrive occurs with the same company for both cases. The effect this has on the risk perception is such that despite a different material flow, the same risk levels are observed for all risk elements. The primary motive for this is that for all the risk elements Prodrive accounts on the distributor for dealing with possible risks and they expect the distributor is capable of doing so. This is also reflected in the discussion session where it turns out that the overall ‘gut-feeling’ is better for European contacts, as is the case with the distributor.

There are some elements however that are independent on the communication flow being directly to the manufacturer or through a distributor and still face different values for China and the Netherlands. This is predominant in the logistical risk elements. The transportation costs fraction, the lead time from the
supplier and the size of the products all have greater risk values for the Chinese manufacturers than for Dutch alternatives. Given the nature of the product these factors are important. From the discussion it showed that the production method for this industry is made to order and therefore the production leadtime has a direct effect on the risk exposure. With the relative large distance between the Netherlands and China the transport costs are considerable for these relatively cheap products and extend the leadtime to the supplier even further. Given the logistic characteristics of these products, it is profitable to order relatively large batch sizes since the leadtime is long. This is however reflected in the shipment size which is increased. Therefore it is likely that a relationship exists between the transportation costs and the relative size of the products. In total, the logistic nature of these products have a higher risk value for the Chinese suppliers than for Dutch suppliers because of the changes in logistic parameters. A relationship with the country of origin and the logistic parameters of the case is to be expected.

There are some minor differences noticeable as well. These are predominately oriented towards the responsiveness of the supplier. If a supplier is able to quickly adjust capacity and if alternative suppliers are able to respond quickly are oriented towards responsiveness. That these values are slightly higher in China is not strange. PCB’s are made to order as already noted. Therefore, in order to respond a supplier needs to start up production. This effect is influenced by the distance to China where particularly the transportation times will influence the responsiveness. Although usage of flight transport will allow a supplier to quickly transport the goods, this will incur greater transportation costs and thus impose a greater risk in supplier responsiveness.

Next to the logistic nature of differences, some procedural aspects can be found which are relevant in both the Netherlands and China but have high risk values. There is a high risk value found for health and safety measures of the supplier. During the discussion session it showed that this is primarily due to the characteristics of the products of these cases. The production process of PCB’s require highly toxic chemicals and therefore pose a high risk to health and safety. This production process is independent on the country of origin and therefore the risks to health and safety are considerable. The measures taken by the supplier could be different but Prodrive expects that the distributor monitors the health and safety measures taken by the supplier. During the discussion, it showed that Prodrive requests the audit reports of the manufacturer, and relies on and expects the distributor to audit the manufacturer on the measures taken. Another high risk value is the security of the financial position of the supplier. This finding is consistently high for both the Chinese supplier and the alternative Dutch supplier. It is therefore an interesting element for risk mitigation measures, but not likely to be dependent on the country of origin. The stability of the processes is another high risk value that is consistent across countries. This is probably due to the characteristics of the PCB production process and will be hard to mitigate. The production of PCB’s is a complex process that is subject to many dynamics and may therefore vary independently on the supplier. The final consistently high finding is the high risk for the stability in governmental regulations. From the discussion session it showed that the current Chinese supplier are subject to rapidly changing environmental legislation. Due to the chemicals used in the PCB production process, the factories must be a certain distance from the populated areas. In the discussion session an example was mentioned that a supplier had to shut down a factory caused by new legislation, causing supply disruptions. For Dutch suppliers this is also estimated to be a high risk. An explanation may be that the law on chemicals usage is quite strict and are likely to prohibit using certain chemicals used in the PCB production process in the near future.

5.3.1.1 Supplier responses
A discrepancy between the general risk perception within Prodrive and the supplier is visible in some aspects as well. Particularly the likelihood of HR problems is interesting. The supplier clearly indicates that this is a problem for them. From the discussion session it showed that a distributing party gives Prodrive more flexibility and allows them to switch in manufacturer easily. Therefore, if one manufacturer
faces HR problems, switching to a different manufacturer would avoid supply disruptions. Nevertheless, in the discussion session it showed that particularly after the Chinese New Year, suppliers are known to face HR difficulties. The supplier indicates they are volatile to such HR disturbances and it should be looked at more closely. An even greater difference between the supplier and Prodrive is found in the durability of the materials and substances used for production. Prodrive estimates that a lower risk value is found in China for material stability than in the Netherlands. Possibly the environmental legislation changes play a role in this as well decreasing the relative attractiveness of Dutch suppliers. However, the supplier clearly indicates this as a potential risk. Therefore the durability of the materials and substances used in PCB production should also be looked at more closely. A remarkable finding is the difference in risk perception when it comes to IT quality. Clearly Prodrive does not experience any problems from the IT quality through the distributor. The supplier however indicates that the IT systems which are used are not high in quality. An explanation is presented in the discussion session where it showed that the primary concern for Prodrive is that the information which is communicated is interpreted by the supplier. The method used for interpretation is irrelevant as long as it is effective. Therefore, a threat in IT quality is not perceived.

There are some positive differences found between the Chinese supplying party and the Dutch alternative as well. Primarily the effect on product value is likely to be the prime reason to source PCB’s from China. In addition a lower risk value is observed for the durability of the relationship with the customer. These two elements are likely to be linked to each other. Because a lower total cost is observed when sourcing from Chinese suppliers, a lower product price can be presented to Prodrive’s customers as well.

### 5.4 Portfolio comparison

Now that the cases within a portfolio have been compared and the primary motives for differences are known, the cases can be compared across portfolio’s. In order to do so, two patterns are distinguished in comparing the risk exposure: Consistent delta across cases and consistent for Case I & II but different for III & IV. Consistent delta across cases indicates that a similar risk pattern is observed between China and the Netherlands across portfolio’s, depicted in the top half of Table 10. This means that in the previously presented comparative tables (Table 8 and Table 9), the same element is found with the same difference in direction. Please note that the findings obtained from the supplier have been incorporated in to this table as well, creating a different value for some risk elements than is observed in the previous RDM tables. There may be a difference in size, which could be related to the product or the supplier for that case. When there are contrasting differences in the same row (dark and light), there is no consistency across cases. If there is one different cell and consistency amongst the remaining cells of the row, it is considered consistent across the case and assumed the differing value can be contributed to the supplier. Consistent for Case I & II but different for III & IV indicates that a similar risk pattern is found for the same portfolio, but has a contrast with the other portfolio. These are depicted in the bottom half of Table 10. The remaining case elements are not depicted in this study since they are considered to be either case specific or equal for both the Chinese and Dutch case, making it not relevant for finding Chinese specific global sourcing uncertainties.

#### 5.4.1 Inconsistent Values

Interpreting the inconsistent values across cases, a few things can be noticed. First, the effect of a European sales agent is substantial for the overall risk perception. This is reflected particularly in the communication oriented risk elements. No difference is found between the Dutch alternative and the Chinese supplier for the PCB portfolio. Examples are found such as communication effectiveness and the understanding of Prodrive’s position and strategy. In addition, a sales agent provides increased flexibility
### Consistent Values

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>CASE I</th>
<th>CASE II</th>
<th>CASE III</th>
<th>CASE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supplier has good health and safety measures</td>
<td>C</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>HR issues are not likely to occur at the supplier</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier has high quality IT systems</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The transportation costs aspect of the total costs are limited</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The lead time from the supplier is short</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier is able to provide sufficient stable product quality</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier is able to quickly adjust available capacity</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The alternatives for the supplier are able to quickly respond</td>
<td>NL</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The value of the product is low</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
</tbody>
</table>

### Inconsistent Values

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>CASE I</th>
<th>CASE II</th>
<th>CASE III</th>
<th>CASE IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are long term contracts with the customer and short term contracts with the supplier</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier is resistant for IT breakdowns (back-up scenario)</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier is able to communicate effectively</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The forecast that is presented for this component is reliable</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The lead times provided by the supplier are stable through time</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier understands Prodrive's position and strategy</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The governmental regulations are stable through time</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier is able to integrate or synchronize their IT systems with Prodrive's</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The supplier produces relatively small sized products</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The inventory ownership can be shared with supplier and customer</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The relation with the customer is durable</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The costs of holding inventory are low</td>
<td>C</td>
<td>C</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
<tr>
<td>The materials used are durable in their lifecycle (long lifecycle)</td>
<td>C</td>
<td>NL</td>
<td>RDM Δ</td>
<td>RDM Δ</td>
</tr>
</tbody>
</table>

Table 10 Cross Case Risk Analysis Values

38
for Prodrive in terms of contracting, holding inventory and IT integration. Therefore, it is likely the role of a sales agent or distributor that is more European oriented may have a risk mitigating role to some otherwise country related risks. It helps in explaining the differences found between cases I & II and cases III & IV.

Second, some remarkable consistent and equal values are found for China and the Netherlands. For example it was expected that culture may have an important role and may pose a barrier in global sourcing (Quintens, 2006). The same was found for troubles with flexibility (Kinkel, 2012). Given the context of Prodrive it may be that these variables may pose a risk for other companies who have less acquired knowledge, but Prodrive has sufficient acquired knowledge for the risk to be minimized. Prodrive does not experience a cultural problem and the suppliers are capable of fulfilling demand given the stable environment which can be interpreted from, for instance, forecast consistency and quantity stability. However, for other companies this may be more troublesome while also sourcing from China. Finally, there are some consistent values across cases where China is exposed to a greater or smaller risk than the Netherlands. These values shall be looked at more closely in the next section.

### 5.4.2 Consistent Values

Next to the inconsistent values, consistent values have also been found across portfolio’s. In total, 9 statements of the RDM questionnaire have consistent delta values across cases. A few remarks shall be made on these 9 statements.

First, the primary motive from literature for global sourcing is represented in the data; overall lower costs in China compared to the Netherlands. For all but case I a lower risk is perceived for product value in China. As already mentioned, the specifics of Case I are such that regardless of where the product would be sourced, the value is always critical to the end product and will always face a high risk value. For the remaining cases lower risk values are observed in China.

Second, there are consistent greater risks in health and safety. Through a combination of the RDM values from Prodrive and the comments from the supplier, the health and safety measures have shown to be consistently higher in China than in the Netherlands. Although a correlation with the production process is to be expected, in general terms it can be stated that Prodrive needs to have additional focus to health and safety in general for Chinese suppliers.

Third, a consistent greater risk is observed in Human Resources. This was an extensively discussed topic during the risk management session. In addition, the suppliers have confirmed that indeed HR problems have some frequency for them. The extent to which this will influence the quality delivered by the supplier is unknown and hard to estimate, especially for Chinese suppliers. In the current set-up, it is hard for Prodrive to visit the suppliers and estimate how HR disturbances would influence the risk in quality defects or nonconformities.

Fourth, a consistently greater risk is observed in IT quality. In general, for Chinese suppliers used by Prodrive the quality of the IT systems is inferior compared to Prodrive’s standard. As such a risk in IT quality is observed. This may result in the incorrect communication of data. In fact, some proof for this to occur is visible for Case I, where an IT mismatch is the cause for a significant delivery reliability problem. In general, because of IT difficulties additional communication is required to obtain the correct data required in sourcing from China.

Fifth and sixth are transportation costs and lead time. These are mentioned together because they are clearly associated with the logistic flexibility. What in beforehand seemed obvious is indeed confirmed by the research; sourcing from China increases the risk exposure in logistic capabilities. Simply because of the distance that needs to be covered, transportation costs will be higher for China than for the
Netherlands. Similarly, the lead time will be larger since the distance that needs to be traveled will be larger for China than the Netherlands. Speeding up this transport is possible, but will require additional resources for transport compared to sourcing from the Netherlands.

Seventh, a consistently greater risk is observed in product quality. As mentioned before, this is a primary cause for companies to quite their global sourcing activities (Kenkel, 2012). Therefore, a primary motive for backshoring activities out of China is visible and confirmed by the data from Prodrive.

Eighth and ninth are a suppliers’ capability to adjust capacity and the response times of alternative suppliers. These are both associated with the responsiveness of the suppliers based in China. Although these differences are not that large, it is regarded more difficult to create a sense of urgency at Chinese compared to Dutch suppliers in case of calamities. It is possible, but it requires more effort. As such, a slightly greater risk value is observed for Chinese suppliers in terms of responsiveness.

5.4.3 Country of origin dynamics

Currently, the primary motive for Prodrive to source from China is to achieve cost benefits. These benefits are predominately required in order to sustain its expanding product portfolio. For high volume low cost products such as consumer electronics, a drive for cost optimization is continuous. Given the consistent finding that the product value is found to be lower in China, this is achieved at the moment. However, in order to obtain these benefits, some consistently higher risks are being faced. Therefore, currently the balance is still in the favor of sourcing from China. For some cases however, it may be that the margin that is left is not that large. For example in Case I a marginal cost benefit is achieved by sourcing from China. In addition, significant risk values need to be accepted to obtain the goods from this supplier. Although the context of Case I is not the same as that of the other cases, it is exemplary for the current benefits that can be achieved by sourcing from China. Changes in the dynamics of the country of origin may expose a greater risk value and change this balance. For Prodrive, an assessment towards the sensitivity of the identified country of origin elements shall now be performed. This way, the resilience of the current sourcing activities towards dynamics in China can be estimated. However, this relationship can only be shown on a conceptual level. Therefore, the relationships that will be described next serve for understanding how risk perceptions may change, given a country dynamic. The magnitude in which the perceived risk level will change cannot be estimated.

5.4.3.1 Direct COO effects

The direct COO elements identified earlier are minimum labor costs, raw material prices and currency exchange risk. For the assessed cases quite some sensitivity towards these elements can be shown. The margin for incurring additional costs in sourcing from China is not that large. The products that are predominately sourced from China are quite labor intensive and therefore exposed to minimum wage developments. Particularly cases I and II have a labor intensive production process where many workers are required to produce the products. Cases III and IV have a more automated production process and is therefore expected to be less sensitive towards labor costs development. The opposite is the case for raw material prices. Cases I and II do not make extensive use of scarcely available raw materials, while this is the case for cases III and IV. In terms of currency exchange risk Prodrive doesn’t face this is much. All Chinese suppliers invoice in US Dollar currency, a currency in which Prodrive also receives revenue. This revenue stream extends that of sourcing raw materials. As such, no risk exposure exists in currency exchange risk. Note that in translation of profit’s from US Dollar to Euro’s a risk to currency exchanges exists but extends the scope of this research.

5.4.3.2 Indirect COO effects

Next to the direct COO elements, a set of seven indirect COO elements have been identified from theory. These indirect elements may further clarify how changing COO dynamics will affect the risk perception.
Based on the consistent values from the risk assessment in the previous section, six main domains can be distinguished: costs, human capital, IT infrastructure, logistics, product quality and supplier responsiveness. For each indirect COO a short relation is brought forward to one, or several of these domains.

First, the governmental regulations in a country may influence the human capital, logistics, responsiveness and cost. The governmental regulations will in general allow a degree of flexibility for suppliers to operate through legislation. For example certain laws in the ease of hiring and firing will affect both the human capital as well as the responsiveness domain. If a change in legislation with regard to hiring and firing is made such that it becomes more cumbersome to hire staff, this may affect the observed risk levels such that a supplier is not able to respond as quickly. This can also be observed the other way around, indicating that when legislation is made easier for hiring and firing, a supplier is better able adjust its capacity to the requirements. In a similar fashion a relationship can be established for laws involving the ease of customs and thus affects logistics.

Second, the infrastructure efficiency in a country may influence the IT quality, logistics and responsiveness. If a country has a high quality standard in infrastructure, the general transportation times will be more deterministic, involving less uncertainty in the logistic domain. In addition, a supplier will be able to respond quickly because a high quality information structure allows to respond fast. Similarly, if infrastructure such as broadband connections are frequent in the country, IT quality will be more likely to have a decent quality. This will influence the accuracy of information exchange between customer and supplier, reducing uncertainty.

Third and fourth, the distance to the COO and the export rating will affect the logistics and cost domains. Although the distance itself will not change, it is a reasonable estimator for predicting the transportation costs aspect of the total costs. The export rating of a country will be a measure for the attractiveness of shippers and transportation companies to visit ports and airports in the COO. In popular exporting countries, more competition between shippers will exist. As such, frequent transports will be offered with lower prices. Therefore, this will also affect logistics and costs.

Fifth, the countries PMI will be a measure for predicting the economic climate of the country. For exporting countries like China this will be a measure for the exporting volume, thereby influencing the transportation costs. As such the PMI can be monitor to predict a change in the domains of logistics and costs of sourcing from China.

Sixth, the environmental hazard likelihood will influence the domains of logistics and costs, especially on a portfolio level. If many of the suppliers within the portfolio are concentrated in the same region, the risk that is observed through environmental hazards may be large. This will affect the material availability and the costs of these components if that region were to be struck by a hazard. For example, many PCB manufacturers are located in the Guangdong region in China. If a disaster would hit this region, material availability of PCB’s will become troublesome. Prodrive has anticipated on this by having alternative suppliers close by. Therefore, in developing a portfolio the supplier concentration should be checked.

Seventh and finally the cultural alignment may influence the human capital and the product quality. Some countries are famous for their generally constant high quality products. It seems as providing a certain quality level is embedded in cultural values. As such, the expectation for high quality may be linked to a countries culture. Although this is unlikely to change, it will affect the perception of how suppliers are likely to perceive quality problems. In addition, examples have been shown of frequent HR disturbances because of cultural aspects such as holidays. Therefore a link to human capital can be formulated.

Since the objective of this study was to develop an approach which allows companies to mitigate global sourcing risks, anticipating on the dynamics of the country of origin, a relationship between risk values and country of origin dynamics was required. Now that this relationship has been shown between the
consistently greater sourcing risks in China and the identified country of origin elements from the literature study, in the next section a diagnosis can be formulated with regard to the uncertainty levels of Prodrive regarding sourcing from China.

5.5 Prodrive Diagnosis

In the previous sections the risks per portfolio and across portfolio’s have been analyzed. Next, the consistently greater risk values were associated to a (or several) country of origin elements. Reviewing all the mentioned data a diagnosis can be formulated with regard to the uncertainty in Chinese sourcing and what exposure is present towards China developments.

5.5.1 Results

When all the results and interpretations are taken into account, it can be stated that indeed a relationship between certain sourcing risk elements and country of origin elements exist. With the case study results from Prodrive, it has been shown that some risk elements face consistently higher risks in China compared to the Netherlands, independent on supplier and product. The domains where additional risk levels are encountered are not focused in a specific domain, but scattered across six different domains. As such, risk mitigation measures will have to be oriented towards a broad set of domains. Currently, the greater risk levels in these domains can be accepted because the major benefit of cost savings is still there. However, a change in country dynamics may have an effect in one or several of these domains and disturb the balance which currently exists.

In addition to the consistently greater risks, a few remarkable effects can be noticed. First, the effect of the supplier selection process on the risk perception is substantial. The difference in risk values between cases I and II is such that many of the differences can be contributed towards the fact that the supplier of case I has not been selected by Prodrive but by the customer. Case II faces either generally lower or no greater risk at all compared to case I when comparing Chinese and Dutch sourcing. Therefore, the uncertainty level encountered with Chinese suppliers is greater when no supplier selection process has been completed.

Second, a European sales agent has a large effect on the perceived risk levels. The selected cases face roughly the same logistic nature; goods are produced in China and shipped to the Netherlands. However, the difference in risk perception between the PCB portfolio where a European sales agent is active and the Cables & connector portfolio which is dealt with directly, is substantial. This is reflected particularly in the communication oriented risk elements such as contracting possibilities, order updates accuracy etc. A European sales agent therefore has a clear risk mitigating effect on Chinese sourcing.

5.5.2 COORMC

Given the findings of the risk diagnosis, Prodrive’s position on the COORMC as defined in the theoretical framework can be configured. To determine where on the continuum Prodrive can be positioned, the elements of frequency, sensitivity and uncertainty will be conceptually assessed. By assessing for the three variables if they have a low, medium or high value, a general feel for Prodrive’s position on the COORMC can be obtained. Given the conceptual nature of the COORMC, a further empirical assessment cannot be established. Nevertheless, the position will help in determining which kind of risk mitigation measure is justified to reduce the uncertainty entailed with Chinese sourcing. On one side of the COORMC are project measures and on the other side or country measures. In between, hybrid measures can be taken.
From the RDM studies performed at Prodrive, some clear differences became apparent between the cases. However, in line with the COORMC model, only when there is sufficient frequency, uncertainty and specificity will a form of country of origin measures be effective. Therefore, the cases studied need to be extrapolated to the entire supply base for that country: Prodrive has 82 direct suppliers in Asia (similar to case I and case II) and 60 manufacturers in a custom component category that are delivered through mainly European distribution channels (like case III and IV). The fast majority of this supply base is oriented in China. In total, the entire purchased volume for the Asia pacific region is close to 5 million Euros of which 2 million is sourced directly from predominantly Chinese suppliers. Therefore, the sourcing from China cannot be called an incident, and as such the frequency of Chinese sourcing is sufficiently high, indicating that in the COORMC some form of country of origin measures are justified. In terms of uncertainty in the country of origin values, it became clear that quite some variables identified by Kolp (2012) as country of origin elements have seen dramatic fluctuations in recent years for China. Therefore, the uncertainty in country of origin elements is such that some form of country of origin risk mitigation measures seems justified. Lastly, in terms of specificity it has been shown that there is quite some sensitivity to country of origin elements by showing the conceptual relationship between consistently high six risk domains and country of origin elements. Like with Williamson’s (2008) transaction cost model, specificity is considered the most determining variable on the COORMC. In the current state there is a balance where sourcing from China is still profitable, but some sensitivity has been shown. Therefore, a medium value is assigned to the sensitivity domain. As such, the frequency, uncertainty and sensitivity aspects are so that at the very least some form of country of origin risk mitigation is advisory for Prodrive. A visual representation of Prodrive’s position on the COORMC is presented in Figure 14 where Prodrive is represented by the red bar on the scale. However, as also can be observed from the case analysis, quite a number delta values between the observed Chinese and Dutch risk values can be attributed to the specific way of working of the individual supplier or the product it supplies. It seems logical to make an assessment per risk element whether it should be mitigated through project measures, country of origin measures or a hybrid form.

![Figure 14 Prodrive in the COORMC](image)

Prodrive’s position on the COORMC and the results from the risk diagnosis shall be used in the next chapter. In the next chapter, a set of solutions shall be designed corresponding to the COORMC for Prodrive which will reduce its uncertainty levels with Chinese sourcing.
6. Solution Design

So far, the theory and practical part of this study that provide data have been completed. At this point in time, the collected data shall be used to design a solution oriented towards reducing uncertainty with Chinese sourcing. To do so, this chapter will be structured as follows: First, several measures are designed which are based on the different mitigation levels in the COORMC. For each level, a (set of) measures is designed. Of these measures, a solution shall be selected after which an implementation plan is set up for Prodrive.

6.1 Design

The risk mitigation design for Prodrive will consist of three separate aspects: project mitigation, hybrid mitigation and country of origin mitigation, in line with the COORMC. Project mitigation concerns mitigation measures for the values observed as high or fatal risk for the risk elements but unique to that case. Hybrid mitigation will be applied to values where case I and II have higher risk values for China compared to the Netherlands but cases III & IV do not. The country of origin risk mitigation shall be designed by suggesting measures to where the risk values are consistently higher for China. This way, the COORMC is used by checking the frequency of a greater risk value in China and the sensitivity to the country of origin value. This section shall proceed with describing some measures of each kind.

6.1.1 Project Mitigation

Project risk mitigation is useful when no clear differences can be found between the country of origin and the reference country, indicating case specific risk. This is the case for some high risk values found in the supplier's process stability for cases I, III and IV. As a measure, the supplier can be requested to inform Prodrive proactively of changing production processes and raw material usage at time of supplier selection. Currently no such assessment or request is made in the supplier selection process of whether the supplier is capable and willing to do so. Incorporating this into the selection method is, given Prodrive's selection process, relatively straightforward. Another example is the stability of governmental regulations for cases III and IV. These have high values for both countries. Particularly the environmental aspects of governmental regulations are a threat to these products. One way of mitigating this risk is by checking if a supplier is proactive in investigating alternative environmental healthy substances for production. This would also influence the health and safety concern for these cases. Given the supply base construction of PCB’s at Prodrive, it is probably wise to request the distributing party to audit the manufacturers upon the proactiveness and prefer selection of manufacturers who do have such progressive policies. For any type of project risk, increasing flexibility in terms of having multiple suppliers on standby will reduce the chance of supplier specific risks escalating in to incidents (Sodhi & Tang, 2012).

6.1.2 Hybrid Mitigation

For designing hybrid mitigation, the influence a distributor party in the supply chain is used. It has already been observed that many risk elements have a lower risk value when a distributor party is between Prodrive and the Chinese manufacturer. Therefore, to mitigate risks in communication, logistics and increased flexibility in the supply chain, Prodrive might consider starting or hiring a distribution party for their current direct Chinese suppliers. This measure will have significant effects for Prodrive’s overall risk exposure of and control over its supply base. Given the data, it would allow Prodrive to have more control
over supplier IT quality, IT resilience, forecast reliability, health and safety measures in place at the supplier, lead time stability, supplier communication effectiveness, and the supplier’s understanding of Prodrive’s position. For all of these elements, a consistently greater risk value is observed for China than the Netherlands for case I & II compared to cases III & IV. Therefore, the role of an intermediary that translates and puts forward Prodrive’s requests to a suited supplier would greatly reduce the uncertainty entailed with sourcing from China. In addition, with a distributing party logistics can be optimized, lowering overall transaction costs and the sensitivity to fuel prices. On the COORMC this is a hybrid measure since it does not directly target country of origin elements, but mediates global sourcing risk across the projects. An important decision to be made is whether to start or to hire an intermediary that will play a distributing role. Substantial benefits can be obtained from starting an own distributing agency in China. For instance, by placing the distributor party as a part of the Prodrive Holding, Prodrive would be able to profit from the friendly tax climate in most countries to Western firms. A schematic overview of the measure is presented in Figure 15. This would give Prodrive B.V. one party to contact for their Chinese sourcing and would give Prodrive Holding the chance to make a margin on both the procurement from China as well as selling products to the customers of Prodrive B.V. However, the obvious downsides are that the Chinese distributor will require additional resources. An alternative is hiring specialized intermediaries such as Lee & Fung. This is a large company which optimizes logistics and communication within supply chains from the Chinese mainland to worldwide customers. However, given the experience Prodrive has with Chinese suppliers and the ambitions of China not only as a sourcing market but also as a potential base for customers, it is advisory to have an entity in place in China. This will require some strategic planning and resource allocation that will be further explained in the implementation section.

![Figure 15 Risk mitigation measure: Chinese distributor](image)

### 6.1.3 Country of origin Mitigation

Next to the effects that differed across cases, some risk values have been observed for China compared to the Netherlands that are consistent across cases. Despite the distributor party in the supply chain for cases III and IV, these variables continued to face greater risks. For these elements, it is interesting to design risk mitigation strategies towards the country of origin variable associated with the consistent risk element(s). For each direct country of origin variable a risk mitigation measure and how it would influence the associated risk element(s) are presented briefly. For the indirect COO elements a selection is made
based on the relationship with the observed consistent greater risk levels for China. The risk mitigation measures that are presented will be placed in a Prodrive and COORMC perspective, for a more general risk mitigation approach please find Sodhi and Tang (2012).

One of the consistently greater risks was observed for elements that can be associated with the stability and the price level of raw materials. Raw material prices have a direct influence on the lifecycle of that material and the value of the product. In addition, if prices are low and stable a supplier is able to offer flexibility by increasing stock levels of the raw materials. These risk elements therefore can be influenced by stabilizing the raw material prices at a low level. One possibility is the reduction of sensitivity by engaging in financial hedging (Sodhi & Tang, 2012). Financial hedging is an instrument which stabilizes the price of a certain raw material at the cost of a premium. Hedging can also be applied to balance financial risks through currency exchange. With this method, the uncertainty in raw material prices and currency can be reduced since the price level has stabilized under the hedging contract. However, hedging means fixating which also means not profiting from possible favorable declines in material prices or currency exchange rates. Therefore, hedging is a speculative instrument that may backfire. It is an instrument that should be used thoughtfully and considerately (Sodhi & Tang, 2012). A successful hedging strategy will give cheaper and fixed material prices or cheap exchange rates. As a mechanism for not being exposed to raw material price risks, Prodrive may request their supplier to set up a hedging strategy, possibly sharing the premium on hedging since Prodrive would profit from the hedging as well through stable product value and material availability. In addition, the supplier can offer more flexibility since under hedging a supplier will have more insight in to what the costs for additional stock levels will be. However, this would be focused on specific suppliers and not on the country. To make country oriented hedging possible, Prodrive would have to engage in hedging themselves for certain raw materials that multiple suppliers can utilize. The most likely candidates are commonalities in raw materials such as certain metals and polymers. For instance all Chinese mechanics suppliers could profit from the same sheet metal hedge contract. Given Prodrive’s current supply base and wide array of products that are sourced from China, the sensitivity to common raw materials are not in such volumes that hedging at the country level will be profitable. Therefore it is wise that if a hedging strategy is formulated, it is set up with one or preferably several suppliers such that Prodrive benefits for multiple cases. To determine if and when a hedge contract should be set up, Prodrive might monitor certain indexes such as the PMI. The PMI has shown to be a relatively good predictor of demand fluctuations to raw materials. Another application is to fix currency exchange rates through hedging. Given Prodrive’s supply base in China the common currency used is US Dollar. There would be a risk if Prodrive had to change all its revenue income from Euros to US Dollars. However, Prodrive also receives revenue in US Dollars on a separate account. Therefore there is no uncertainty in the COORMC for exchange in currency and the consistent risk elements being influenced by the exchange rates (product value and transport costs) are not relevant in the sourcing sense. There is a risk in translating the profits made in US dollars to Euros where hedging may help, but this is out of scope for this research. A financial risk is also present for the supplier itself. Prodrive will have to incorporate a structural financial analysis in their supplier selection and audit procedures for this. The observed greater risk values therefore are not related to exchange risks depending on the country of origin and should be dealt with on a case specific basis.

A second direct country of origin element that has been associated with consistently greater risk elements is the trend in minimum wages. This trend is quite recent and therefore not many risk mitigation strategies have been developed yet. The obvious answer to mitigate risks emerging from country specific measures is avoiding the risk by migrating to different countries. Sodhi & Tang (2012) state that having multiple production facilities across the planet will allow companies to switch between production facilities, anticipating on prices of labor. However, this is not a feasible solution for many locally based firms and can only work for the largest firms around. An alternative measure is to have multiple suppliers in different countries instead. Although this is in itself not a mitigating measure to minimum wages in a country, it is effective in anticipating on price increases through higher labor costs. Having additional suppliers in place
would also decrease the risk level in responsiveness of alternative sources, which has also been shown to be a consistently greater risk in China. In addition, it cancels out the effect of natural hazards in a specific region (Sodhi & Tang, 2012). The fact that the current supplier's production capacity is limited by the labor costs is something that will have to be accepted for that specific supplier. For Prodrive a way to set up alternative suppliers in different countries emerges from cases III & IV where a distribution party provided additional flexibility in switching between suppliers. Setting up additional distribution channels would give the same flexibility to current direct channel Chinese suppliers, somewhat avoiding the risks that may occur through climbing wages. While this study is focused at mitigation, certain avoiding measures might also help in managing the risk in global sourcing (Sodhi & Tang, 2012). Eventually the ultimate avoiding measure is to abandon the country of origin and switch to a different country.

A third country of origin element is that of logistical uncertainty. Both the lead time as well as the transportation costs are observed as consistently greater risk values for China than the Netherlands. Obviously, a considerate share of these values can be attributed to the distance between China and the Netherlands. While this in itself will not change, it can be a measure for how sensitive Prodrive is towards changes in prices that are associated with transportation or logistics. One way of mitigating risks is by having multi-modal transports, multi-carrier transports and multiple routes (Sodhi & Tang, 2012). Because many Chinese suppliers will not ship to the Netherlands, Prodrive has a considerable responsibility on the efficiency of logistics with which carrier to select using which mode of transport. Currently, Prodrive uses an intermediary for arranging the best transportation mechanism. However, the frequency is such that in current events Prodrive may profit from consolidating several Chinese shipments into one shipment between China and the Netherlands. This way, the costs of transportation are distributed across many products and different suppliers such that the effect is minimized. This requires a logistics intermediary that can either be the current transportation intermediary or the distributing agency mentioned earlier. If the share of transportation costs is high for the products shipped, it may be useful to monitor shipping price indexes such as the export rating and Chinese shipping index, see Figure 16. Low value products will be affected more strongly by the cost of transportation. Having multi-carrier transports and multi-modal transports provide flexibility in transports as well as lead-times (Sodhi & Tang, 2012). Depending on the country of origin variables of distance and indices such as the export rating, strategic transportation planning may be profitable. Enabling an intermediary to determine such strategies since the volume of goods per supplier is not up to multiples of full shipment containers per supplier, is a form of a hybrid measure in the COORMC. Many projects may profit but it is not yet a measure designed specifically to the country of origin since many suppliers in neighboring countries can also profit.

![Shanghai Containerized Freight Index](source: chineseshipping.com.cn)

The last country of origin element that has a relationship with a consistent risk element is that of cultural alignment. As also represented by the Prodrive cases, HR disturbances may cause suppliers to have fluctuations in the quality of the goods provided (Oehmen, 2009). The HR disturbances in China are
largely due to a cultural aspect of workers not returnin
g to their work after public holidays. Although at the
country level this would be hard to mitigate, Prodrive can select their suppliers on employee reward
systems and development programs as this is the key motive for Chinese workers (Oehmen, 2009).
Therefore, cultural alignment may be represented in the supplier selection and evaluation in place at
Prodrive where a distinction is made depending on the country of origin of the supplier, taking risky
cultural characteristics into account. In the COORMC the supplier selection and evaluation is project-
based, however differentiating the importance of elements in the selection and evaluation process for
different countries of origin is a hybrid measure.

6.2 Selection

Of the previously mentioned risk mitigation measures, some are selected for Prodrive. The primary
motivation for this is based on Prodrive’s position in the COORMC. In the COORMC Prodrive has been
placed in between the project and the country measures in the risk diagnosis in the previous chapter. The
number of suppliers and shipments from China, the uncertainty on country of origin elements and the
sensitivity towards these elements are such that more COO oriented measures than strict project
measures are profitable, but not yet so that strict country measures are required. Therefore, some hybrid
measures for Prodrive will be selected. First, the implementation of a distribution office and second some
adjustments to selection & audit processes for suppliers. A representation of the selected hybrid
measures for Prodrive in the COORMC is presented in Figure 17.

![Figure 17 Prodrive measures in COORMC](image)

The distribution office should function as a separate company within Prodrive Holding by sourcing from
several suppliers in the Asia region. This way, the distribution company can focus completely on
optimizing the information, material and cash flows from Prodrive to their Chinese suppliers. In addition,
setting up a distribution office will allow Prodrive to have one single focus point instead of managing
individual Chinese suppliers. This consolidation is not just for information, but also for goods. Setting up a
distribution office will allow for transport consolidation from China to Prodrive, thereby reducing the
transportation costs. Next to the optimization of separate flows, having a distribution point for the Chinese
suppliers will allow Prodrive to have initial quality checks carried out, making return flows to the supplier
easier and the chances of defects arriving in the Netherlands smaller. By setting up the distribution office
within the Prodrive Holding in a tax friendly country, additional financial gain can be obtained as well as a
presence for future sales opportunities.

Next to setting up a distribution office, Prodrive needs to reconsider its selection and auditing processes
when it comes to Chinese suppliers. In a more general sense, it is probably best to deviate the specifics
of supplier selection dependent on the country of origin and its appliance. This will allow selection and
evaluation of suppliers based on the likely risks in that country. This way, Prodrive will reassure itself its
suppliers are well equipped against possible changes in the country of origin. The changes should at
least be expanded with a financial health check, employee development plans, health and safety
measures in place and environmental proactiveness. Taking the largest risk exposures into account by differentiating to a certain country creates a more robust selection and auditing policy.

6.3 Implementation Plan

In order to implement the two selected measures, an implementation plan is set up. This plan will consist of three phases which will develop a new business entity in the Prodrive Holding and adjust the current selection and audit processes. Before these transition phases are described, first the current situation is explained.

6.3.1 Current situation

In the current situation, Prodrive has a representative office stationed in Hong Kong. However, currently no activities are being employed there. In the past, this representative office has been used to facilitate the contacts with Chinese suppliers. However, no clear approach and strategy was formulated to develop an effective representative office. In the transition phases the current Hong Kong representative office entity shall be remodeled towards a new business (NBE) entity in the Prodrive Holding.

Next to the Hong Kong representative office, a supplier selection and evaluation process is already in place. This process consists of sending out a predefined questionnaire to the prospect supplier before it is selected. The response is received and processed according to a set of pass & fail criteria, as well as a scoring mechanism. Currently, no differentiation is applied to a specific country of origin in applying pass & fail criteria or scoring methodologies. A similar methodology is in place for the evaluation process. A predefined questionnaire is send out the supplier after which it is processed and combined with a supplier visit. In the scoring mechanisms no methodology is used for differentiating for a specific country of origin. In the transition phases, a remodeling of the pass & fail criteria and scoring mechanism shall be developed for the selection and evaluation procedures for Chinese suppliers.

6.3.2 Phase 1

In the first phase, the main priority is to obtain resource commitment from senior management. In order to achieve this, a business case needs to be developed by the supply chain manager. In this business case, the specifics of how the NBE needs to operate and how it has to cooperate with Prodrive needs to be formulated. Although it goes beyond the scope of this research to formulate a complete business case, some important elements are mentioned briefly from a Prodrive perspective and from the new business entity.

From Prodrive:

- Prodrive and the NBE needs to be independent. This way, sourcing for Prodrive will be just like dealing with any other distributor. This is similar to the European distributor agent currently used for PCB sourcing and will reduce the risk perception for Chinese sourcing.
- Prodrive will order goods from the NBE through automated ordering procedures, minimizing the amount of labor required for order processing.
- Prodrive will request quotes and pay the NBE for the delivered goods.
- Prodrive will primarily use the NBE for sourcing activities, but may also utilize the NBE’s network for acquisition of new customers.
- Prodrive will allocate a part of its profits to the NBE, since a fraction of the profit made by Prodrive is made possible by the NBE activities. Therefore this fraction is taxed according to Hong Kong
tax law. This generates an immediate financial benefit since Hong Kong taxes are lower than in the Netherlands.

For the day-to-day operations in terms of responsibility and tasks, Prodrive will experience the NBE as any other supplier.

From the NBE:

- The NBE will select Chinese suppliers suitable for the needs of its customers. Initially, this customer base will only consist of Prodrive but it may be expanded to other customers as well, providing the same functions.
- The NBE will order goods at it’s selected suppliers based on the requirements of it’s customers. In the long term, inventory keeping becomes a possibility.
- The NBE will charge Prodrive for the delivered goods through a transfer pricing policy.
- Initially, the NBE will outsource it’s logistic handling but, when sufficient volume has been centralized, will own it’s own warehouses and coordinate it’s transports. This is not only profitable for adding value, but also contributes to the 0% tax on offshore activities charged in Hong Kong.

The following resources need to be claimed in the business case:

- Funds for sending Prodrive employee to Hong Kong to restart the current branch office.
- Funds for configuring the current ERP system such that the NBE is added to the Prodrive Holding.
- Initially one FTE is required for coordinating the transition from the current branch office to the NBE in Hong Kong.
- From Prodrive, a key stake holder is identified in the supply chain manager who should be made available for coordination of the transition from the current branch office to the NBE.
- A purchasing process engineer must be made available to reconfigure the current supplier selection and evaluation process to distinguish to country and industry specifics.

In the business case, SMART goals have to be formulated, for example:

- In line with the current sourcing strategy, the NBE will manage the current Chinese supply base and source for new suppliers, to realize a reduction of 5% of the realized Chinese spend at the end of 2014.
- Implement inter-company transfer pricing and the required ERP modules for the NBE, to act as an independent company at the end of 2014.

Once the business case has been presented and approved by senior management, the first transition phase can start.

### 6.3.3 Phase 2

In the first transition phase, two activities are executed in parallel. First, the supply chain manager will hire or select a FTE that will be transferred to the Hong Kong branch office. This FTE will have to become familiar with the Prodrive sourcing processes first before transferred to Hong Kong. This is probably done the best way by assigning strategic purchasing tasks to the new FTE when still based with Prodrive. This way, the new FTE can get acquainted with Prodrive’s Chinese sourcing specifics through experience. Once transferred, this FTE will restart the current inactive branch office of Prodrive. This way, the new FTE can already become responsible for the current Chinese supply base. This includes the selection and coordination of the Chinese supply base of Prodrive.
In parallel to the reboot of the branch office, the supplier selection and evaluation procedure is redesigned. A list of special sensitivities has to be set up by a process engineer for each portfolio. This way, when a supplier is selected or evaluated, a specific measurement methodology can be used. In addition to the portfolio, a different measuring mechanism has to be developed for interpretation of the Chinese suppliers. This measurement mechanism should place more emphasis on a financial health check, employee development plans, health and safety measures in place and environmental proactiveness as these are currently not or not explicitly tested for Chinese suppliers.

6.3.4 Phase 3

After the second transition phase, the branch office has been rebooted by the transferred Prodrive FTE and the supplier selection and evaluation mechanisms have been redesigned. In the third transition phase the transfer from the branch office to the NBE can start and the implementation of the new selection and evaluation methodology can be performed. In order to be able to transfer the activities from the branch office to the NBE, several infrastructural requirements exist:

- The NBE has to be set up with the Hong Kong authorities and chamber of commerce.
- A Hong Kong based accountant has to be selected for assessing and validating the financial actions performed in the NBE. This will have to be validated with the current accountant of Prodrive and the controlling department such that a valid business coordination is set up.
- In line with the previous item, the NBE should become an own entity in the ERP system. Therefore, a configuration project needs to be completed which defines the NBE next to Prodrive B.V. and under the Prodrive Holding with the correct consolidation assignment.
- One aspect of the consolidation assignment is the profit transfer from Prodrive to the NBE in the consolidation of the Prodrive Holding. An agreement has to be set up with Dutch tax authorities to agree on a percentage which may be allocated from Prodrive to the NBE.
- Another aspect of the consolidation is an agreement is with Hong Kong tax authorities for assigning an offshore/onshore percentage to the activities employed in the NBE. The offshore activities in the Hong Kong based NBE will be charged 0% tax.

If these activities have been completed, the FTE in the branch office from Prodrive can be transferred to the NBE and the branch office can be closed. This includes a set of activities

- The Chinese suppliers will have to be informed that the sourcing channel will be updated from Prodrive to the NBE.
- The ERP system for Prodrive should be configured such that the materials will be sourced from the NBE instead of the Chinese suppliers.
- The ERP system for the NBE should be configured such that the materials previously sourced through Prodrive will be configured such that the NBE will source these materials from the Chinese suppliers

Next to all transition elements, on a more conceptual level the risk exposure levels should be reassessed. Given the fact that the implementation of the NBE is aimed to drastically change the risk perception of Prodrive, a reassessment is required after implementation to test the measure effectiveness. This can be accomplished by performing a quickscan that may consist of assigning a risk value to the statements of the RDM questionnaire similar to the RDM discussion session with a few NBE involved purchasers. By comparing the values before and after the NBE set up, the effect of the NBE to the Chinese sourcing risk exposure can be validated. In addition, as the supply base grows and time progresses, the position of Prodrive on the COORMC may change for Chinese sourcing by changing frequency or sensitivity values. In addition, the already dynamics COO uncertainties may become even more uncertain. As such, even with the NBE in place, additional measures may be required to safeguard the future efficiency of global sourcing. Performing a quickscan regularly may expose the shift in COORMC position.
The quickscan methodology can also be applied to support further global sourcing growth of Prodrive to other countries than China. Since the current business model is oriented to further global sourcing expansion, new countries of origin are likely to become relevant in the near future. As Prodrive builds up experience in dealing with new countries of origin, assessing the COORMC position of Prodrive’s supply base for those countries will guide the structure of measures and policies. Regular assessment will enable Prodrive to test for changes in country dynamics, sensitivity towards these dynamics and the frequency of sourcing from that country. Based upon this assessment, applicable measures can be taken such that sourcing from that country remains effective. Regular assessment can, ultimately, motivate Prodrive to backshore or relocate their sourcing activities to other countries of origin.
7. Discussion & Conclusion

This research has shown that additional uncertainty is faced when sourcing from China from the Netherlands. This finding validates the presumption that global sourcing adds complexity, as proposed by Trent & Monczka (2003) and Quintens (2006). In addition, the primary reason for initiating global sourcing has also been shown: Sourcing from China occurs in general at lower cost, by which a competitive advantage is created. As such, the initial presumptions preliminary to this research have been validated. Next, the findings that are based upon these presumptions will be addressed. Next, the contributions of this study shall be discussed. In addition, some recommendations, limitations and future research directions are presented.

7.1 Findings

This research has been performed in order to answer the following main research question: How can the uncertainty in Chinese sourcing be reduced and the lessons learned applied in further global sourcing expansion? To answer this research question, a risk assessment methodology for global sourcing risk was developed and executed. From this results of this analysis a solution design has been formulated.

To ensure the risk assessment would include all relevant aspects entailed with global sourcing, a theoretical base was formulated. This theoretical base studied the developments which have led to global sourcing and to the factors underlying the current backshoring trend. It showed that three main domains could be distinguished that decide the uncertainty levels that are faced in global sourcing; the risk context, the country of origin and risk mitigation measures. In order to perform a risk assessment, the risk context needed to be assessed. To do so, a more detailed list of measurable elements was required. These were derived by combining and comparing several studies to global sourcing risk. With this set of risk elements, one aspect of the first sub research question had been answered; the set of risk elements used to measure the risk context show which uncertainties are relevant in global sourcing. However, in order to explain how the current backshoring trend for particularly China may have emerged, solely the risk context is not sufficient. Therefore, the developments that the country of origin faces will influence the risk perception. For China, the rapidly developing minimum wage levels have been shown to be a factor that have caused companies to backshore activities to the US or relocate to other low wage countries (Kinkel, 2012, Roberts, 2008). The increase in production caused combined with more difficulties with quality and flexibility in China have started a backshoring trend (Kinkel, 2012). Therefore, in order to estimate which uncertainties are relevant in global sourcing, the uncertainty of the developing country needs to be taken in to account. Therefore, a set of direct and indirect country of origin effects have been formulated which may influence the global sourcing risk exposure. Together with the initial set of risk elements for the risk context, a complete answer to the first sub research question had been formulated.

To assess the uncertainties, an assessment methodology had to be developed. In order to do so, based on the risk elements derived from theory a RDM questionnaire was set up. The questionnaire was structured so that comparisons in risk levels between Dutch and Chinese sourcing would become visible. This way, the additional uncertainty brought forward with Chinese sourcing could be derived. To cancel out effects due to supplier or product specifics, four different cases were assessed. This way, by comparing the different risk values for these cases, the increased risk levels for China could be determined. This way, the second sub research question had been answered since a methodology for measuring the uncertainty entailed with global sourcing could be measured.

Next, the RDM was performed based on the questionnaire. For each case a comparison was made between the current Chinese supplier and a possible Dutch alternative to investigate the differences in
risk perception. For each case, the specifics of the case causing different risk values between China and the Netherlands were discussed. Next, the cases were compared first within a portfolio and subsequently across portfolio’s. This way, 8 risk elements were found that had consistently greater risk values in China than in the Netherlands. In addition, a consistent finding was found that the general product value is lower in China than in the Netherlands. The domains where additional risk levels are encountered are not focused in a specific domain, but scattered across six different domains. Therefore the greater risk levels are not concentrated in one aspect such as product quality, but range across different aspects. On human capital, IT infrastructure, logistics, supplier responsiveness, product quality and cost greater risk levels were observed. These six domains are a representation of the risk context, but do not take the country of origin elements in to account. When investigating the relationship between the country of origin and the risk levels it can be observed that Chinese uncertainty levels are influenced by the country of origin developments. Particularly the direct effects will cause greater uncertainty levels through fluctuations in minimum wage and raw material prices. Currently, the greater risk levels in these domains can be accepted because the major benefit of cost savings is still there. However, a change in country dynamics may have an effect in one or several of these domains and disturb the balance which currently exists. As such, Chinese uncertainty levels are greater in the mentioned six domains and are influenced by the dynamics on a country scale in China. This answers the third sub research question.

The fourth sub research question is oriented towards achieving greater control on Chinese sourcing by reducing the uncertainty. To do so, initially a theoretical foundation was established. Risk mitigation can be performed on three levels, project measures, hybrid measures or country of origin measures. These measures form a continuum similar to that of transaction cost economics. In order to determine effective mitigation measures to reduce uncertainty, the position of the firm in this continuum (COORMC) will have to be established. This is done by assessing three criteria; frequency of sourcing from the country, sensitivity towards country dynamics and uncertainty in country dynamics. By conceptually assessing the position, effective risk measures can be formulated. For Prodrive, the position on this continuum was developed after the risk assessment and the sensitivity towards country of origin values had been established. Next, appropriate risk mitigation measures were designed that correspond to Prodrive’s position in the continuum. As such, two hybrid measures were formulated that affect multiple sourcing projects but are not targeted to the country of origin per se. Therefore, reducing uncertainty in Chinese sourcing can be achieved by firstly establishing the position of the firm in the COORMC. Next, based on this position appropriate risk mitigation measures can be designed that take the sensitivity towards country of origin dynamics and the greater risk values observed from the risk assessment in to account.

The fifth and final sub research question is focused on the lessons that can be learned from China for further global sourcing expansion. At this point in the research, this question can be answered. A few things can be noted based on this research that may apply to other countries than China alone. First, sourcing from a specific country will bring forward a country specific dynamic that will influence the uncertainty levels observed in global sourcing activities. For China this is observed in the previously mentioned six domains. For other countries these domains may also apply in some extend. Given the values in uncertainty these domains have caused for Prodrive, it is advised to investigate beforehand where additional uncertainty can be expected. Typically, this is only based on the product that is sourced. For example, analyses are performed on the production process in place at the supplier. However, this research has shown that independent on product or supplier, uncertainties are also country dependent. Therefore, not only the project specific items but also the country specific items need to be taken in to account when considering to source from a new supplier and a new country. Second, the need for a type of risk mitigation measures will depend on the frequency, uncertainty and sensitivity measures in the COORMC. This will decide if risk mitigation strategy should be designed on a project level, country level or a hybrid level. Where a large volume is sourced from an instable country for products and suppliers that have a significant sensitivity towards country developments, risk mitigation should be oriented towards the country of origin. For example, updating the supplier selection process such that only highly
automated suppliers are selected in the country will minimize the sensitivity towards increasing minimum wages. Ultimately, changes in country dynamics may cause a change in the COORMC of the sourcing in that country that ultimately leaving the country is the only option to maintain effective sourcing. When this is applied to China, it can be stated that depending on the sensitivity of the cases to be sourced from China, it is still profitable to source or not. For instance, low margin production industries such as textile companies will probably do best not to source from China since the sensitivity to the cost of labor is high. Together with the highly uncertain value of Chinese labor costs, it is best not to source from China. In addition, assessing the position of Prodrive global sourcing activities to other countries than China will guide global sourcing to remainder of Prodrive’s global sourcing supply base as well. Third, the effect of having an intermediary firm between the producing supplier and the sourcing company significantly reduces several risk levels, but especially oriented towards communication. Therefore, when additional uncertainty is being faced in communicational aspects for a new country of origin, adding an intermediary will reduce the uncertainty.

With the sub research questions answered, an answer to the main research question can now be formulated. In order to reduce the uncertainty in Chinese sourcing, companies will have to assess their risk exposure in China. This risk exposure will be composed of a risk context element and a country of origin element. With this assessment, the position of the company on the COORMC can be determined that will allow for designing effective uncertainty reducing measures. These can be either focused to project specifics, country specifics or hybrid measures. The lessons that can be obtained from China are that companies need to anticipate and estimate how their sourcing will be affected by dynamics of the country. In addition, designing effective risk mitigation measures will depend on three elements that may differ from firm to firm and from project to project: frequency of sourcing, uncertainty in country dynamics and sensitivity towards changes in country dynamics. Finally, the effect of an intermediary on communication uncertainty is such that significantly lower uncertainty is observed when an intermediary is placed between the producing supplier and the sourcing customer.

7.2 Contributions

Based on the previously stated findings, this study has made some contributions to the academic literature. First, a set of risk elements has been collected based on the work of other scholars in the global sourcing risk field. These elements are distributed over a set of categories and are logically related. The most important contribution however is that these elements are measurable and can be used for performing a risk assessment. Current sourcing risk models are typically oriented towards a specific category such as disruption likelihood or dyadic effects. The current research has combined these dispersed models in to one global sourcing risk elements model. In addition to a redefinition of the risk context, country dynamics are specifically related to the risk context. The current sourcing risk literature fails to provide an effective answer for answering the current backshoring trend. The risk elements model with the country of origin elements especially focus on the relationship between the country of origin and the risk exposure. Such a perspective on global sourcing risk is, to the best of the author’s knowledge, new to the academic literature. Second, a new methodology for assessing global sourcing risk in a specific country of origin has been developed. By using a comparative approach in an RDM methodology, the benefits of RDM can be utilized while at the same time having a measure for where different risk levels can be observed in the country of origin compared to the reference country. By combining several assessments across products and suppliers, the consistencies that may be attributed towards the country of origin can be found with this methodology. Such a comparative risk assessment methodology has not been found in the academic literature. Third, the COORMC has been formulated based on transaction cost economics that helps in explaining why and when backshoring may occur. Based on the frequency of transactions in the country, the sensitivity towards country dynamics and the uncertainty entailed with the developments of the country, a general feel for which risk measures are effective for the company is created. This means that a difference may exist for two companies sourcing from the same country. For
example, if one company is positioned in the middle of the COORMC backshoring from the country of origin is not required and other measures can be taken to increase sourcing effectiveness. However, if another company sources from the same country of origin, only the uncertainty aspect is shared. The sensitivity and frequency aspect of the COORMC may be different which may lead this company to backshore from the same country of origin. Although the explanation presented is only shown on a conceptual level, the approach used for explaining how backshoring may be effective for one company sourcing from a country of origin but is not effective for other companies sourcing from the same country, is new to the academic literature. Fourth, this research has performed a process that will create awareness amongst practitioners on the dynamics brought forward by the country of origin. As such, which risk mitigation measures to take given the specifics of the supply base in the country can be determined by applying the approach used in this study. Investigating the relationship of consistent uncertainties for the country and the country dynamics and consequently determining the position on the COORMC will aid decision making for practitioners in the global sourcing field.

7.3 Recommendations

Several recommendations can be made with regard to the implementation of the results of this research. First, the proposed solutions to set up a distribution channel and change the supplier selection and evaluation procedures should be implemented. Next, it should be rechecked to see how the risk exposure levels have developed. The solutions have been designed based on the findings of this study and are therefore likely to positively affect the risk exposure. However, this expectation should be validated after the implementation. In this research it has been shown that some differences may exist between the supplier and Prodrive. Therefore, it is important to incorporate the supplier in this validation as well. Second, the solutions have been designed based on a part of the entire supply base of Prodrive present in China. It should be checked if the proposed solutions are also applicable to the remainder of the supply base in China and if these suppliers would also benefit. Given the results of the current study, it is expected that the influence of setting up the distribution channel will also contribute in the remaining custom component categories that are directly procured from Chinese suppliers. Third, the proposed solution contains a guideline for implementation. However, at the current point in time there is too much uncertainty to develop a complete business case required for obtaining resources. Although the most important aspects have been noted, additional research should be performed to analyze how the new business should function and operate, which requirements exist for this and how these can be fulfilled. An important note is to define clear goals in the implementation planning of the business case such that progress and evaluation can be performed effectively. Fourth, with the further expansion of Prodrive’s global sourcing activities, assessing the country specific risk and how it may affect Prodrive’s sourcing effectiveness will bring insight which measures are applicable to mitigate risk. In addition, in the event of changing country of origin dynamics or sensitivity towards these dynamics, assessing the COORMC position can help Prodrive identify if and when to backshore or reposition their sourcing activities from the country of origin.

7.4 Limitations & Future research

This research is bounded by some limitations which will be discussed next. First, although the suggested improvements and models used are valid within this research, it is set up within the context and practitioners at an electronics design and production company. As such, the possible consequences this may have on the risk perception and the measures adopted from it have not been considered. An interesting possibility for future research would be to check if the frequency, sensitivity and uncertainty elements in the COORMC are influenced by the context in which it is applied. For example, a relationship may exist between industry type and the relative influence of the three variables of the COORMC. Second, because of resource constraints this study has been performed at one company, for one country
of origin, for four cases. The applicability of the methods used were chosen such that they will also work outside these limits but further research to assess the applicability to other countries is required. These countries may have different dynamics than China and may require additional country of origin elements to explain and incorporate the country of origin effects in the risk assessment. In a similar fashion, although the COORMC was derived from a generally accepted economic theory and is capable of explaining the current dynamics in China, further research is required to test if it is capable of explaining dynamics in other countries.
A. References


B. Appendix I: RDM classification list

<table>
<thead>
<tr>
<th>SCORE</th>
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<tr>
<td>Certainty</td>
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</tr>
<tr>
<td>*</td>
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<table>
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<td>Certainty</td>
<td>Ability of team to influence course of action</td>
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</table>

**Mean of the risk classification:**

- **F** = Fatal risk;
- **H** = High risk;
- **M** = Medium risk;
- **L** = Low risk;
- **S** = Safe, no risk.

*A combination of classes means that the risk team should work out whether the disagreement can be resolved and hence a single risk classification can be achieved. If consensus can’t be achieved the worst possible case should be assumed.*

*Will be included in Risk management session*
### C. Appendix II: Risk elements list

<table>
<thead>
<tr>
<th>Industrial</th>
<th>Organizational</th>
<th>Product</th>
<th>Network</th>
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<tr>
<td>Capacity and responsiveness of alternate sources</td>
<td>Order fulfillment errors</td>
<td>inaccurate forecast longer lead times, product variety, seasonality</td>
<td>vertical integration of supply chain</td>
</tr>
<tr>
<td>Cost of capacity</td>
<td>Costs of holding inventory</td>
<td>High transportation costs</td>
<td>Communication difficulties</td>
</tr>
<tr>
<td>process change likelihood</td>
<td>Cost of capacity</td>
<td>material change/obsolescence</td>
<td>supplier/company alignment</td>
</tr>
<tr>
<td>regulatory change likelihood</td>
<td>Lack of capacity flexibility</td>
<td>inventory holding costs</td>
<td>financial data sharing</td>
</tr>
<tr>
<td>tier 2 supplier information sharing</td>
<td>Quality of service and responsiveness</td>
<td>product value</td>
<td>miscommunication between tiers</td>
</tr>
<tr>
<td>Bullwhip effect: information distortion</td>
<td>Delivery performance</td>
<td>creation of larger assemblies</td>
<td>inventory status sharing</td>
</tr>
<tr>
<td>vertical integration of supply chain</td>
<td>High capacity utilization supply source</td>
<td>quality problems likelihood</td>
<td>system integration</td>
</tr>
<tr>
<td>capacity flexibility</td>
<td>Inflexibility of supply source</td>
<td></td>
<td>Rate of exchange</td>
</tr>
<tr>
<td>Adverse changes in industry regulation</td>
<td>Lack of effective system integration</td>
<td></td>
<td>financial strength of customers</td>
</tr>
<tr>
<td>Material change/obsolescence</td>
<td>Lack of compatibility with IT</td>
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<tr>
<td>tier 2 supplier information sharing</td>
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<td>tier 2 performance monitoring</td>
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<td>production schedule sharing</td>
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<tr>
<td>hr issues likelihood</td>
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<td></td>
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<tr>
<td>supplier is providing proof of insurance</td>
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<tr>
<td>IT breakdown</td>
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<td>Bullwhip effect: information distortion</td>
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<td>long-term vs short-term contracts</td>
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<td>demand and supply uncertainty</td>
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<tr>
<td>liability uncertainty</td>
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<td>Transit time</td>
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<td>forecast errors</td>
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<td>safety hazards</td>
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<tr>
<td>bankruptcy</td>
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<tr>
<td>debt &amp; credit rating</td>
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### D. Appendix III: Questionnaire Prodrive

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Country of Origin</th>
<th>Level of certainty that statement will be true</th>
<th>Ability to influence course of action</th>
<th>Relative importance of statement of</th>
</tr>
</thead>
<tbody>
<tr>
<td>The supplier is able to quickly adjust available capacity</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>The supplier has stable production processes</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>The governmental regulations are stable through time</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>The materials used have are durable (long lifecycle)</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>The supplier has no difficulties with fulfilling requested demand</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>The costs of holding inventory are low</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>The supplier is able to offer high service and responds quickly</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>The supplier has high quality IT systems</td>
<td>China (Supplier)</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
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<tr>
<td>China (Supplier)</td>
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<tr>
<td>Netherlands (Alternative supplier)</td>
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<tr>
<td>China (Supplier)</td>
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<tr>
<td>Netherlands (Alternative supplier)</td>
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<tr>
<td>China (Supplier)</td>
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<tr>
<td>Netherlands (Alternative supplier)</td>
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<tr>
<td>China (Supplier)</td>
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<tr>
<td>Netherlands (Alternative supplier)</td>
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</tbody>
</table>
The supplier is likely to share their production schedule

China (Supplier)

Netherlands (Alternative supplier)

HR issues are likely to occur at the supplier

China (Supplier)

Netherlands (Alternative supplier)

The supplier provides for insurance of transport

China (Supplier)

Netherlands (Alternative supplier)

The supplier is resistant for IT breakdowns (back-up scenario)

China (Supplier)

Netherlands (Alternative supplier)

There are long term contracts with the customer and short term contracts with the supplier

China (Supplier)

Netherlands (Alternative supplier)

The requested quantities are stable through time

China (Supplier)

Netherlands (Alternative supplier)

The liability level is stable through time

China (Supplier)

Netherlands (Alternative supplier)

The lead time from the supplier is short

China (Supplier)

Netherlands (Alternative supplier)

The forecast that is presented for this component is reliable

China (Supplier)

Netherlands (Alternative supplier)

The supplier has good health and safety measures

China (Supplier)

Netherlands (Alternative supplier)

The supplier has a good financial position

China (Supplier)

Netherlands (Alternative supplier)
The lead times provided by the supplier are stable through time
China (Supplier)
Netherlands (Alternative supplier)

The transportation costs aspect of the total costs are limited
China (Supplier)
Netherlands (Alternative supplier)

The value of the product is low
China (Supplier)
Netherlands (Alternative supplier)

The supplier produces relatively small sized products
China (Supplier)
Netherlands (Alternative supplier)

The supplier is able to provide stable product quality
China (Supplier)
Netherlands (Alternative supplier)

The supplier is able to communicate effectively
China (Supplier)
Netherlands (Alternative supplier)

The supplier understands Prodrive's position and strategy
China (Supplier)
Netherlands (Alternative supplier)

The supplier understands Prodrives requests, order updates and meets these
China (Supplier)
Netherlands (Alternative supplier)

The supplier is able to integrate or synchronize their IT systems with Prodrive's
China (Supplier)
Netherlands (Alternative supplier)

The customer for the components are financially strong
China (Supplier)
Netherlands (Alternative supplier)

The inventory ownership can be shared with supplier and customer
China (Supplier)
Netherlands (Alternative supplier)
<table>
<thead>
<tr>
<th>The culture between Prodrive and the supplier is similar</th>
<th>China (Supplier)</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Netherlands (Alternative supplier)</td>
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</tr>
<tr>
<td>The performance delivered by the supplier is communicated towards the supplier</td>
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<td></td>
<td>Netherlands (Alternative supplier)</td>
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<tr>
<td>The relation with the customer is durable</td>
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<td></td>
<td>Netherlands (Alternative supplier)</td>
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<tr>
<td>The relation with the supplier is durable</td>
<td>China (Supplier)</td>
<td></td>
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<tr>
<td></td>
<td>Netherlands (Alternative supplier)</td>
<td></td>
</tr>
<tr>
<td>The alternatives for the supplier are able to quickly respond</td>
<td>China (Supplier)</td>
<td></td>
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<tr>
<td></td>
<td>Netherlands (Alternative supplier)</td>
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## E. Appendix IV: Questionnaire Suppliers

<table>
<thead>
<tr>
<th>Level of certainty that statement will be true</th>
<th>Ability to influence course of action</th>
<th>Relative importance of statement</th>
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<tr>
<td>Very low</td>
<td>Very high</td>
<td>Very low</td>
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<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| You proactively communicate with your suppliers and have scheduled meetings & order updates | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| You place your orders with your suppliers based on what is ordered by your customers | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Your technology roadmap is oriented towards vertical integration | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| The materials required for your products have short lifecycles | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Your suppliers’ have low capacity utilization, and are able to upscale production on a short notice | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| The IT systems you use allow for data integration, for example EDI messages | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| You actively monitor and measure your suppliers’ performance | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| There is low turnover in your personnel | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| In case of an IT system failure, you have a back-up and recovery plan | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| In case of a calamity to health and safety of employees, a clear calamity plan is present. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Your current ratio is greater than 1 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Your debt ratio is smaller than 1 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Your inventory holding costs are low | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| You understands Prodrive’s future strategy and the role you play | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| You give insight in to your financial statements | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| You provide a continuous real life inventory status | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| You actively respond to Prodrive’s request communicated in the order report | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
### F. Appendix V: Initial RDM results

<table>
<thead>
<tr>
<th>Questionnaire element</th>
<th>COO*</th>
<th>Un*</th>
<th>In*</th>
<th>Im*</th>
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<tbody>
<tr>
<td>The supplier is able to quickly adjust available capacity</td>
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<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
</tr>
<tr>
<td>The suppliers’ processes are stable through time</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
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</tr>
<tr>
<td>The governmental regulations are stable through time</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
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<tr>
<td>The materials used are durable in their lifecycle (long lifecycle)</td>
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<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
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<tr>
<td>The supplier is capable of fulfilling demand</td>
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<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
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<tr>
<td>The costs of holding inventory are low</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
</tr>
<tr>
<td>The supplier is able to offer high service and responds quickly</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
</tr>
<tr>
<td>The supplier has high quality IT systems</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
</tr>
<tr>
<td>The supplier is likely to share their production schedule</td>
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<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
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<tr>
<td>HR issues are not likely to occur at the supplier</td>
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<td>0 0 0 0 0 0 0 0 0 0</td>
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<tr>
<td>The supplier provides for insurance of transport</td>
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<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
<td></td>
</tr>
<tr>
<td>The supplier is resistant for IT breakdowns (back-up scenario)</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>0 0 0 0 0 0 0 0 0 0</td>
<td>L L L L</td>
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</tr>
<tr>
<td>There are long term contracts with the customer and short term contracts with the supplier</td>
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<td>L L L L</td>
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<tr>
<td>The requested quantities are stable through time</td>
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<tr>
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<tr>
<td>The lead time from the supplier is short</td>
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<tr>
<td>The forecast that is presented for this component is reliable</td>
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<tr>
<td>The supplier has good health and safety measures</td>
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<tr>
<td>The supplier has a good financial position</td>
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<td>The lead times provided by the supplier are stable through time</td>
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<td>The transportation costs aspect of the total costs are limited</td>
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<tr>
<td>The costs for holding inventory are low</td>
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<td>The supplier understands Prodrive’s position and strategy</td>
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<td>The supplier understands Prodrive’s requests, order updates and meets these</td>
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<td>The performance delivered by the supplier is communicated towards the supplier</td>
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<th>Level of influence</th>
<th>Level of relative importance</th>
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<td>Level of influence</td>
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<td>COO*</td>
<td>Country of origin (C = China, NL = Netherlands)</td>
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### G. Appendix VI: Responses from Suppliers

#### CASE I: Responses from Suppliers

<table>
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<th>Statements</th>
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<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>You proactively communicate with your suppliers and have recurrent meetings &amp; order updates</td>
<td>x</td>
<td></td>
<td>x</td>
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<tr>
<td>You place your orders with your suppliers based on what is ordered by your customers</td>
<td>x</td>
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<tr>
<td>Your technology roadmap is oriented towards vertical integration</td>
<td>x</td>
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<td>x</td>
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<tr>
<td>The materials required for your products have short lifecycles</td>
<td>x</td>
<td></td>
<td>x</td>
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<tr>
<td>Your suppliers’ have low capacity utilization, and are able to upscale production on a short notice</td>
<td>x</td>
<td></td>
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<tr>
<td>The IT systems you use allow for data integration, for example EDI processing</td>
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<tr>
<td>You actively monitor and measure your suppliers’ performance</td>
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<tr>
<td>There is low turnover in your personnel</td>
<td>x</td>
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<td>x</td>
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<td>In case of an IT system failure, you have a back-up and recovery plan</td>
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<td>In case of a calamity to health and safety of employees, a clear calamity plan is present</td>
<td>x</td>
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<tr>
<td>Your current ratio is greater than 1</td>
<td>x</td>
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<tr>
<td>Your debt ratio is smaller than 1</td>
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<tr>
<td>Your inventory holding costs are low</td>
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<td>x</td>
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<td>You understand Prodrive’s future strategy and the role you play</td>
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<td>You place your orders with your suppliers based on what is ordered by your customers</td>
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<td>You place your orders with your suppliers based on what is ordered by your customers</td>
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<td>Your technology roadmap is oriented towards vertical integration</td>
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<td>The materials required for your products have short lifecycles</td>
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<tr>
<td>Your suppliers’ have low capacity utilization, and are able to upscale production on a short notice</td>
<td>x</td>
<td>x</td>
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<td>The IT systems you use allow for data integration, for example EDI processing</td>
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<td>There is low turnover in your personnel</td>
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<tr>
<td>In case of an IT system failure, you have a back-up and recovery plan</td>
<td>x</td>
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<tr>
<td>In case of a calamity to health and safety of employees, a clear calamity plan is present.</td>
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<tr>
<td>Your current ratio is greater than 1</td>
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<td>Your debt ratio is smaller than 1</td>
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<tr>
<td>Your inventory holding costs are low</td>
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<tr>
<td>You understand Prodrive’s future strategy and the role you play</td>
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<tr>
<td>You give insight in to your financial statements</td>
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<tr>
<td>You provide a continuous inventory status</td>
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<tr>
<td>You actively respond to Prodrive’s requests communicated in the weekly order report</td>
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</table>
[Introduction]
[Initial results case I presentation]
JK: I would like to treat all question marks per case, indicating that they should be either a 0, m or * depending on their risk level. For these items a question mark is often linked to a spread in risk which can range from low to fatal. Depending on what the initial output was, a spread is indicated. A question mark has to be replaced by a 0, m or * and the question is what it will have to be. If there are no questions about the system I would like to start with the first item.

MG: Do we get to see what the initial results were?

JK: No not besides the question marks. The goal of the discussion is to treat every question as if you have to fill it in again but now collectively, which should bring different points of view to the table.

MG: A * indicates a high risk?

JK: Yes, for each statement you have to indicate whether the question can be related to a low to high risk.

JS: A * for importance indicates?

JK: That you find it of great importance

JS: So a * for influence indicates that we have a lot of influence?

JK: No a * would indicate that you have little influence, and therefore it poses a high risk.

JK: If no further questions remain, I would like to start with case I

[CASE I]

JK: For certain are you for Case I that the supplier is able to quickly adjust capacity?

HC: I think not so much

JS: Well that's your opinion. I believe they can adjust quite quickly. Expanding might be a problem but amongst current customers they can quickly switch to support us.

JK: So in a case of ramp-up you expect they can continue to supply you?

JS: Yes, if you cross your production capacity, it might become a problem. But if we supply a forecast in advance it will not be a problem. We've had a problem where we had a shortage where we gave them a call and 2 weeks later we received an additional shipment. So I think they are able to quickly adjust.

JK: All right, so why do you think different HC?
HC: Well when we had difficulties in December and January, we had additional need. We needed them on a short notice. And that was not possible.

JS: Yes, but that was only because we didn’t forecast it in advance. The capacity wasn’t available. We had a maximum of 40k pcs, which we already demanded.

JK: So as long as you forecast in advance it will not be much of a problem?

JS: No I think it will be possible then.

HC: Is the question about forecast or about unexpected demand?

JK: It is about the information you are able to supply to the supplier and if they can adjust to it.

RM: It is a translation of our customers demand in the forecast.

HC: Well then I think they are able to do so.

JK: So you are quite sure, and it’s a low risk?

RM: Well I have a question about this. If you compare to a Dutch alternative, how do they perform in adjusting capacity?

JS: Hard to say. But I expect that.

RM: Well given this part, manufacturer A***** would be an alternative and what is our level of influence here compared to the current supplier?

JK: Well not so much influence, but level of certainty

RM: Yes level of certainty.

RM: I think it still poses a risk.

RDW: I think we have no idea. Do you really know if they can do it for us? Do we know that?

JS: What is the difference?

RDW: Do you know if the supplier can support as in difficult times? If I talk to the alternative, I know we could pressure through our distributors. Can we do that with our current Supplier. I think we are not certain they can do it for us.

JS: I think they can, but I am not sure if they will.

RM: I would not say a 0 for uncertainty.

JK: So given RDW’s argument, the question is if they will do it for you, given Prodrive’s position?

RDW: I think the most important is how important we are to them. If a customer in the consumer market brings great volumes compared to us, we are peanuts compared to them. So I’m not so sure we can influence their schedules and capacity since our volumes are small compared to their other customers. So I think it’s a high risk.

RM: I agree with you its high, but is it fatal?

JK: It’s about certainty, not about the level of risk.

RDW: Well they can, but not sure if they can do it for us.

RM: No for Prodrive it’s not so sure

RDW: That is hard to say

RM: I would say an m, since we are sure they can be we are not sure they can do it for us.

RDW: Yes I agree.

JK: **Ok, so the next question is how important do you find this?**

JS: I think it’s quite important

RDW: I think it’s incredibly important. It’s the consumer market which is high dynamic so they have to be flexible. Another consumer customer recently wanted to cancel an order because they couldn’t supply.

JS: There is no in between. Its yes or no.

JK: So let’s pose you become certain about their inability to do so. Will it be a reason to leave this supplier?

RDW: Definitely

JS: Yes, and given our current doubts we are already looking for other parties.
JK: Alright, so it’s very important. I would like to go the next item since there are quite some remaining. ‘The supplier is able to fulfill demand’. There is no consensus about our influence and importance. **What do you think about influence?**

RDW: I think average. Have we had difficulty in the past?

JS: Yes.

RDW: Were you able to solve these issues?

JS: Yes, but it required additional communication. So I would say average.

JK: **How important is it?**

RM: I think it’s crucial

RDW: Yes

JS: For sure.

JK: This spread is between S and L so I will not discuss it further here. After our discussion I can create the result. The costs of inventory are high, I would like to distinguish if applicable between China and the Netherlands.

JS: At the supplier or with us?

JK: Both, but let’s start with them.

JS: I would say hardly any at all

RM: Are these our inventory costs? Or theirs?

JK: Yours.

BT: So for instance if there’s a high MOQ, we have high costs

JS: Well we don’t have high MOQ’s but we do have substantial stock levels

HC: Safety stock right?

JS: Yes

RDW: to cover risks?

JS: Yes and we have seen that our customer has pushed back some orders, which increased our stock level since we had to order quite a bit in advance for lead times and shipping.

RDW: customer or us?

JS: Both

RDW: So they are high? You have to see it relative to the product

JS: Yes its high

JK: **Ok, and would it be different for a Dutch alternative?**

JS: Well lets say we would purchase it through our distributors, we have good conditions which means we could let the safety aspect be covered by them.

RDW: Well I would say medium, since we then too would have high MOQ’s also at Dutch parties.

JK: Yes so basically you are saying that the safety aspect would be covered by your distributor, but you will still have a high MOQ?

RDW: Yes, for the safety buffer they can provide we don’t have to pay a lot.

JK: **Ok, and does the same account for the level of influence you have? So for Chinese parties you have little influence on the stock costs you have to accept compared to Dutch alternatives?**

RM: Yes, it’s like RDW said. Because we have good agreements with our Dutch suppliers which enables to work the supply chain.

RDW: Yes so we have a high influence on the Dutch chain, but little on the Chinese.

RM: But how high is the relative difference, should it be m or *?

JK: Well you could say that you have less influence compared to Dutch alternative but is it little or hardly any?

RDW: Well it’s hard to say.

RM: I would say less

JS: Yes it’s less

JK: But how much less?
RM: that's hard to estimate
JS: I agree
JK: So let's say how much can you do about your conditions that determine your stock costs, so pricing MOQ's etc.
RDW: Well you can do something about that but the differences are quite substantial. But you have to 'sacrifice' so to speak a part of your conditions for it, so its medium.
JS: I think you have to account for lead times and transports. So that would increase stock.
RDW: Yes, but despite that you may still influence some aspects of stock.
RM: Indeed, but that's a fact of life with dealing with China
JK: Alright, so we can go to the next topic where the level of influence you have on their IT systems quality? If you can motivate them to invest in it?
RDW: I believe I answered a low influence. Just because we shout, they will not run.
BT: If we are a small party, they will certainly not act upon just us.
RM: We are not the party that keeps the supplier alive.
RDW: We are not Apple for instance. But even they will have little influence except in their selection policy.
JK: So you say you will never have influence, no matter how big you are it's something you have to look in to beforehand.
RDW: Well it's what I am afraid of.
JS: I think it's easier for them to work with our manual options than it is for them to work with our automatic interfacing options, at least until now.
RM: So I would say no influence at all
JK: And is it different for the level of influence you have on Dutch supplier?
HC: I would say it's the same because of the same reasons.
RM: Well we do have influence there. We are more flexible in our distribution channels and can easier switch. The distributor is the party with which we directly communicate. And the distributors are more flexible in their way of working. We have more influence on their ways of working and their IT approach.
RDW: Yes I agree.
JK: But can you motivate them to invest in their IT infrastructure?
RM: I believe so. We have had seen examples of that in the past.
RDW: Indeed. We can motivate them but not a lot, so I would say its medium. Only small adjustments to the current infrastructure or custom applications of the infrastructure will be possible, not the complete system.
RM: No that will not be possible.
JK: Alright.
HC: The only thing we do is sending out order reports?
JK: Well that's part of it. Its about more things; order acceptance, communication of dates, invoice accuracy etc.
HC: Alright.
JK: To what extend do you expect and are you certain that Dutch suppliers supply you their production schedule?
RDW: I think they can and will.
RM: Really? Will A**** supply us that if we require it?
RDW: Yes, I think they will if we have problems. We can contact the factory directly and then well get a schedule declaring what will produced and when.
JK: For HR difficulties you are not sure about its importance for Chinese suppliers.
EZ: Well its important if you take a look at the continuity of their supply.
JK: But important or crucial?
EZ: Well it depends on what level you will take a look at the problem. You could say delivery reliability is the most important. However it is often influenced by their HR. If they simply gather people from the street or desert and expect them to produce the same quality as before that will not be the case. This is a frequent occurrence in for instance Chinese New Year.

JK: **Ok, so if that is an important aspect for Chinese suppliers, does that importance differs from Dutch suppliers?**

EZ: For sure

RDW: Yes

JK: But is the item less of an issue?

EZ: Yes. HR difficulties will be solved by qualified people. For instance temporary workers with qualifications to do that job.

RDW: And in addition the level of automation will be higher, so the impact HR has on the product quality is lower to begin with.

RM: Yes, but you have to compare A***** with Supplier1. And A***** produces in multiple locations, among which China. So why would the influence be different?

EZ: Well let’s put it like this: If I have a European contact, I am more in my comfort zone than when I have to escalate to Chinese manufacturers myself.

RM: Yes, I agree. But that’s gut feeling, the question is why do you feel that way?

RDW: Well, of course. But you are never sure. If the supplier is so highly automated that it doesn’t matter which random Chinese is pushing the buttons, it has no importance.

JK: So you are not sure enough about the influence of HR on the production quality to say something about its importance?

RDW: Yes.

JK: So its identical if its China or through an alternative party. But with the gut feelings you have, do you need to make a distinction?

RDW: Yes I would say so.

EZ: Yes I think so

RM: But that’s only based on gut feelings.

EZ: no, if you take a look at how work is executed and what the HR policies are, the possibility of an HR disturbance is much more likely and therefore more important.

RDW: If there is European influence, a different way of working is in effect than when it would be Chinese founded and based. A***** will have different policies than a local party.

RM: Yes that’s true, there would be more focus upon the continuity of the product.

JK: So there is a difference, but what are the values?

JS: Well I don’t care to much if its HR issues over here or there as long as it has no consequences. Its only consequences but that would reflect in for instance delivery reliability.

MG: But let’s say we are assigned a new contact within the supplier. It would cost considerably more effort to get the Chinese parties up to speed than the European/Dutch alternative.

JK: So for Dutch it is of less importance, but not as crucial as direct effects such as delivery reliability.

JK: **What influence do you have to make the supplier provide insurance for transport?**

RM: But all deliveries are ex works

RDW: so that would mean no influence

JS: That's not true, this supplier provides DDU or DDP. But I guess this supplier is an exception to the rule.

RM: Well you have influence then for this case.

JS: Yes.

JK: **All right, so what is the level of importance they provide proof of insurance?**

EZ: Well its always important

MG: Yes, quite important

BT: Are there large shipments involved?
JS: Quite big yes.
RDW: The importance is high. If we have to provide for it ourselves we make sure it's theirs, otherwise we wouldn't get it ensured.
JK: **To what level do you know they have a calamity plan available?**
EZ: No, no idea. They don't even know it themselves where they will be working next week. But I have also seen other examples. I think this supplier is quite professional.
JS: I think so too. But for this point I have no idea.
JK: So you have no certainty
JS: Well I have read audit reports from the past.
EZ: Has this supplier been audited?
JS: Yes our customer has performed an audit with this supplier.
JK: **So I believe the next point might have been confusing. It states that the supplier is flexible in their contracting, making sure you get flexibility with the Chinese supplier.**
RDW: So basically the question is how sure you think we can arrange our supplier agreement with them?
EZ: Well I think this influence is low.
MG: Yes
EZ: If you are looking at what we are doing right now, contracting our supply base with our current supply base in Europe, so no Asia. In the current set up I think it's impossible to have this contract set up with the logistic conditions we have here from this location.
JS: No I don't see that happen.
JK: So that's little influence.
JK: **What level of certainty do you have that Dutch parties are willing to assign these agreements?**
EZ: Quite easily based on current events.
JK: **To what extend are you sure that the demand is stable towards the supplier?**
JS: That's fully dependent on what the customer is providing to us. But based on what we have seen so far it's quite consistent.
JK: So that would mean quite certain.
MG: But in the startup we have seen some great fluctuations
RDW: Well consumer markets are no medical markets for instance. If they put a large order we need 100k additional pieces in half a year. The fluctuations are very great in this industry. Or do you know this customer will have continuous demand?
JK: So you are saying 'yes its stable' and you say 'no its not'
JS: If you analyze the forecast sheets from the customer, it's quite consistent. The delta is maybe 10k 20k pieces but not 100k
RDW: So no increased demands are expected?
JK: Well says that to the level of certainty?
JS: Well we don't have a long term forecast yet. So not: so sure.
MG: I think we are also facing quite some product changes although this is partly due to us. So the quantities we communicate to the supply chain still fluctuate because we ourselves shift which version of the product we are producing when.
RDW: So the initial series are under pressure already, but redesign issues cause for additional fluctuations.
JK: So currently it's quite stable, but there is no good feeling for the long term, so its average. Do you agree?
JS: Yes I think so
JK: **To what extent do you have influence on the liability you are facing?**
RM: Which kind of liability
JK: Well for instance the chances of deadstock
RDW: For this customer
MG: It’s very dependent on what you customer can do for you
RDW: I think we basically transfer our demand 1:1 to our supplier
EZ: What lotsize windows do we work with here?
JK: Four weeks
EZ: And they have no difficulty. It is always greater than the MOQ and the fluctuations we are presenting with that lotsize has caused no problems.
JS: No, not so far.
MG: And the forecast is known quite some distance towards the future?
JS: About 16 weeks
RDW: Yes so what we get from our customer, is transferred to our supplier.
JS: On key items we have full liability coverage from our customer for those 16 weeks. This is a key item so I would say we have great influence

JK: To what extend do you know that the forecast we present is reliable?
RDW: On the forecast not so much.
JS: Beyond those 16 weeks we are not sure.
JK: Within those 16 weeks you have some certainty, but within those weeks it is. So how about influence?
EZ: Yes we do. We arrange with the customer what is accepted. These are terms we agree with our customer, we could also not agree so we have some influence.
RM: So if they say we need 50k additional pieces within those 16 weeks, what do we say?
EZ: Well that depends on if there is an additional strategic motive to go for that 50k pieces. If the board says it has to be done.. then we will have to.
RDW: But it’s not forecast.
JK: No but it says something about it’s forecast reliability.
RDW: Exactly, so it’s not sure beyond those 16 weeks.
JK: So ou have little influence.
RDW: I expect so.
JK: And is it different for when you work with Dutch suppliers?
EZ: Well you would work with different lotsize windows, so the fluctuations would be different,
JK: So you are saying that because you have shorter lotsize windows with Dutch parties, it is more volatile to fluctuations
EZ: Yes, indeed
JK: Does everybody agree?
MG: I think so

JK About finances, for Dutch alternatives what do you know about their financial position?
EZ: I basically look at the barrier. How easy is it to check dutch parties financial position compared to those of Chinese parties. Because in those cases we have to run in by finance and it costs additional resources, whereas here we could simply contact the chamber of commerce. We should be very keen on it over there, but
JS: We are not practicing that
EZ: Not enough.
BT: So we can’t get this information about Chinese parties?
EZ: It is possible, but it costs much more effort. I think it’s wise to perform a financial health analysis on our Asian supply base.
JK: So it’s difficult but not impossible.
EZ: For the consumer market such volumes are involved, that it should be much more important than we are currently treating it.
MG: On the local market you have far better feelings about which parties are the big players, and some are active in the stock market which helps the transparency.

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JK: **To what extend are you sure about stable leadtimes of this part**

EZ: Both in a positive and negative fashion: no

JK: So you are not sure?

EZ: Sometimes they can deliver in lightning speed, other times it takes much longer than expected.

MG: It is quite varying

RDW: If they state: it is in 6 weeks. Do they always supply in 6 weeks?

HC: Well in my experience they do.

EZ: I think HC has the best experience about this.

HC: They simply deliver on time.

JK: **What is the influence you have on the fraction of transportation costs on the total costs?**

MG: Well we have a choice between transportation modes and in lotsizes, so we have much influences

JK: You control both the order size as well as the transportation costs?

RDW: Yes

BP: What do they deliver? DDU?

JS: DDU

RDW: On boat?

HC: Yes

RDW: So if they deliver in 6 weeks, it means they put it on a boat as soon as we order, impressive.

JK: **To what extend is the value of the product low, what is the level of certainty?**

JS: compared to European prices?

RM: or compared to the product value? Because in the product value its quite expensive

JK: Given the current turnover for this part, is it value high?

RDW: On a component level this part is expensive

MG: If this part is $12 it is high

JK: **What is the level of influence?**

RM: At the very least something

MG: Do we have the design power?

JS: The customer has negotiated these items, and the fluctuations are not more than a few cents. So something, but not a lot.

JK: More towards average of negligible?

JS: I would say negligible.

JK: **To what extend do they move with you in terms of order updates, reschedules, what is your influence level?**

EZ: Do they respond properly to the order report?

HC: I see no problems

JS: Often they do, yes. They say they do, but experience tells that on shipments they combine order lines.

HC: Then it becomes a puzzle what they have sent in that shipment, and with which order line it corresponds. The same holds for invoices.

JK: I assume you try to improve that, but it doesn’t improve?

JS: It works fine during production, but as soon as they have sent the goods, the confusion starts.

JK: So what is your influence?

JS: We have some influence, but it requires additional effort through email and phone calls. A permanent solution will require different action.

JK: **All right, and in what extend do you think it is important the supplier is able to integrate their systems with yours?**

MG: I think it is important

RM: Does it matter to us?

RDW: I don’t care if they do it manually or through a system, as long as they actively respond to it.
MG: The order report is our means of communication, as long as they reply I don’t care how
EZ: As long as it is accurate
JK: To what extend do you think it is important to share inventory ownership? What is the
difference with Dutch suppliers?
MG: I would say equally important, but in practice that might not be so.
BT: I would say because China is quite the distance, it is more important there.
JK: And why?
MG: I think because you have the feeling you have less control over the situation
RM: I think it should be equally important.
MG: I agree with you don’t want to, but you see a greater risk and this enables you to act upon it.
RDW: Currently, you can’t have the same inventory ownerships as you would be able to here.
MG: We want to, but it is not so.
JK: Alright, there is a difference, but how important is this difference
RDW: Well if it were vital, we wouldn’t be there in the first place
BT: So it’s not so important
RDW: Indeed, it is of less importance.
JK: To what extend do you think cultural similarities are important?
BT: I think you don’t want to find it important for China
MG: As long as they act on what we request of them.
HC: Chinese people are not based on intrinsic responsibilities as we have here, but more on
hierarchy. Give a job and they do.
JS: Exactly
HC: If I say ‘it’s your responsibility, fix it’ it will not be as effective as having an order and pressure
through hierarchy forces.
JK: Alright, so how would that influence the importance?
HC: As long as they are able to fulfill what’s required, it’s not important
JS: You have to know how to deal with the difference, the difference itself is not important
RM: We also have differences with Germans, as long as we know how to deal with it.
JK: To what extend do you communicate the supplier’s performance towards the supplier?
JS: I have never done so, delivery reliability or whatever
RM: So they have no clue if we are satisfied or not
JS: I don’t think so
JK: So you are sure it is not happening
JK: To what extend do you think it’s important the relationship is durable?
BT: Are there other parties in China who can supply this at the same conditions?
HC: Yes they are there
RDW: You have to check at Prodrive’s philosophy. When the project finishes and the volumes increase,
it is important the relationship is good such that what we want is what is done.
JK: Would you consider offering new projects/business with this supplier, what is its importance?
MG: A supplier is selected to eventually deal with it as much as possible.
HC: If there performance levels are good, why not?
RDW: In this case it is a subcontracting
RM: If they deliver quality, we could consider involving them with other projects too.
JK: To what extend do you know alternative suppliers are available in China which can act
upon this?
JS: We have a second source ready to go in China
MG: So we are confident
JS: When we place an order, it is as fast as the current supplier
JK: Is there a difference in response time between Dutch and Chinese alternative parties?
RM: Like question and answer? Or like order and delivery?
JK: The latter, and then the amount of influence you have.
RDW: When you use a plane, it would not matter that much.
JK: So there is no difference, but what is the level of influence?
MG: As long as you pay
RDW: I think you have substantial influence.

[CASE II]

JK: To what extend do you expect you can influence transport conditions?
JS: No influence with the supplier, it is ex-works you have to deal with.
RDW: Nothing, since this is a low value product
RM: Indeed
JK: And how important is it for this case?
BT: I’d say not important
RM: considering the value, not important
RDW: It’s not important if they can deliver it, or we would have chosen otherwise
JK: To what extend can you motivate the supplier to accept your contracts?
RDW: I think little
RM: Yes I think the same as Case I, at least in the current situation
JK: To what extend is the demand pattern reliable?
MG: This part is much better available in the market
JS: It is the same situation as Case I, on short notice yes, long term no.
JK: What about the level of influence with Dutch alternative?
RM: I’d say as much as with Chinese
JS: I think so too
RM: you can arrange the same with Dutch suppliers. The same parameter options and the same customer, so no difference
JS: I agree
RDW: I would say you have more influence in the Netherlands.
JK: You have already stated you have a lot of influence in China, so it would be even higher but at least as high
JK: In liability terms, what is the level of certainty that it is stable for Dutch and Chinese suppliers?
RDW: I think the same as case I
MG: Well not completely, this is more a standard part
RDW: It is not a key item?
JS: No
JK: So its stable, and not much?
RM: Even if you order 100k pcs, it’s not much. So yes
JK: Does it differ for Dutch scenarios?
RM: No, I don’t think so.
JK: Is the level of influence different for liability to the supplier?
RDW: I don’t think so
MG: No
RDW: You should compare this with a Dutch distributor, where we would have a lot of influence since the agreements are in place.
JK: Lead time, what is the level of influence you have with the supplier?
JS: None
RDW: Have we had difficulties?
JS: Yes, in a few weeks we had an alternative
RDW: So that means quite some influence, which I had not expected
JS: Yes, me neither
RM: So you do have a lot of influence
RDW: So I would say at least medium, because they were more expensive

JK: **What level of reliability is there with the forecast?**
RM: For the same customer as Case I?
JK: Yes, but are there the same logistical setup and is the influence different?
HC: No, don’t think so
RM: And how high?
JS: You have as much influence on the forecast, so equally for both Dutch as well as Chinese.
RM: But low or high?
JS: These are not key items, so you have only 8 weeks.
MG: It’s based on the forecast, which is unreliable. And you have little influence on it
RDW: Agreed
RM: Indeed, so little influence

JK: **What about finance? What certainty does there exist on their financial position?**
BT: Isn’t it equally much as case I?
RM: No, we’ve tested this supplier
JS: Yes with finance we have performed an analysis. So we are quite sure.
BT: So why hasn’t this been performed on the supplier for Case I?
MG: Good question
JS: Because this a supplier we’ve selected ourselves whereas the supplier for case I has been provided to us by the customer
RM: We have used our customer’s experience rather than our own

JK: **In what extend can you influence the transport costs on the total costs?**
HC: It depends on the shipper, so not much influence
RM: You have a transport mode selection
RDW: I would say you have great influence
MG: You can order greater quantities, reducing the fraction
JS: The quantities you purchase are quite low and low value, so the transporting costs have a greater influence
RDW: You have great influence, because if you order in 4 weeks and have to arrange for air freight, it is high so you would purchase greater quantities to reduce the fraction.
JK: Do you agree HC?
HC: Yes, in this case
JK: **To what extend can you influence the value of the product with the Supplier?**
RM: Something we’ve selected? I would say at least some influence.
BT: Yes you have always room to negotiate
RM: You can perform benchmarks, giving you a position.
JS: Well, comparing to European targets I provide them a lower target that they have to reach so I have influence.
RDW: If the value is low, you have great influence it is a good available part.
JK: **And when Dutch parties are considered, what is the level of certainty you have?**
RDW: If it is a wide available part, it should be
RM: For these parts
JS: Considering the product it is used in, it’s not a key item
RDW: It would never become a key item
MG: But the difference between China and Europe is substantial
JK: Would it become a key item if it were sourced through European or Dutch channels?
RDW: No
JS: It would be more, but not key.
JK: **To what extend can you influence the supplier's efficiency in communication?**
JS: I think the communication with this supplier is quite good
HC: Including order reports?
JK: Yes
HC: I think we have quite some influence.
JS: I agree;
MG: Are you sure, BT has called with them and it was quite difficult?
JS: Well, I've never seen problems
JK: So quite some influence
RDW: When there was an issue, you solved it very soon
JS: Yes, no problem
JK: **Would you state that the supplier is able to integrate their IT with yours?**
JS: Same as Case I, don't care how as long as it happens
RM: What's our influence?
JS: Minimal, they would not change their systems for us
RDW: None
JK: **What's the certainty?**
JS: I have no idea
MG: EZ have you been there?
EZ: Yes, and I am quite sure they can't. At least it doesn't appear that way. They have about 9M USD turnover, so it's not that big of a player. They have quite some qualifications though.
JK: **The customer involved, how certain are you that the financial position is good?**
EZ: We are sure it's good. Considering their solvability and what they can pre-finance, its not an issue.
JK: **is there a difference in certainty if you can share inventory ownership?**
MG: In general Dutch communicate more directly and faster, which improves your certainty
JK: That's communication, but is it also more likely?
MG: Yes.
RM: In the current situation
JK: And how certain are you?
JK: **And what is the difference with China?**
MG: Well, if you place an order, it won't be much of a problem. But considering inventory ownership? I don't think we know what our position is.
RM: No, we don't
JK: **How important is it for Dutch suppliers?**
EZ: Its important.
MG: Well, it's a low value part which is widely available, so it's not that important
JK: Does the value influence the importance? Or is it important regardless?
MG: Well, the importance has grown
EZ: But it would be more important for high value, so medium
JK: **How would you qualify the cultural similarities between Prodrive and Dutch alternative suppliers?**
EZ: I think you are more likely to find Chinese parties having the same culture rather than Dutch parties.
RM: Yes?
EZ: Yes, the moral is more Asian than the typical Dutch mindset: '5 o clock let's go!'
JK: Yes, but HC said previously that Chinese are not proactive in their responsibility, which would not stroke with Dutch mindset
EZ: More about tasks rather than responsibilities
BT: I would say for a part like this, it's not important
JK: Yes, that is for importance but what about certainty?
RM: I'm not so sure
RDW: The influence is low
JK: Low as in none, or nothing?
RDW: I would say nothing. I think the culture between connector manufacturers is completely different.
They work from a catalogue where we are solution providers.
MG: It's not mass customization, so to speak

CASE III & IV

JK: Moving to case III en IV, since everybody filled exactly equal answers for III and IV. Since III and IV have the same European sales agent but different suppliers, you state the party sending the invoice is decisive.
RM: Yes, but I think that has to do with we don’t know who’s behind it. Well, the name of course, but not the party.
JK: Yes, so the direct contact is the one who determines what the risks will be and where.
MG: The sales agent is our contact
RDW: And they perform audits with the suppliers
JK: So there is no difference on a supplier level
RDW: No, this is what the sales agent does. For new suppliers used by our sales agent we always approve them.
EZ: Yes, I request the audit report for that supplier from the sales agent, and store it and I don’t do anything else with it. It is their responsibility.
JK: So the supplier is not an issue
EZ: Often we don’t even know where it is produced, but we know who we pay.

[...]

JK: **New is governmental regulations. How is the certainty you have that the Chinese supplier will be affected by changes in regulations?**
EZ: There is a great risk involved.
RDW: Great
MG: Yes
EZ: From one month to another they might change the environmental policies. The government works with areas around the populated areas and a supplier told me that where a PCB factory is allowed may shift 5 zones in one year, it caused O**** to shut down.
RDW: They have started moving to Mongolia as well
EZ: And it can be disruptive to your delivery reliability
JK: **And what is the importance?**
RDW: We think its very important
MG: Yes
JK: **How does it relate to the influence the sales agent may play?**
RDW: They ensure quality is delivered, but it remains a risk.
EZ: Depends on the product. If it is in ramp-up with short lead times it's a risk. But these are quite simple and they can change suppliers easily and on short notice. However if it was a direct link to
the supplier involved it would have been much higher. This is also the reason we leaving a current PCB manufacturer because it does not want to work through European sales channels. There is to much handling and communication involved.

JK: What about production schedules? Are Dutch parties likely to share these?
RDW: Yes, no problem
EZ: When you ask it, they will give it
RDW: You can ask which steps for which PCB how long it will take etc. And it will be presented
JK: To what extend is a contract with the European sales agent about logistics etc important?
RDW: So far we have always worked with hard orders, without contract.
JK: So do you think it’s not important then?
RDW: well the intention is to contract them
EZ: I think that might be a problem, but we think it’s of some importance.
RDW: I have never had problems on the short term availability in ramp-up or decline. They work based on a certain production batch size, which is what you order and what you get. Considering our recent benchmark, we can shift at any moment.
EZ: That would not change with an agreement, we could still switch.
MG: When a change to a PCB is required, we are currently very able to support this, given we don’t have order windows or forecast based ordering.
JK: So far for availability it’s not important, but for instance for liability it would?
RDW: Medium then
JK: Does it differ for Dutch parties?
EZ: No, it’s PCBs
JK: Not different or not important?
RM: Not different
MG: Not different
JK: what’s the extent of influence?
EZ: It doesn’t matter
JK: Considering health and safety, what’s the certainty the Chinese supplier have proper health and safety measures?
RDW: not sure
JK: Does the sales agent influence the policy?
RDW: no, the sales agent is primarily focused on quality and price. I don’t think this is a priority, I don’t know if they select on this.
EZ: In their audit reports they check this.
MG: If there’s child labor and the lot
EZ: yeah its quite an important aspect in their audit policies, given the nature of the production process its quite environmentally dangerous. So we are sure, because the sales agent provides for this.
JK: How important is it?
EZ: It’s very important. In our business plan we also state this.
JK: What is the influence you have with Dutch alternatives?
EZ: More than China, but not much.
MG: If we say no, it’s unlikely they would change it.
RM: But you don’t have to purchase it there
MG: That’s different. Can you change that R***** will change their building structure? I don’t think so.
JK: Transportation costs are limited in the total costs, what is the level of certainty? Considering the sales agent?
EZ: Considerate
RDW: Yes, they recalculate
RM: It will have a great influence
JK: What is the level of influence for Dutch parties?
EZ: negligible
MG: if it requires a taxi drive, it will not add that much to the costs
JK: But is it important then?
MG: No, time is more important
EZ: Not really
JK: How important are inventory holding costs for PCB’s supplied from China? Considering Lead times etc.
MG: Quite large, there’s a large deadstock risk
EZ: Especially in ramp-up and decline phases it is important.
JK: For the Dutch alternatives, how do the inventory holding costs differ from the current situation?
RM: We state that China is low, for our inventory.
EZ: The sales agent will have to keep holding inventory. With the agreement we want to close they will have to.
MG: But currently they don’t. Is this different for Dutch alternative parties? I don’t think so.
JK: What influence do you have with Dutch alternatives?
MG: We will have to see. They must have commitment for it. It are unique products.
EZ: The throughput time is much greater than what we want to give as commitment. But other custom parties have signed it as well (non PCB).
MG: That is a different production process.
RDW: And they are able to produce on much shorter notice. The current situation would only allow rush through air transport from China.
JK: But its about Dutch alternatives
EZ: I would say medium
JK: What about importance?
EZ: The same as before, so high
JK: The value of the product, in certainty terms?
JS: Low value, and I’m quite sure
EZ: It’s not a key item
MG: 8% of our purchase volume is on PCB’s
RDW: I would say its medium for these products.
EZ: still quite a lot, it’s still in the top 10
JK: How about influence?
EZ: Equal
JS: Equal
JK: Low or high?
EZ: Through benchmarking, so medium.
RM: You have some influence
JK: How important is the value?
RDW: Very important
JS: For both cases
JK: What is the size of shipments, in certainty?
JS: Simply dimensions?
RM: No idea
MG: It’s made to order, so strictly what is required
RDW: Not full pallets
RM: And it’s the same in the Netherlands.
JS: Basically they come in a box, wrapped in foil.
JK: Difference in influence?
RDW:  No
RM:  Equally much as China
MG:  We have some influence
JK:  What is the importance?
EZ:  Low, not really.
JK:  System integration IT, influence?
EZ:  the sales agent can be influenced by us. They will do it for us. The same for holds Dutch alternatives.
JK:  and its importance?
EZ:  Yes it conform our supplier development, and clear targets for this year
RDW:  It is medium, not as important as immediate delivery reliability
EZ:  All right medium
JK:  How is the inventory ownership importance for Dutch alternatives?
EZ:  Also medium, equally important
MG:  Yes
### I. Appendix VIII: Final RDM Results

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Case I</th>
<th>Case II</th>
<th>Case III</th>
<th>Case IV</th>
<th>RDM</th>
<th>RDM</th>
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<tr>
<th>CoO*</th>
<th>Country of origin (C = China, NL = Netherlands)</th>
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<tr>
<td>Un*</td>
<td>Level of uncertainty</td>
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<tr>
<td>bF*</td>
<td>Level of influence</td>
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<tr>
<td>bRIM</td>
<td>Level of relative importance</td>
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## J. Appendix IX: RDM Delta Analysis

### Questionnaire

<table>
<thead>
<tr>
<th>Case I</th>
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<th>Case III</th>
<th>Case IV</th>
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<tr>
<td>Co</td>
<td>RDM</td>
<td>RDM</td>
<td>RDM</td>
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<tr>
<td>The supplier is able to quickly adjust available capacity</td>
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<td>The suppliers' processes are stable through time</td>
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<td>The governmental regulations are stable through time</td>
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<td>The materials used are durable in their lifecycle (long lifecycle)</td>
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<td>The supplier is capable of fulfilling demand</td>
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<tr>
<td>The supplier has high quality IT systems</td>
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<td>The supplier is likely to share their production schedule</td>
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<td>The forecast that is presented for this component is reliable</td>
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<td>The supplier has a good health and safety measures</td>
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<td>The supplier produces relatively small sized products</td>
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<td>The supplier is able to provide sufficient stable product quality</td>
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