# Risk assessment in global supply chains, witrh an application to the high-tech manufacturing industry

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# Risk assessment in global supply chains, with an application to the high-tech manufacturing industry

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# Abstract

When ordering commercial items abroad it sometimes happens that customs intervenes and a certain amount of duty has to be paid. Such items are often relatively inexpensive and not ordered in bulk. This situation is different for a company that has order a plethora of items and additionally also has to contend with time constraints.

This is the situation that the high-tech firm find itself in. Locally the customs agreements are clear and there is relatively low uncertainty but internationally the story changes. To facilitate the customs handling process the high-tech firm has contracted customs brokers; these are often large firms specialized in customs handling and thus have good relationships with the customs authorities.

As these customs brokers are located internationally it is both hard and necessary for the high-tech firm to monitor their activities. Monitoring is essential, as unwarranted duty payments and a potential down time loss of €72.000,- per hour (the high-tech firm, 2015) due to delays can seriously hinder the high-tech firm's processes.

By conducting a risk analysis and defining relevant measurement indicators this thesis provides a structured approach to managing key risks in customs brokerage. Moreover, by analyzing operational data the root causes of data discrepancies have been identified. Additionally, a tool is developed with which the high-tech firm can conduct operational data analysis anytime.

In the end the combination of, a structured measurement approach and the root cause analysis insights of data discrepancies, show that clear contractual agreements are vital and thus close collaboration with the customs brokers is necessary.

# MANAGEMENT SUMMARY

This research is conducted at a high-tech company X which will be referred to as “the high-tech firm” for the remainder of this thesis. High tech companies are under constant time pressure to deliver their goods to their customers on time. At the same time a lot of the goods are transported across borders, where the company needs to adhere to customs regulations, in other words it needs to remain “customs compliant”. If a company is non-compliant its goods can be stopped or subjected to additional checking, thus getting delayed.

This research project will focus mainly on the prime components of a risk management process, namely identification, measurement and inference of results. The initial part of this paper aims to identify the risks that accompany the customs brokerage process. This risk overview is made to firstly identity the focus areas in this sector and secondly to gain understanding regarding what facets warrant introducing control mechanisms.

Furthermore, the identification of measurement indicators will be discussed. By linking the previously identified (key) risks with relevant measurement indicators, this paper aims to develop a control framework with which such firms can manage their customs brokerage process. Lastly, available operational data will be analyzed and inferences will be made regarding the cause of the (potential) issues. The focus in this analysis will be on the Harmonized Tariff System (HTS), which is a classification of goods used to determine customs duties. A change in such codes may result in a (negative) financial impact. Due to this reason, the high-tech firm would like to have, the extent and cause of such (potential) alterations, to be examined.

This can be summarized as the main goal of this research paper:

*How to assess and mitigate compliance risks related to customs brokerage?*

This study presents a segmented approach with two main components. On the one hand, there is the control of the risk framework and on the other hand there is the data analysis. The first part focusses on identifying key risks and linking them to relevant measurement indicators. This process is done by consulting experts on customs law and regulations. After conducting interviews an initial risk overview is made, which is subsequently structured and aggregated into four categories; general-, operational-, service- and administrative compliance. Afterwards a second round of interviews follows in which a more “brainstorm” oriented approach is used so that measurement indicators can be found to control the identified risks.

Lastly, available operational data is analyzed and inferences are made regarding the cause of the (potential) issues. The analysis is done in excel and the inferences are made by utilizing approaches such as Venn diagrams and Bayesian analysis.

The analyzed operational data shows that the alterations in the HTS-codes can be categorized in products labelled with “PCA” which are basically circuit boards and “ASSY” which are subassembly items. These

categories prove to be most prone to alterations. Furthermore, looking into the duty payments it is found that every alteration results in a higher duty payment.

To consolidate this approach and give the high-tech firm a convenient way of performing such analysis, a tool is developed by utilizing Excel VBA. This tool called, the Operational Data Analysis Tool (ODAT), can perform the above-mentioned analysis within seconds with large chunks of data. Like this the high-tech firm can quickly assess how its brokers are performing and steer the process where necessary.

# PREFACE

Much of this research could not have been done without the involvement of many experts currently working at the high-tech firm. By taking the time to provide me with essential information regarding the process and practical subtleties, the experts have enabled me to deliver a document that is both theoretically adequate but also practically relevant.

I would further like to thank my mentor Pr. dr. A.W. Veenstra for his assistance in arranging this internship and for this guidance throughout the project. Additionally, his PhD student Mete Sevinc pleasantly assisted me with brainstorming sessions and building an analytical analysis models.

I would also like to thank my parents for supporting me to pursue a Masters' degree in Engineering and enabling me to reach my full potential as a student but also as a person. I know I have not taken the easiest of roads towards my goal but their support has been consistent and I am glad to at least partially repay them for all their support and sacrifices.

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Finally, I'd like to thank my lovely girlfriend Yvette, who I have chased for the full stretch of this project. While intellectually I have journeyed with this research paper, emotionally I have journeyed with you. We have shared many ups and downs over this project's duration. Thank you for then being my motivation, and now, for also being my love.

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# 1 INTRODUCTION

High tech companies are under constant time pressure to deliver their goods to their customers on time. At the same time a lot of the goods are transported across borders, where the company needs to adhere to customs regulations, in other words it needs to remain “customs compliant”. If a company is non-compliant its goods can be stopped or subjected to additional checking, thus getting delayed.

In order to circumvent this, a firm must collaborate with other parties in its own supply-chain to generate vital data. This dependency can be costly if the provided data is inaccurate. In order to gain insight in the functioning of the other parts in the supply chain and to manage the above listed risks, it is necessary to deploy some form of internal controls.

Until a few years ago, customs were checking everything coming to and going from the Netherlands, but to improve Europe’s competitive position on the global market this has been reduced and checking now is especially done by means of sampling at the borders of the EU. This can only be made possible by engaging in extensive collaboration done by the individual customs departments within the EU countries. For companies that want the same treatment for goods coming in and going out from the EU, they must setup a similar form of collaboration with the relevant (international) customs authorities. For the Netherlands, this arrangement with the customs is called an Authorized Economic Operator (AEO) license. This means that companies have to establish and maintain a visible level of internal control to minimize the probability of violating custom compliance (European Commission, 2014). When a company successfully achieves, and maintains this certification, its goods are less frequently checked and are able to pass swiftly through the customs clearance process.

While this may be the case in the EU, internationally there are additional factors present that complicate this process. For example, country-specific laws & legislations and language and cultural barriers are prime examples of things that further complicate the customs process. To circumvent this problem companies turn to local customs brokers that have customs’ specific expertise in these countries. These customs brokers function as middle men that primarily deal with the customs part of the supply chain.

The main task of a customs broker is to make up a customs declaration for inbound and outbound items. The declaration is required to have a one-to-one correspondence with the documentation that is sent with the shipment.

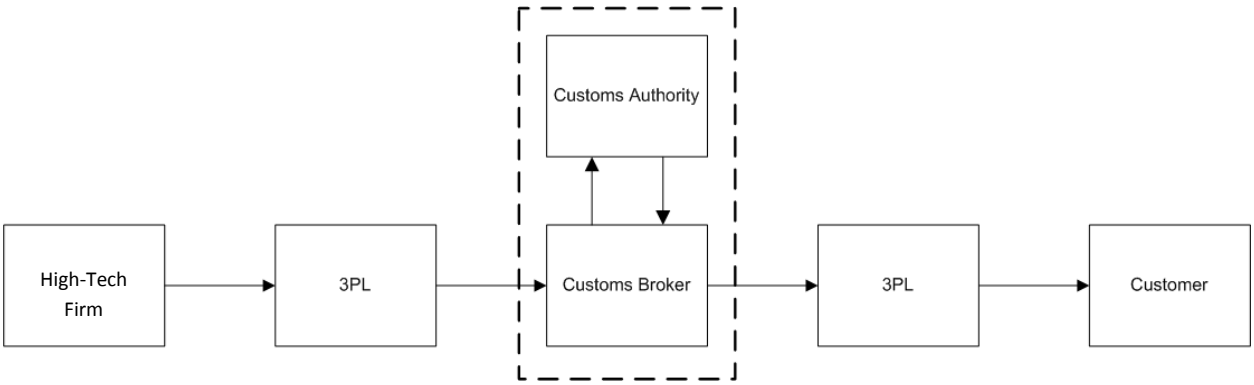



Figure 1 Goods flow of the high-tech firm

While contracting customs brokers, provides a firm with useful expertise, failure to collaborate with these custom brokers could at the same time prove to be a costly liability (Hallikas et al, 2004). A few examples of things that may go wrong are: products not cleared by customs due to miscommunication or that a higher cost is charged due to information asymmetry. The main risk to a firm is lack of insight in to the process of the customs broker (figure 1), which is also the primary goal of this thesis.

## 1.1 Research Goal

As illustrated above, the activities of the customs broker are a vital part of the high-tech firm's supply chain which warrants a comprehensive monitoring approach. Before monitoring can be done it is essential to identify and evaluate the risks that are present. This will be the goal of this thesis and is summarized below.

The goal of this project can be summarized by the following objective:

1. Identify the key risks and construct a structured monitoring approach to mitigate these risks.
    a. The operational data (ex: HTS classifications) is already being measured worldwide. As there are potentially more risks present in the customs brokerage process it is important to first identify these and then construct a means of making them measurable.
    b. The data regarding the HTS codes is already being measured worldwide. Via a data analysis, which will be elaborated upon in the upcoming chapters, this research project will aim to illustrate the prominent discrepancies and attempt to make inferences regarding the causes and possible solutions.

The above aims to ensure that the high-tech firm eliminates the risk of not being customs compliant and avoids issues such as sanctions, loss of licenses, negative image towards clients, etc. The important factor for the party that wishes to implement such an approach is to understand the link between the performance measure and the desired performance objective (Brooks and Coleman, 2003), this process is vital when defining the measurement indicators.

In order to accomplish the above defined goals, it is important to formulate the research questions that will facilitate this process. This will be done in the following paragraph.

## 1.2 RESEARCH QUESTIONS

After formulating the goal of this research project, this chapter shows which questions will be answered during the course of this assignment. With the leading objective formulated below:

- **How to assess and mitigate compliance risks related to customs brokerage?**

The main research question stated above will be accompanied by three sub questions in order to specify the issues that this research project will cover. The first question is related to point a. and aims to identify the key risks associated with the customs brokerage process.

1. What are the key compliance risks in the customs brokerage process?

After the important compliance risks, have been identified the focus is on deriving the relevant variables that need to be measured. In order to do this the following sub research question is formulated:

2. Which indicators adequately capture the control discrepancy which follows from the identified risks?
3. How to classify the causal relationships discovered by analyzing the available operational brokerage data and what are the potential solutions?

As mentioned in point b, certain data is already being measured. This data can readily be used to conduct data analysis and attempt to classify the discrepancies found.

With the above defined sub questions this research project hopes to answer the main research question and thus provide a management framework to structurally identify, analyze and mitigate risks in a customs brokerage context.

## 1.3 PROJECT SCOPE

The above plan of action states a structured approach with which the customs brokerage issue can be dealt with. However due to the time constraints of this research project some parts will be left to the company. For example, the implementation of the additional indicators that will be identified via the risk analysis, will not be considered. As for well informed decision making it is necessary to first have analyzed the measurement results. Furthermore, data from Korea was the only data which was readily available for this project, thus this research will concentrate on that region. However, we assume that many insights from Korea are also applicable to other regions. The elaboration of the applicability will be reserved for chapter 4.

# 2 High-Tech Branch Description

## 2.1 General Introduction

The high-tech firm analyzed in this project is engaged in manufacturing machinery, and also in the servicing of an installed base. For the latter, modules and spare parts are kept in stock in warehouses around the World which enables service engineers to minimize downtime of the installed base as much as possible. All in all, in the high-tech firm's supply chains, 90% of the cost of goods is attributed to suppliers. The number of individual chains, leading into customer's global locations is about 100. Total value of products in stock all around the world is about €2,5 bln. Total spend on logistics is about €100 mln. For service supply chains, the complexity is in avoiding down time of machines at all costs. Down time costs customers €72.000 per hour. Therefore, an average installation window for spare parts is 20 minutes per week (the high-tech firm Case, 2015).

## 2.2 Customs specific

The high-tech firm usually is an innovative company, and as a result, it invents products, components and parts on a daily basis. In fact, sometimes, it does this at a rate of some 150 products per day. For the international shipment of these components and parts, a proper classification of the goods is required for customs purposes.

The high-tech firm has a process in place for the approval of new HT codes, which is codified in a form that needs to be filled in by engineers who come up with new product requirements. These engineers specify in detail what kind of product it needs to be, what materials need to be used, and who supplies critical components of the new product, but they have awareness on the logistics and customs consequences of these decisions. This means that data quality relevant for logistics, such as volume and weight, packing conditions, origin of the product, or components of the product, and so on, needs to receive special attention.

There is an agreement with Customs on the need to classify intermediate goods. These are goods that are developed and produced for integration in another product. Sometimes, however, this integration can take a long period, and then potentially unclassified goods are taken into storage. the high-tech firm has the policy to classify these goods as an a-typical good in the high-tech firm, to distinguish them from the actual the high-tech firm goods, if classification is required. The description of a product consists of the following items:

1. Product description: type of product, component parts, technical descriptions and drawings,
2. Origin (EU or non-EU),
3. Value: delivered by the finance department who makes cost calculations,
4. Codes for export restrictions for strategic or dual use goods,
5. Volume and weight,
6. Article descriptions.

## 2.3 CUSTOMS CLEARANCE

When being transported across borders, goods are required to pass through customs. Customs is required to ensure that goods are permissible to enter a country and the correct duty payments are charged (De Wulf et al, 2015). This process is called the customs clearance process and forms an important part of this research project.

According to De Wulf et al (2015) customs clearance work involves the preparation and submission of documentations that are needed to facilitate export or imports into a country, the representation of clients during the customs process, assessment, payment of relevant duties and lastly the responsibility of handing over the cargo and the relevant documentation to the next cycle in the supply chain.

In the customs clearance process, there are two basic types of flows; import and export. These flows require their own specific accompanying documentation to able to pass through customs clearance:

- Exports Documentation: Purchase order from Buyer, Sales Invoice, Packing List, Shipping bill, Bill of Lading or air way bill, Certificate of Origin and any other specific documentation as specified by the buyer, or as required by financial institutions or LC terms or as per importing country regulations.
- Imports Documentation: Purchase Order from Buyer, Sales Invoice of supplier, Bill of Entry, Bill of Lading or Air way bill, Packing List, Certificate of Origin, and any other specific documentation required by the buyer, or financial institution or the importing country regulation.

The above-mentioned steps are of course only general. The rules, regulations and laws can be different depending on which country the goods are being transported to or from. Warehousing and storage fees add up quickly is the customs clearance process does not happen smoothly, not to forget the delay for the end customer. While most freight forwarders offer the possibility to have the customs clearance done by them as well, it is also possible to hire a specialized agent; a customs broker. The section below discusses this agent in detail.

## 2.4 CUSTOMS BROKERAGE

The key principles of the customs brokerage process are standardized worldwide. While the governments of the respective countries are entitled to enlist additional demands, the core principles remain the same. Therefore, this thesis uses the description of the U.S. Customs and Border Protection as it is well structured and more detailed than descriptions provided by the governments of most other countries. This is primarily due to the fact that the United States has strengthened its security measures to cope with the increased global risk of terrorism.

According to the U.S. Customs and Border Protection documentation, customs brokerage is defined as: “The customs broker is a highly-trained import and export professional. Licensed by the U.S. Customs & Border Protection, the customs broker must possess a thorough knowledge of Customs Regulations and the U.S. Harmonized Tariff Schedule. The customs broker must keep abreast of the constant changes in the law and regulations that govern imports into the U.S.”. This definition indicates that the broker is a ‘middleman’ capable of understanding the business as well as the customs requirements.

The tasks of the customs broker are as follows according to the US Customs and Border Protection documentation:

- Prepares and files Customs entries to help effect the release of import shipments
- Assist importers in the proper tariff classification of their imported products, helping to ensure the proper Customs duties are paid, file necessary paperwork or electronic documentation, to obtain release from other government agencies.
- Works with the transport company to help ensure the import shipment is delivered to the final consignee.

It should be noted that the second and third point are examples of country specific customs regulations. In essence the filing of the declaration is the primary function of the customs broker.

Lastly it is necessary to define what the import process flow is according to the U.S. Customs and Border Protection documentation: “The customs broker receives shipment documents, reviews the documents, then prepares and files the customs entry U.S. Customs reviews the information submitted, either electronically or by actual review of the documents U.S. Customs determines whether they will need to examine the shipment U.S. Customs releases the shipment, meaning it is allowed to be delivered to the ultimate consignee”

## 2.5 RESEARCH DELIVERABLES

After defining the questions that this research project aims to answer it is important to explicitly state the deliverables that will result from conducting this research. This will be done by indicating the relevant deliverable for each research question and consequently combining these elements into a combined deliverable.

- Research Question 1
  - This will provide a framework of the key risks that are present in the customs brokerage process.
- Research Question 2
  - This will provide measurable indicators with which the risks can be quantified and objectively assessed.
- Research Question 3
  - This will provide a visualization of the causal relationships in the operational brokerage data.

From the first three deliverables, a measurement model will be created. Additionally, a tool will be created which will assist in the visualization of the operational brokerage data to facilitate objective monitoring and preventive problem solving.

# 3 Research Methodology

Before it is possible to develop a fitting methodology for this research project it is firstly important to inventorize what is already present and what this research project should add to that basis. A compliance framework was an initiative by the high-tech firm and the customs authority to develop a set of measurements with which the high-tech firm could prove its compliancy. This thesis aims to build on this initiative; it was a collaborative effort with the customs authority to define measurements to remain visibly compliant. However, the defined measurements were constructed with a different risk assessment approach in mind than this thesis aims to employ. In the aforementioned framework customs brokerage was just one of the risks that needed to be controlled, while in this thesis the aim is to thoroughly zoom in on this particular aspect of the high-tech firm's supply chain.

In this section the aim is to describe a methodology with which the aforementioned issues can be dealt with in a structured manner. Below, there is an illustration of "The Process Improvement Chain" model by Barabino (2001), which will be used to describe the various steps that will be taken in this research paper. As this methodological approach is generic, it will be molded to meet the specific requirements of this research. The setup of the research project as well as these modifications to the below defined framework will be the focus of this chapter.

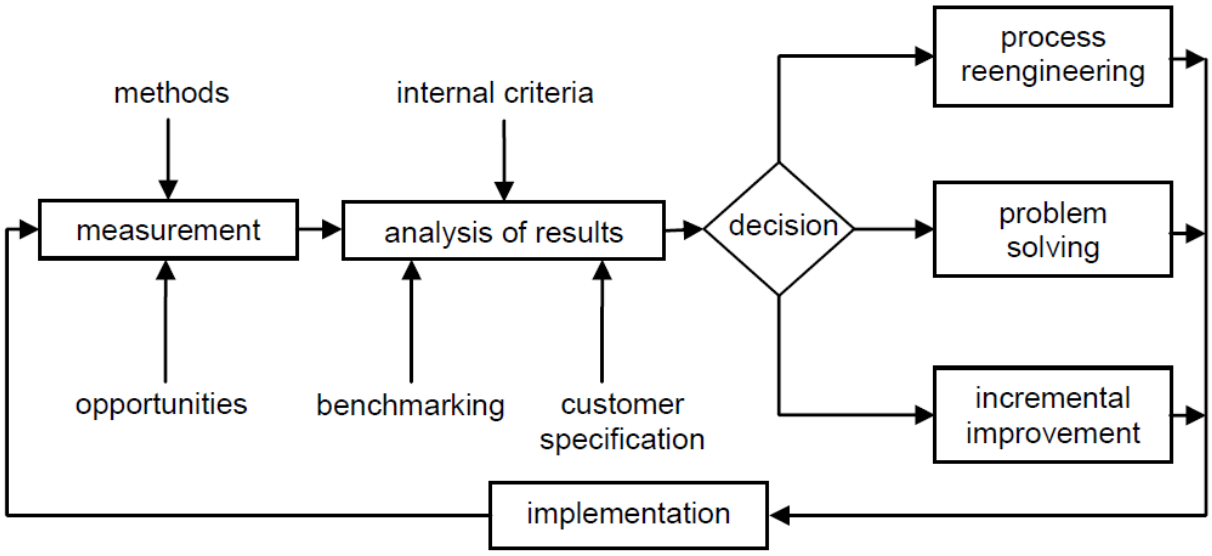



**FIGURE 2 THE PROCESS IMPROVEMENT CHAIN (BARABINO 2001)**

The aim of the above model is to facilitate process implementation by means of systematic monitoring and periodical performance recording, so that process critical aspects can be identified and can be used to reengineer process activities (Franceschini et al, 2007).

Franceschini et al (2007) continue to state the main activities that are essential when constructing a performance measurement framework:

- Measurement
    - Here the prime focus is on defining which performance measurements are needed and what the corresponding data requirements are. The two aspects that are considered while defining these indicators are process criticalness & growth potential.
- Analysis of results
    - When doing this, it is important to look at what the company aspires (internal criteria), how do the obtained results compare to the defined thresholds (benchmarking) and what the customer desires (customer specification).
- Decision
    - Then it becomes necessary to take a decision. The resulting decision will logically depend on the amount of discrepancy between the measured performance level and the target performance level. These could be individual problem solving, incremental improvements or process reengineering.
- Implementation
    - Lastly the decision that has been taken must be implemented as that is the real test of the process until then. The obtained results will be relayed and will serve as input for the process. Like this a dynamic and adaptive process is created which stays applicable even during changes in the supply chain environment.

## 3.1 Insights from the auditing literature

While the literature by Barabino (2001) provides a decent basis to develop a structured problem solving approach, it is important to understand what the actionable tasks should be of each step. For this it is useful to reference the auditing literature as it provides many frameworks that can assist in defining a plan of action.

In an organization where there are multiple processes and flows intertwined it can become difficult to troubleshoot when something goes wrong. This is often due to the fact the there is a lack of overview over the entirety of the process. Without overview, one can also not understand the possible risks accompanied with the current activities. This is where auditing literature can provide assistance. Senft and Gallegos (2008) describe a financial auditing approach within the IT sector but the general steps can also be used when auditing/constructing a monitoring approach.

Senft and Gallegos (2008) continue to state that “The phases of auditing activities typically overlap and involve some reassessment and retracing of procedures performed earlier”. This indicates that there not a particular fixed mandate which needs to be followed. It is instead a learning process which, while structured, aims to be dynamic in its implementation.

At the start of any audit it is necessary to gain insight into the process. The most commonly used method for this is flowcharting. “Flowcharts represent a method for identifying and evaluating control strengths and weaknesses within a system” (Senft & Gallegos, 2008). Understanding the strengths and weaknesses

within a process is essential to a successful audit, as the major influences are the ones that require adequate management.

While an auditing process as stated previously need not be rigid it still needs a basic structured approach at its foundation. Such an 'audit engagement' contains the following phases (Senft & Gallegos, 2008):

- Preliminary review
- Application analysis
- Preliminary evaluation of internal controls
- Compliance testing
- Final evaluation of internal controls
- Substantive testing

The above steps, while having distinct goals, cannot be seen as independent stages. This is largely due to the fact that the scope of each step is dependent on the outcome of the preceding step.

The review procedure is conducted on a general level, without going into details such as inter-dependence and causality. The goal here is to get familiarized with the company, its line of business and its key systems. The ideal approach for an external auditor would be to tour the client's company and observe the various business processes. But due to time constraints and company policies it is often advised to limit this step to the processes that are directly relevant to the defined area of analysis.

Relatedly the next step is to inventorize what systems (manual as well as automated) are already present and determine their importance (contribution) to the company's business processes. This step is generally done through conducting interviews and having discussions with key executives within the project's relevant area of expertise (Senft & Gallegos, 2008).

Via these interviews and discussions, the auditor can construct a generic overview of the relevant process and gain insights regarding its functioning and more importantly its failings. Subsequently an auditor should be able to present an auditing plan containing the following key elements:

1. Define objectives: In this step the auditor defines general objectives that will be used to verify the methods of risk management employed by the company.
2. Build a basic understanding of the area being audited: Here the auditor reviews summarized information and aims to evaluate it in relation to the objectives of the audit.
3. Build a detailed understanding of the area being audited: The auditor moves on to interview key personnel in order to determine policies and practices that add to creating a detailed understanding of the processes.
4. Evaluate controls, strengths, and weaknesses: Here begins the definition of relevant controls in order to achieve the defined auditing objectives.
5. Design the audit procedures: the auditor constructs a structured approach for the area that is being audited, selects applicable verification techniques and defines the performance thresholds.
6. Test the critical controls, processes, and apparent exposures: The testing is performed by the auditor by means of using documentary evidence, corroborating interviews and personal observation.

7. Evaluate the results: The aim of this final step is to evaluate the results and prepare a report on the relevant findings.

The seven steps mentioned above cannot be seen in isolation. The preparative elements mentioned beforehand are vital in making the above approach succeed.

## 3.2 Application of the Research Methodology

The above research methodology provides a good basis for analyzing the proposed problems. However, it is a generic model which needs to be specified to this context in order to be relevant. This is the purpose of this section and to additionally utilize the auditing literature to explain what steps will be taken at each of the stages.

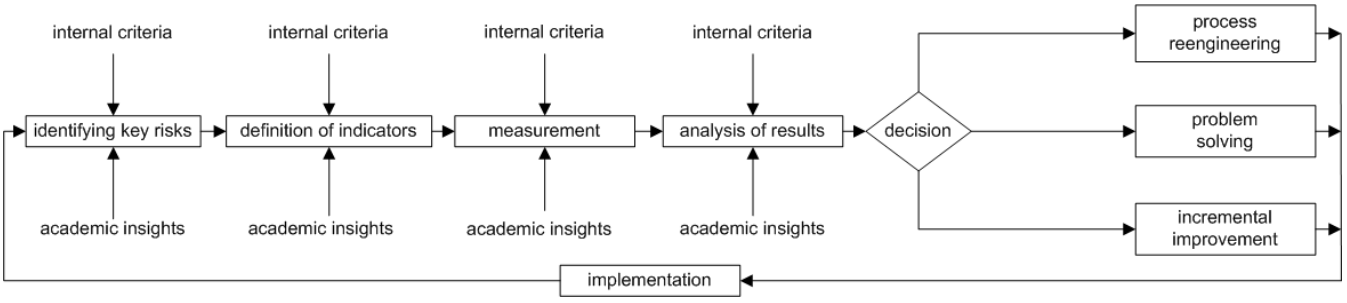



**FIGURE 3 THE ADJUSTED PROCESS IMPROVEMENT CHAIN**

**(ADAPTED FROM BARABINO, 2001)**

Figure 3 shows the adjusted process improvement chain, which includes the specific requirements of this research project. The methodological structure of this thesis will be discussed by elaborating on this adjusted model below.

### 3.2.1 Identifying Key Risks

The first step is to gain insight into the situation and is connected to the first research question. This is done partly by consulting risk management literature and for the company specific knowledge, experts will be consulted. By interviewing experts from various departments that have insight into the process, the key risks in the customs brokerage process can be identified.

### 3.2.2 Definition of Indicator

The formulation of the indicators is part of the second step and is related to the second research question. This model aims to define indicators that will assist in making the defined key risks, measurable. The inputs for this model will be internal expert advice and insights by consulting academic literature. Additionally, the prioritizing of the defined indicator which corresponds with research question 4 is also part of this step.

### 3.2.3 Measurement

After having defined the indicators to adequately manage the key risks, it is necessary to conduct the actual measurement. Here it is important to define how big the sample size will be and the time interval of the measurements.

### 3.2.3 Analysis of Results

Figure 3 presents the 'general' flow of analysis in this paper. The part that slightly deviates from this flow is the data consistency analysis. This is because various aspects of data consistency are already being measured (HTS, CoO, Value) so the analysis of the results can be done immediately (and quantitatively) as explained in the third research question. This is why this part will receive separate attention as the possibility of looking for patterns and making inferences is readily available. This could potentially be done by utilizing Bayesian Networks. For the rest the prime analysis & validation will be done via external critiques. The external aspect is important in order to gain fresh input to challenge the opinion of the internal experts.

### 3.2.4 Decision

The decision stage will depend heavily on what results the measurement analysis has provided. It could be that the performance discrepancy is low and can be solved by means of active problem solving or by setting up a plan of incremental improvement. Whereas if the difference with the desired performance is high and the area is critical to the high-tech firm's core business then the decision could be made to implement process reengineering in order to remedy the issue.

There is a distinction here as well between the data consistency analysis and the rest of the focus areas. This is because as mentioned earlier the data for the data consistency analysis is readily available, so the analysis of results and the decision making can be done earlier than the rest for which the data measurement first needs to be set-up. The decision making for the second part may not be possible due to the time constraints of this internship.

### 3.2.5 Implementation

When an appropriate decision is made, it must be implemented. This process will illustrate if the analysis up to this point was adequate. As the aim of this approach is to improve the overall performance and if this appears to be insufficient then a feedback loop is needed which will alter the initial process. Like this the high-tech firm can keep critically evaluating and thus refining their risk management approach.

# 4 Literature Review

The following section aims to provide a short summary of the relevant literature that will be utilized to assess and answer the formulated research questions. For reasons of clarity, this section follows the outlined methodological approach.

Firstly, the topic of risk identification will be discussed by discussing insights from auditing- and supply chain management literature. Next the focus shifts to the formulation of performance indicators with which auditing-, supply chain management and performance management literature can provide valuable insights. Lastly literature encompassing Venn diagrams and the application of Bayes' theorem is discussed. This facilitates with the predictive aspect of the data analysis and indicator prioritization.

## 4.1 Risk Identification

"Our task is not to avoid risk but to recognize it" (Raftery, 2003). When thinking about risk, the first thought that comes to mind is avoidance. However, risk is inherent to each and every process. So, it is a much more pragmatic approach to actively seek out risks and implement ways of management. That is precisely the focus of this chapter.

Risk management is a common topic in many research areas as risks are present everywhere. As this chapter only focusses on risk identification, the rest of the elements of the risk management approach will be discussed in the upcoming chapters.

Gordon (2008) states that if you are unsure about what to measure and have any sort of system or process in place to do so, how are you going to justify its importance? In order to answer this question, risk identification is necessary. This forms the precedent of what actually needs to be measured (controlled). This section will discuss auditing, supply chain risk management and supplier management literature.

While looking at auditing literature, it was found that auditing is done to guarantee process continuity and as risks can potentially undermine this goal, they are discussed as well. It is a structured approach that uses a preliminary review to inventorize the risks present in the process (Senft & Gallegos, 2008). The preliminary review is used to gain a generic overview of the relevant process and gain insights regarding their functioning and more importantly their failings. Senft & Gallegos (2008) describe the methods used to attain this understanding as:

1. Define objectives: In this step the auditor defines general objectives that will be used to verify the methods of risk management employed by the company.

2. Build a basic understanding of the area being audited: Here the auditor reviews summarized information and aims to evaluate it in relation to the objectives of the audit.

3. Build a detailed understanding of the area being audited: The auditor moves on to interview key personnel in order to determine policies and practices that add to creating a detailed understanding of the processes.

Lastly Senft and Gallegos (2008) emphasize the benefits of flowcharts as means of gaining insight and conducting analysis. “Flowcharts represent a method for identifying and evaluating control strengths and weaknesses within a system” (Senft & Gallegos, 2008). Understanding the strengths and weaknesses within a process is essential to a successful audit, as the major influences are the ones that require adequate management.

In today’s inter-connected world, everybody has to collaborate with other parties in order to do business (Hallikas et al, 2004). It is almost impossible to do everything yourself, from getting the raw materials to delivering the end product, there are lots of people involved in this chain of events. On the one hand the dependency on external parties enables companies to keep their focus on their core activities but it also creates uncertainty as the company has a reduced amount of control over its supply chain (Hubbard & Douglas, 2009).

Risk identification can be achieved by implementing the following steps (SCRLC, 2001):

- Identifying internal and external environments
- Risk identification

Identifying the internal and external environments provides an understanding regarding the locational influences that affect the part of the supply chain being analyzed. While these types of risks could be relevant, they will be discussed later when discussing country specific influences. The risk identification might be setup by conducting; brainstorming session, analyzing previous risk assessments, surveys or other efforts relevant to constructing a list of potential risks within the supply-chain process (SCRLC, 2001).

To be able to effectively implement such a plan there is the need for relevant expertise. That is why SCRLC, 2001 dictates that when defining (potential) risks the employees with the key knowledge should be involved. This initiative also insures that the resulting risk-management processes are adequately aligned with the current business-function processes within the company. This alignment serves as an important step towards validating the need for risk management practices. Because if something is not in line with the company’s core beliefs and ambitions then it will most likely receive minimum support and thus will not be successful.

## 4.2 Indicator Formulation

In general business literature, it is often mentioned that “you cannot manage what you do not measure” (Bossert, 2004). While this is true, as knowledge is necessary to be able to confidently manage an aspect of the company, the question that often remains is “what needs to be measured?” to manage a certain aspect of a company. This chapter illustrates the process of defining measurable indicators that correspond with the risks that were identified in the previous chapter. Firstly, relevant insights from literature will be discussed. Then the focus shifts to the situation at the high-tech firm and the indicator formulation process is discussed.

The problem is not that companies are not measuring enough, as almost 80% of the managers' state that they are (Gordon, 2008), it is that they often do not know what exactly they are measuring and more importantly for what reason. This is the challenge that will be tackled in this section by highlighting insights from academic research areas such as: auditing, supply chain risk management and supplier management.

Similar to the preceding chapter, the auditing literature also provides useful insights into the process of defining indicators in order to make the defined risks measurable. The proposed process is as follows:

1. Evaluate controls, strengths, and weaknesses: Here begins the definition of relevant controls in order to achieve the defined auditing objectives.
2. Design the audit procedures: the auditor constructs a structured approach for the area that is being audited, selects applicable verification techniques and defines the performance thresholds.

While the definition of performance thresholds will be discussed in upcoming chapters, the rest is largely applicable to this research step. The identified risks can be seen as the weaknesses in the process and the measurements will function as the controls in order to effectively manage them.

The part from supply chain risk management literature that is relevant to this chapter is called: "risk assessment". This process aims to estimate the likelihood and consequence of risks facing a firm, this may initially involve qualitative inference as sometimes it is difficult to estimate these measures for certain risks due to their diverse nature.

Once the high-tech firm has identified the key risks that need to be addressed it can start assessing the likelihood and consequences via a more elaborate way. Here, the bow-tie method will be discussed which is a cause and consequence analysis, aiming to distinguish relevant actions over 2-dimension; cause and likelihood. This can be seen in Figure 4.

While the complex calculations to determine the likelihood and consequence will remain out of scope, this thesis will make a distinction between actions that reduce the likelihood and actions that reduce the consequences.

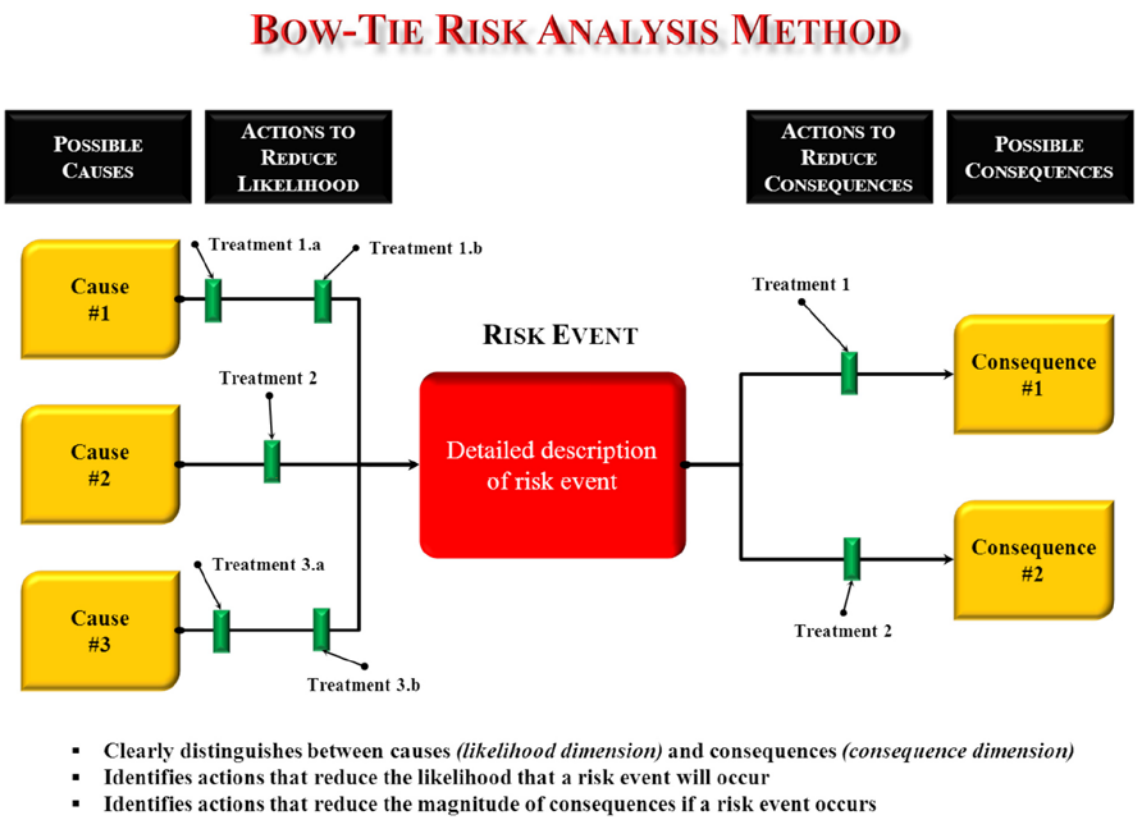



**FIGURE 4 BOW-TIE METHOD FOR LINKING TREATMENT TO CAUSE AND CONSEQUENCE (SCRLC, 2001)**

A lot of causes can be tied to the internal processes of the customs broker; this will be further explained in section 4.3. In order to analyze such processes, it is useful to examine the theory regarding "Supply chain risk management maturity levels".

Maturity is of course an iterative process, as it is impossible to start at the top. While implementing several control-measures a company gradually climbs the maturity ladder (Figure 5).

The maturity levels are defined as follows:

- Level 1
  - Pre-compliant: This level implies that the company is not yet meeting the defined compliance criteria (these could be different per company) and/or have no established supply chain prevention or response protocols. Sometimes limited preventive measures such as personnel checks and freight are already in place but they do not offset risks such as:
    - Business disruptions
    - Reduced economic viability
    - Competitive disadvantages

- Level 2
  - Compliant: These companies have the required measures in place in order to adhere to externally imposed regulations. Even though such companies are compliant, there predominantly reactive, meaning that security is perceived as a cost. These firms may benefit from fewer inspections and shorter border delays but their disruption risk remains high.
- Level 3
  - Secure: Such companies are often unsatisfied with just the externally imposed security standards. These firms aim to actively develop a more rigorous approach to protect heir, brand, employees, assets and stakeholders. Such firms have integrated security into their business model and are thus focus on preventive instead of reactive problem solving. In this phase the collaboration with various parties in the supply chain is also important.

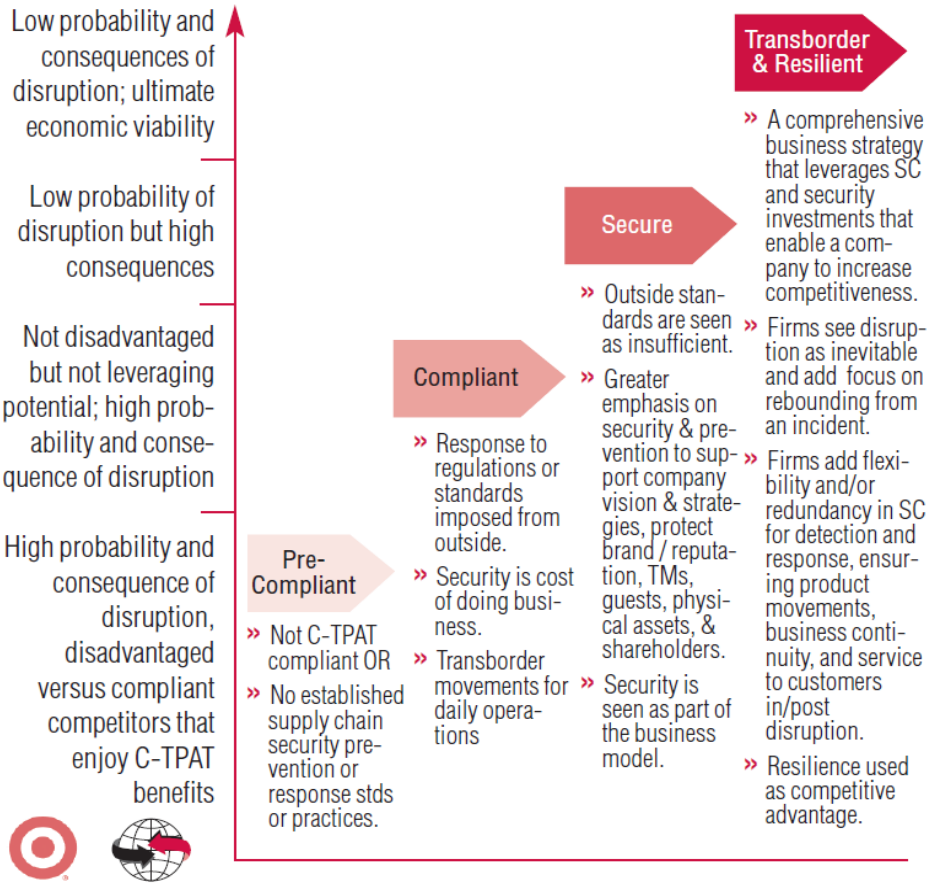



**FIGURE 5 SUPPLY CHAIN RISK MANAGEMENT MATURITY LEVELS (RICE & TENNEY, 2007)**

- Level 4
    - Resilient: This is the highest level that a firm can achieve. Resilient companies see risk management as a means of getting ahead in the market. Here the thought process has evolved to the point that avoidable disruptions are handled preventively while unavoidable disruptions are managed by having a sound reactive plan in place. These firms have reduced their non-compliance risk, are less prone to security breaches and have adequate procedures in place to circumvent (potential) disruptions.

Setting up a system and defining specific processes for monitoring requires a considerable effort on a company's part, not ignoring the monetary resources as well. When proposing such an idea to a company's senior management it is necessary to highlight the benefits that are relevant for them (Brooks et al, 2003). For example:

- The quantified consequences of poor supplier quality.
- Having proof from academic literature regarding the benefits of supplier measurement.
- Analyze the biggest issues the company is currently facing and check which part is influenced by suppliers.
- Analyze and calculate current supplier problems to gain an estimate of future savings.

### 4.2.1 DEFINITION OF AN INDICATOR

This paper often refers to the word 'indicator' as a means to measure a certain property. In this section the aim is to provide the reader with a uniform definition regarding this term. A term that is closely related to indicator is "representation-target". This term aims to make the context, that it represents, tangible. To better illustrate the meaning and the relationship of these terms to one another the following example is constructed.

"For example, if the context is the "logistic process" of a company and the representation-target is "the classification of suppliers", the "delivery time" and the "number of defective products" are two of the possible related indicators." (Franceschini et al, 2007)

Even though the concept may seem clear, the determination of a key subset of indicators is a real challenge. In order to do this one must identify the most significant variables that adequately describe a particular phenomenon (Halliday et al, 1996)

### 4.2.2 TYPES OF INDICATORS

Franceschini et al (2007) distinguish between two types of indicators: basic indicators & derived indicators. An indicator is seen as basic if it is obtained as a direct observation of an empirical system. For example: the number of manufactured parts, the lapse time between events etc. A derived indicator is obtained by the synthesis of two or more indicators. For example: the ratio between defective and good products, the total number of products created by a set of production lines, etc.

The final thing to be discussed in this section is the Uniqueness property of indicators. The uniqueness is defined as the number of indicators needed to represent a representation-target, so the fewer indicators that are necessary, the higher the uniqueness property becomes. Basically, the conclusion that

Franceschini et al (2007) reach is that the more specific the definition of the representation-target, the fewer the needed indicators, thus increasing the uniqueness property. All of this to ensure that what's being measured is actually what is desired (Namiri & Stojanovic, 2007).

## 4.3 Data analysis

While considering a situation where a feature of an entity directly influences another feature of the same entity, it is important to be able to make inferences regarding this relationship. This is where the importance of Bays' theorem is highlighted. Bayes' theorem provides the tools to calculate conditional probabilities in order to model such occurrences.

This paragraph initially delves into a related theory of relational modelling; Venn diagrams. Having created a basis of understanding, the section will continue to explore Bayes' theorem in more detail and conclude with an introduction to Bayesian Networks.

Initially referred to as "schemes of schematic representation" by Venn (1880), Venn diagrams are created to represent logic by means of a visual model. Figure 8 shows examples of Venn diagrams which represent relationships between elements by utilizing circles.

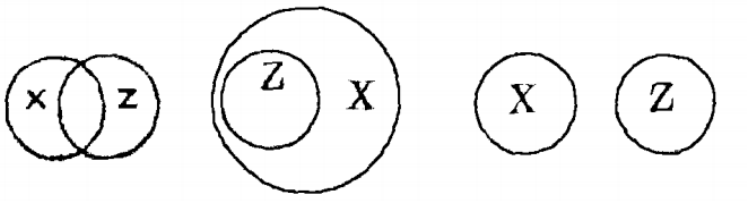



**FIGURE 6 EXAMPLES OF VENN DIAGRAMS (VENN, 1880)**

Figure 6 shows three diagrams representing a relationship between sets {X} and {Z}. The diagram on the left show a common area (intersection) of X and Z. The diagram in the middle shows that Z is a subset of X. Lastly, the diagram on the right shows that there is no relationship between X and Z as the two circles do not intersect.

As the above explanation shows, the basics of Venn diagrams are very easy to comprehend but at the same time provide a powerful tool to visualize relationships between multiple sets (Chow, 2007). The next part focusses on Bayes' theorem which introduces the idea of conditional probabilities.

### 4.3.1 Statistical Analysis

A Bayesian network which is also sometimes referred to as "belief network", is a directed graphical model that represents conditional probabilities between variables of interest (Dogan & Aydin, 2011). The application of Bayesian networks is primarily in the fields of knowledge representation, inference and decision analysis under uncertainty.

Bayes' theorem basically provides a means of calculating conditional probabilities, so the probability of an event occurring given the fact that another event occurrence has preceded it. Formally this can be written as:

$$P(A|B) = \frac{P(B|A) * P(A)}{P(B)}$$

**EQUATION 1 BAYES' THEOREM (FENTON & NEIL, 2012)**

The above theory assists in gaining understanding regarding conditional probabilities but is fairly static and does not allow for scenarios with differing input probabilities. For this Bayesian networks prove to be a very valuable tool.

A Bayesian network consists of a set of nodes and arcs. The nodes represent the various variables, while the arcs link the nodes that are directly dependent. A connection from node A to B signifies a direct causal or influential dependence of A on B. In Bayesian network terminology A is called parent node, while B is referred to as a child node. A potential danger of circular reasoning exists in Bayesian networks, in order to solve this problem BN's are required to be acyclic. Meaning that If there is an arc from A to B and from B to C, that no arc can exist between C and A.

Each node within a BN has its own node probability table (NPT). This implies that probability of that node given its set of parent nodes. If a node does not have parents, it is referred to as a root node and its NPT is simply equal to its probability distribution.

The BN modelling can be done by utilizing the program AgenaRisk, with which different scenarios can be modelled. By constructing these scenarios, the impact of the various variables can be visualized.

# 5 Risk Assessment

The section looks to identify the key risks in the custom brokerage part of the high-tech firm's supply chain. The highlighted area in figure 7 illustrates that this is the first step in the process improvement chain model that was introduced in chapter 3. It is important to conduct a risk analysis as this helps identify the issues that warrant monitoring.

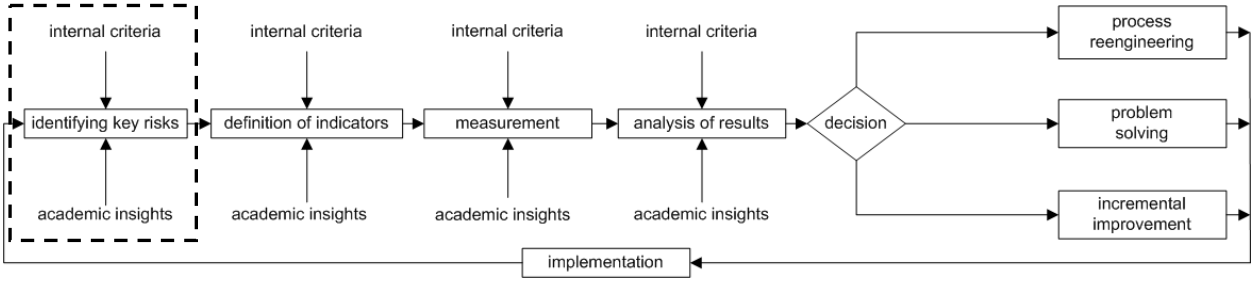



**FIGURE 7 RISK ASSESMENT (RESEARCH METHODOLOGY)**

## 5.1 Risk Overview

Due to globalization, the supply chains of most companies extend across (multiple) borders. This entails, that delays caused by problems in the customs brokerage process, could create a snowball effect resulting in (increasing) delays for the rest of the supply chain. In order to circumvent such problems, companies turn to risk mitigation (Bossert, 2004).

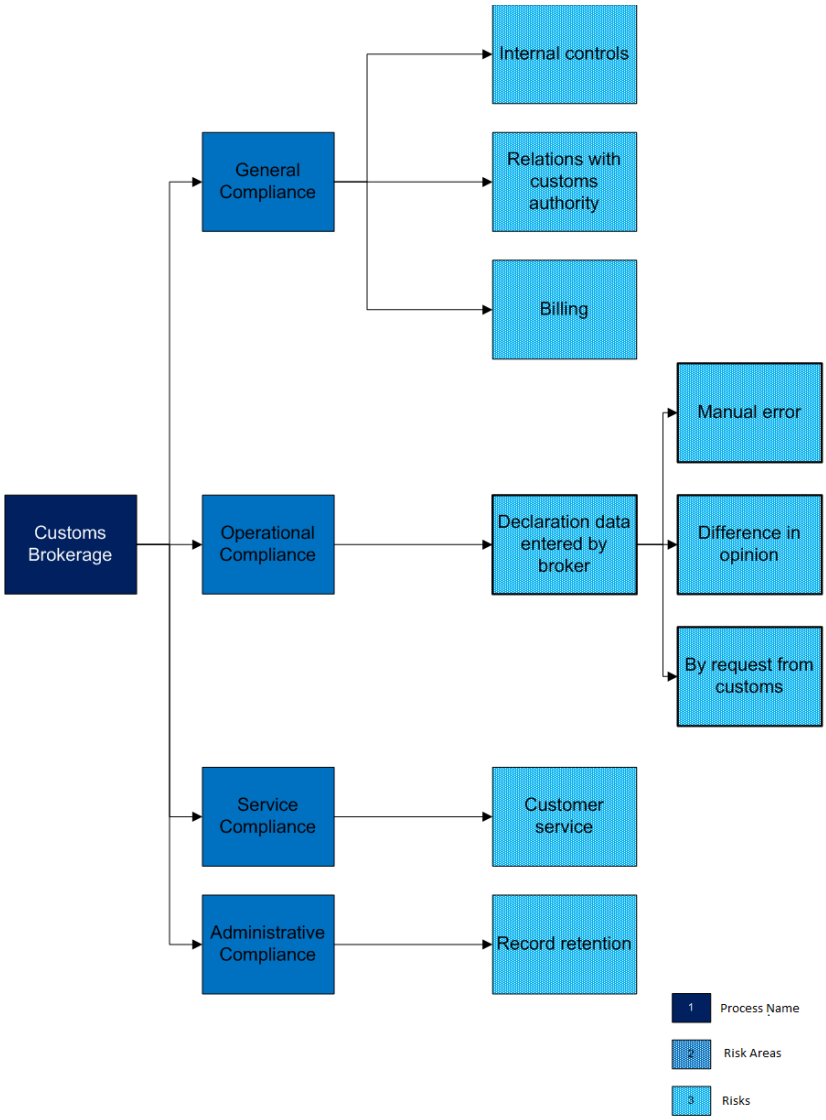



**FIGURE 8 RISK IDENTIFICATION FRAMEWORK**

The first step in designing a monitoring approach is the identification of compliance risks. However, without the link between the performance measure and the desired performance objective the measurement is meaningless (Brooks and Coleman, 2003). In order to identify what needs to be measured a risk assessment is necessary.

During the time of the internship a basis for a structural approach to control the Customs Brokerage process is set up. It will be implemented in 2017. Thus, in order to gain understanding regarding the brokerage process it was necessary to interview key stakeholders. Interviews form a good way of assessing not only the process flow and the potential risks, but also the opinion of key personnel regarding the customs brokerage process (Senft & Gallegos, 2008).

In collaboration with the Senior manager warehousing, 2 Senior customs' specialists and the Senior manager customs the risk identification framework of Figure 8 was developed

### 5.1.1 Interviewing Approach

The interviews were held one-on-one with each expert (Namiri & Stojanovic, 2007). The first step was outlining the areas of brokerage activities, which was done with the European customs expert. This yielded the categories: Operational Compliance, Service Compliance and Administrative Compliance. As some activities, could be placed in a particular category and thus were of a 'general' nature, they were placed in the category General Compliance.

Subsequently, the experts were asked to list the risks that corresponding to each category (so including general risks). The experts were in agreement with a set of risks that are listed in figure 8. This process involved making iterative steps; having in-depth discussions regarding which risk to include or exclude from the model. The risks listed in figure 8 are deemed "key risks" as the experts have found these to be most influential to the high-tech firm's goals; timeliness and cost effectiveness.

## 5.2 Risk Explanation

Firstly, from the interviews with experts the following four categories are formulated: General, Operation, Service and Administrative. Thus, this setup is chosen while identifying and structuring the risks in this first step of constructing a monitoring approach (Schlegel & Trent, 2014).

Via desk research (existing risk assessment documentation) and by consulting the aforementioned experts the following risks are identified:

1. General Compliance
    a. Internal controls: It is beneficial for a firm to engage with a party that is self-critical and strives to deliver the best performance. The degree to which the customs broker has internal controls in place, can be an additional indication regarding how much the broker's processes are "in control". A broker with no internal controls in place is a liability as there is no check on the quality of its internal processes that make up the service that it delivers to its clients.

Relations with customs authority: This risk could be damaging if the broker has a negative image with the customs authority because of for example: not adhering to regulations/ mal-practicing. This could result in the broker being subjected to additional checks which leads to delays for the broker and thus for the high-tech firm employing the broker.

Billing: This is a potential risk as the broker's billing should depend on the amount of work delivered; if there is a mismatch then the high-tech firm is paying for unreceived services.

2. Operational Compliance
    a. Declaration data entered by broker: Making a declaration is the main activity of the broker. This involves taking data that comes with the shipment and entering it onto a

customs declaration. If this is done incorrectly then the customs authority can request additional checks which results in additional delays. For this part there is data available, therefore this risk is further distributed in the types of discrepancies: manual error (not on purpose), difference in opinion (on purpose) and by request from customs. These alternatives will be further explored in the data analysis chapter later on in this thesis.

3. Service Compliance

Inquiry handling (the high-tech firm<>Customs): When there is a question from the high-tech firm to the broker or from the customs authority to the broker it is important that it is dealt with efficiently. The risk is that with inadequate inquiry handling, issues will be resolved at a slower pace which conclusively causes delays for all parties involved.

4. Administrative Compliance
    a. Record retention of import/export declaration: The customs authority reserves the right to inquire about relevant customs documents for a period of three years after the shipment is made. This introduces the risk of not having an adequate record keeping in place. If the broker is unable to provide the requested documents, the company whose shipment it involves could face sanctions and/or revoking of licenses.

## 5.3 Other Risks

While the internal process of the broker can potentially be seen as a risk, it is argued here that there should be a boundary to the scope of the risk analysis. the high-tech firm's aim should be to create awareness, not to take over the broker's responsibilities (Lambert et al, 1999).

- Workforce knowledge, workforce description and license management: When outsourcing a key activity to a third party a firm aims to harness expertise that are not present internally (Deepen, 2007). Inadequately educated employees could cause delays by making vital discrepancies that could intensively delay the entire process. Relatedly an inadequate work description could also seriously hinder the process as; well educated employees with an inadequate work description will also experience reduced efficiency.

While the above is most certainly a risk, it is not a risk worth taking into account for the high-tech firm. the high-tech firm demands that the broker adequately delivers certain services and how the broker delivers these services is the broker's responsibility.

- Customs broker's IT-systems: In order to adequately perform its activities, a broker requires adequate support systems. If these systems are outdated and/or malfunctioning this could potentially provide integration problems, processing delays and faulty data (Namiri & Stojanovic, 2007).

Similarly, to the preceding risk, this is not directly relevant for the high-tech firm to gain knowledge about. the high-tech firm is interested in receiving a certain level of quality from the broker and this is just a means with which the broker can provide the expected quality.

## 5.4 Conclusion

This chapter has attempted to illustrate the various risks that are inherent to the customs brokerage process. The identification is done by means of expert consultation as the documentation was rather fragmented. The analysis has shown that risks such as relation with the customs authority, correct billing and adequate license management can be categorized as general risks. Similarly, declaration data that is entered by the broker is an operational risk, inquiry handling is a service risk and record retention is an administrative risk.

The analysis has also provided risks such as workforce knowledge, work description and the broker's IT-systems. Which, even though are valid risks, are not directly relevant to the companies' core objectives. These are means with which the broker can effectively perform its activities and thus are part of the broker's responsibility. the high-tech firm only considers the risks which directly impact its core objectives which are to minimize delays and cost. However, a summary of these 'out of scope risks' is taken into account via the "internal controls" risk that is part of general compliance, as the willingness of the broker to be self-critical indicates the quality/stability of its internal processes.

The negative consequences can be summarized into the following; additional costs, additional delays and negative image for the broker, and for the high-tech firm. In order to offset these consequences, one must identify the most significant variables that adequately describe the particular phenomenon (Halliday et al, 1996), this will be the focus of the upcoming chapter.

# 6 INDICATOR FORMULATION

The section utilizes the identified risks in chapter 5 in order to formulate indicators that help mitigate these risks. The highlighted area in figure 9 illustrates that this is the second step in the process improvement chain model that was introduced in chapter 3. It is important to formulate indicators as monitoring requires measurement.

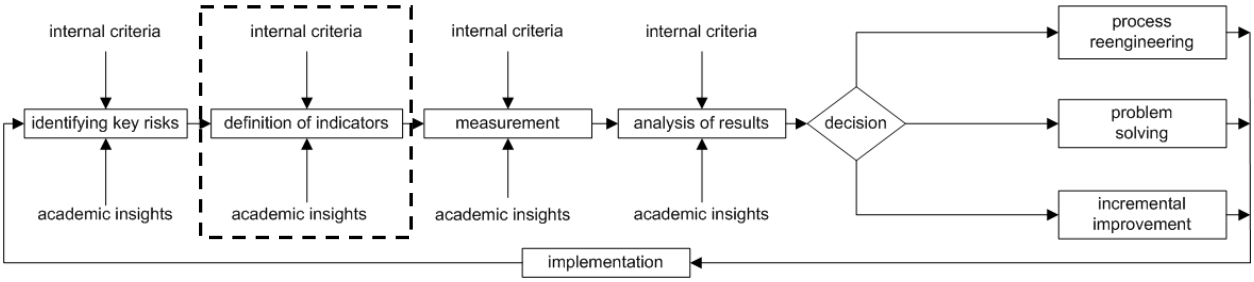



**FIGURE 9 INDICATOR FORMULATION (RESEARCH METHODOLOGY)**

Ideally while defining indicators it is useful to consult internal expertise but just as important is the inclusion of the party that is being monitored, this case the customs brokers (Gordon, 2008). However, due to company policy it is not possible to include brokers operating abroad, so a local broker will be the brokerage party that is consulted.

## 6.1 APPROACH

The approach used in this section is a combination of the indicator literature by Franceschini et al (2007) & Halliday et al (1996), and the bow-tie method proposed by SCRLC (2001). The goal is to combine both approaches in order to reach a desirable subset of measurement indicators. This is done by making logical inferences while the verification of this inference is subsequently done with the help of the experts mentioned in section 5.1. The consolidated results are presented in sections 6.2-6.4.

The combination of the aforementioned approaches is done via a two-fold approach: firstly, the consequences are measured by formulating relevant indicators. The consequences can be measured (and controlled) by checking the output of various processes, while the causes are present at the end of the broker and have to be dealt with separately. Due to this fact, the consequences will be discussed first and later on a structured approach will be introduced to deal with the causes.

The causes and consequences are formulated by conducting interviews with most input from individuals at the high-tech firm that work at a higher aggregation level, as these individuals have a better overview of the process (Rice & Tenney, 2007). While the indicators are formulated by predominantly interviewing personnel at the operational level as they can adequately assess the necessities and possibilities at that level. As this approach combines insights from multiple aggregation levels in the organization it is expected to be more complete and is expected to gain acceptance much easier (Senft & Gallegos, 2008).

For each risk areas; General, Operational, Service and Administrative there are flowcharts to visualize the structure of the indicators. Each flowchart has the risk area as starting point, with the relevant

representation targets (Franceschini et al, 2007), the elements that need to be controlled in that risk area, connected to the risk area.

## 6.2 CONSEQUENCES

The first step in the development of the control framework is the identification of the representation targets and relevant consequences (Halliday et al, 1996). This inventarization is done via desk research and conducting interviews with the aforementioned experts.

Consequently, these insights will be used to develop indicators to monitor and control the consequences, while in section 6.3 this process will be repeated for the causes.

| Risk Area | Risk | Representation Target | Consequence |
|---|---|---|---|
| General Compliance | Internal processes | Internal control | *No critical reflection on own processes, unidentified and thus unmanaged risks that could hinder process effectivity (Namiri et al, 2007).* |
| | Billing | Billing accuracy | *Unjustified, high cost for* the high-tech firm |
| | Relations with customs authority | Brokerage Quality | *Delays or additional checks, bad image with customs and thus inadequate support. Not getting benefit of the doubt.* |
| Operational Compliance | Declaration data entered by broker | Data consistency | *Additional checks, sanctions and a bad image with customs* |
| Service Compliance | Inquiry handling (the high-tech firm<>Customs) | Service adequacy | *Unresolved issues -> delays or customs checks/sanctions* |
| Administrative Compliance | Record retention of import/export declaration | Record retention | *Unresolved issues -> delays, customs checks/sanctions or revoking of licenses.* |

**TABLE 1 OVERVIEW OF CONSEQUENCES**

Table 1 provides an overview of the potential consequences related to the previously identified risks and the representation targets. These consequences will assist in the formulation of indicators in the upcoming section.

### 6.2.1 General Compliance

Figure 10 shows the link; risk area->representation target->indicator. How the respective indicators have been formulated is discussed below per representation target. For example, General Compliance is the risk area, “internal controls” is the representation target and the Control processes maturity level is the indicator.

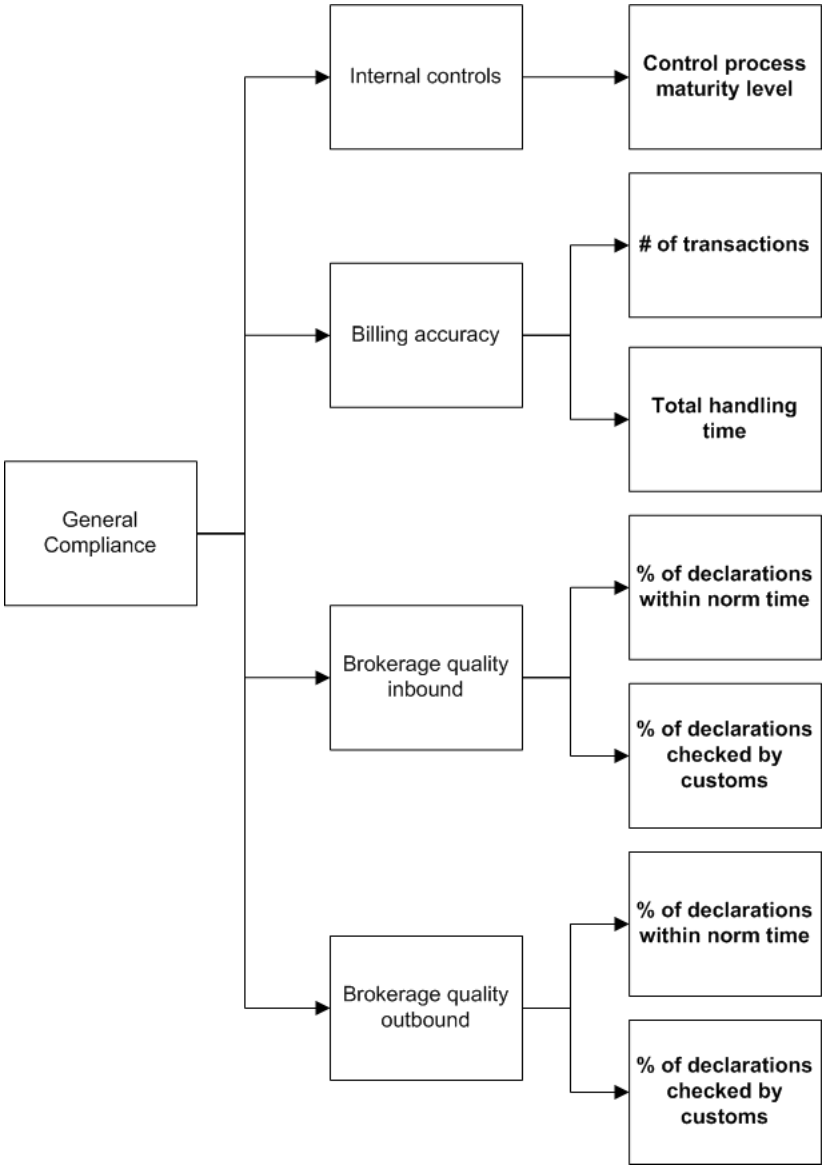



**FIGURE 10 GENERAL COMPLIANCE INDICATORS**

❖ Internal controls

It is mainly the responsibility of the broker to have its processes in order so that it can deliver the demanded service level. But having insight into the process of internal controls can help the high-tech firm be pro-active in solving certain issues (Namiri & Stojanovic, 2007). If the process is sound, then the probability of the output being sound also increases. This preventive mechanism is further elaborated in section 3.4.

This indicator measures how mature the process of internal controls is based on the following criteria, this builds on the description of "other risks" made in paragraph 5.3.

Employees:

- Certification, internal refreshers, adequate work description,

Licensing:

- License renewal process should be started 3 months before expiration. Confirmation letter should be received 2 months before expiration.

Corporate Security:

- Checking internal awareness, checking IT-security

The above is summarized in the following indicator:

Broker's maturity level should be at level 3 (Secure). The provided report will be sample checked by the high-tech firm to confirm maturity.

❖ Billing Accuracy

Ideally a firm would like to pay as little as possible while still receiving good quality service. This is not always realistic, so it is important that clear agreements regarding payment are made and upheld (Deepen, 2007). So, that both parties receive what is mutually agreed upon. Thus, in order to avoid the consequence that the amount billed is not representative of the service delivered, it is important to know the completed tasks and their respective completion times. This is summarized in the following indicator:

➢ # of declarations processed and their respective handling times. Each declaration has an average handling time. If the total cost is disproportionate to the total handling time then this provides reason for additional investigation.

❖ Brokerage quality

Generally speaking, brokerage quality can have two (negative) consequences: either the declaration is wrong and needs to be improved or it needs to be checked. The model below visualizes this process and illustrates how these two consequences can be avoided.

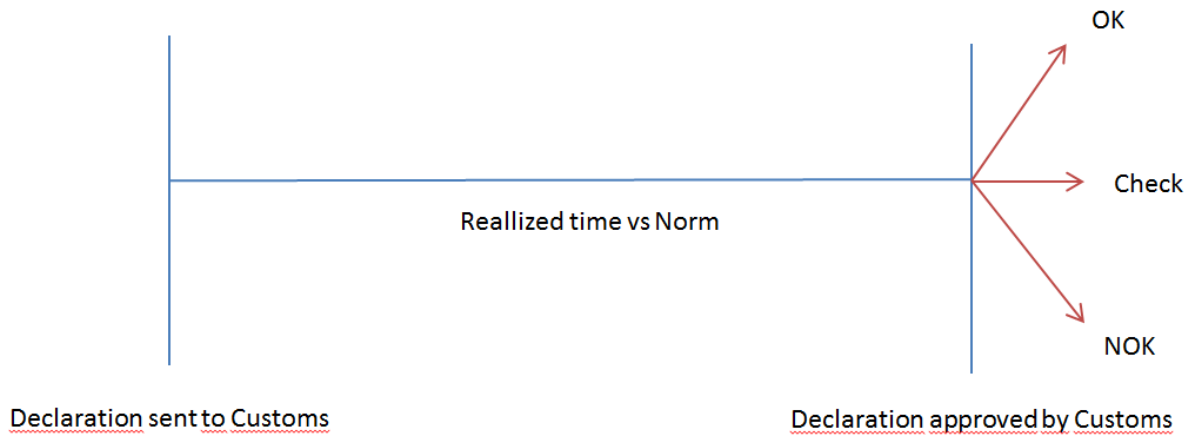



**FIGURE 11 BROKERAGE QUALITY**

When the broker sends the declaration to customs there are three possible outcomes as shown in figure 11:

1. Everything is fine and it receives an "OK" and the declaration is approved.
2. Customs wishes to "Check" the corresponding products/requires additional documentation.
3. The declaration is wrong/incomplete and has to be updated and is deemed "NOK".

From the declarations that exceed the norm. Some are labelled as "Check" and some are labeled as "NOK". For this indicator, the focus is on assessing which percentage is NOK as this is directly influenceable by the broker. The "Check" entails a check from customs which need not be related to the broker's performance.

While a bad image is hard to quantify it does influence the opinion of the other party (customs). After speaking with a former customs employee, it was confirmed that if a customs broker has a track record consisting of structural negligence; it is automatically more likely to encounter additional checking and stricter reinforcement of rules and regulations (De Wulf & Sokol, 2005).

To further verify the declarations that receive a "Check" it is important to understand which part is influenceable by the broker and which part is 'random'. Thus, customs can be contacted to elaborate on the reason of the check.

The above is summarized in the following two indicators:

- % of declarations" exceeding the norm that are classified as "NOK"
- % of declarations exceeding the norm that are classified as "Check" and are due to a fault by the broker

### 6.2.2 OPERATIONAL COMPLIANCE

Figure 12 shows the link; risk area->representation target->indicator. How the respective indicators have been formulated is discussed below per representation target. For example, Operational Compliance is the risk area, Data consistency inbound is the representation target and the % of correct HTS codes on declaration is the indicator.

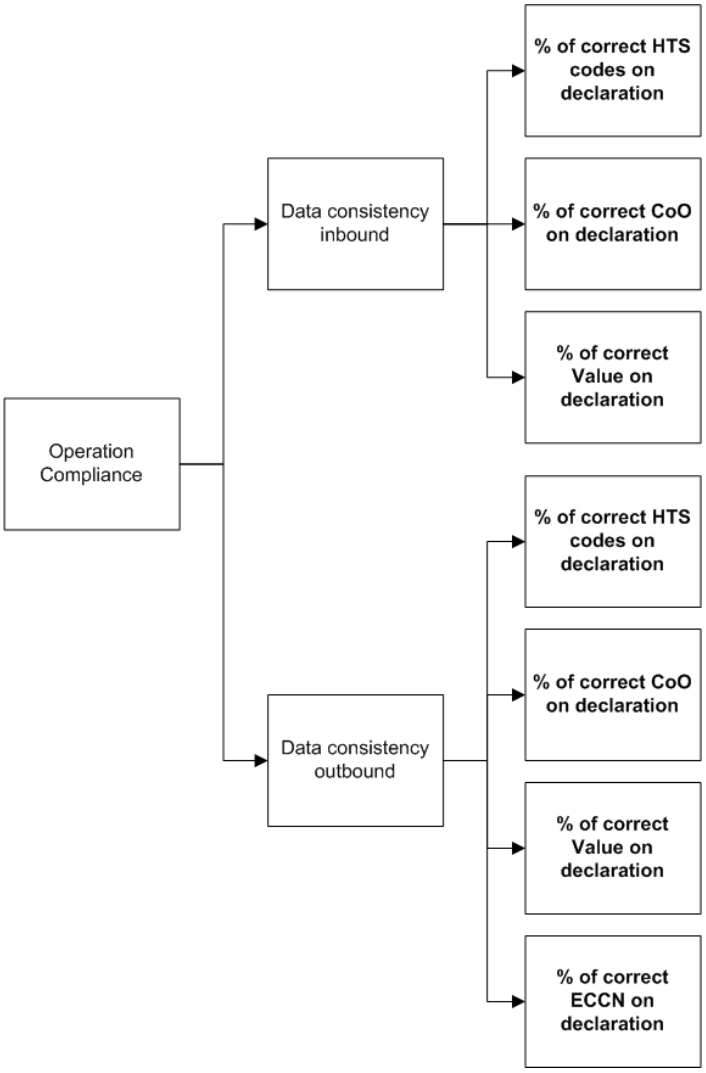



**FIGURE 12 OPERATION COMPLIANCE INDICATORS**

- Data Consistency

Making the declaration for products to customs is the primary task of the customs broker. It goes without saying that this process warrants checking. This is connected with the indicator that measures the brokerage quality by checking the amount of declarations that cause refusal from customs. This indicator checks how often the data entered onto the declaration is consistent with the input data from the high-tech firm. This is summarized in the following indicator:

- % of correct HTS, CoO (country of origin), Value and ECCN (Export Control Classification Number) copied onto declaration.

### 6.2.3 SERVICE COMPLIANCE

Figure 13 shows the link; risk area->representation target->indicator. How the respective indicators have been formulated is discussed below per representation target. For example, Service Compliance is the risk area, Service adequacy inbound is the representation target and the Survey grade: solution adequacy is the indicators.

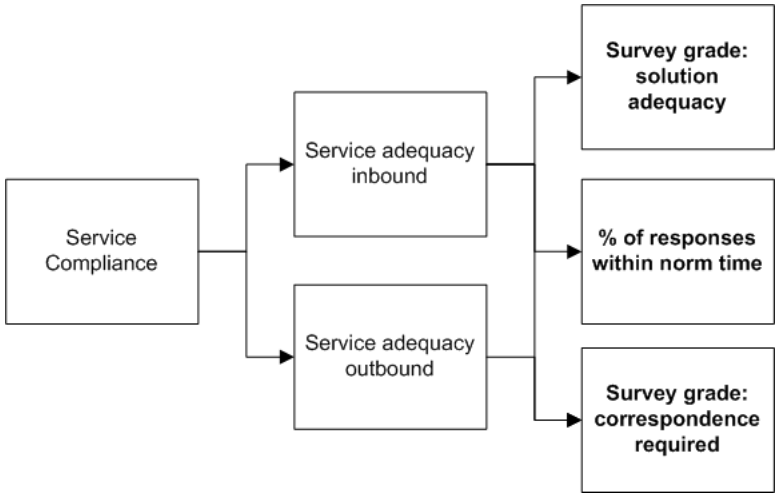



**FIGURE 13 SERVICE COMPLIANCE INDICATORS**

- Service Adequacy

Often there are moments that correspondence is required with the broker to solve certain unforeseen issues. It is important that such correspondence is handled professionally and swiftly as it could for example involve a delayed shipment (Razzaque & Sheng, 1998). The service quality can be measured by logging the correspondence and periodically filling in a survey.

The areas that the experts experience the most problems in are: the quality of the solution provided, the handling time of the inquiry and the amount of times that the broker needs to be approached before an issue is resolved. Thus, the following criteria are formulated to be graded in the aforementioned survey: solution adequacy, handling time and the need for repeat correspondence.

- Check the solution adequacy, handling time and amount of correspondence required. Employees that have correspondence with the broker will be asked to rate the broker based on the above-mentioned criteria for each issue that the broker is approached for. Every quarter on a random date (to avoid time dependent bias) a survey will be filled in which an employee will score the broker on the above-mentioned criteria, based on the data stored over that period.

### 6.2.4 ADMINISTRATIVE COMPLIANCE

Figure 14 shows the link; risk area->representation target->indicator. How the respective indicators have been formulated is discussed below per representation target. For example, Administrative Compliance is the risk area, Record retention inbound is the representation target and the % of complete records in sample is the indicator.

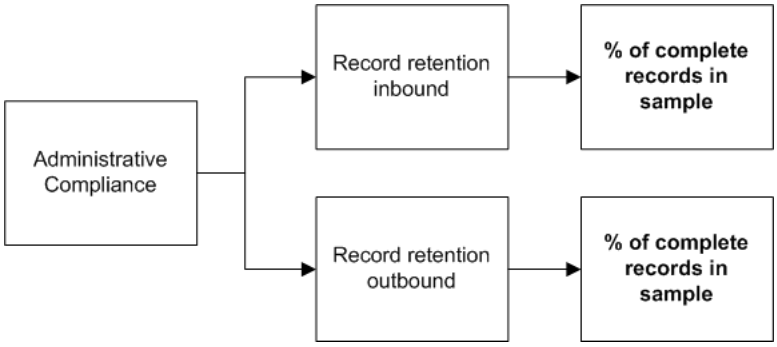



**FIGURE 14 ADMINISTRATIVE COMPLIANCE INDICATORS**

- Record retention

According to regulations it is possible for customs to demand documentation regarding shipments of up to 3 years back (De Wulf & Sokol, 2005). So, it is essential for a customs broker to have a correct filing procedure in place so that all relevant documents for a shipment can be swiftly retrieved and handed over if required.

- Sample check if the administrative records of the broker contain the following documents (if available): Airway Bill, Transport document, Receipt, CMR, EUR certificate/statement and all relevant correspondence.

## 6.3 INDICATOR SIDENOTES

While the inbound and outbound flows are very similar, it is still useful to make a distinction while making the measurements. As there are separate people handling the two flows, it becomes easier to pinpoint issues when the flows are separate. The import declaration is more complex than the outbound one as it only contains information provided by the sending party, so the high-tech firm dependent upon what is provided here.

While causes such as employee knowledge and adequate work description have to be managed, they are part of the customs broker's internal process and thus not the high-tech firm's responsibility. Related to the conclusions drawn in section 3.4, the high-tech firm can gain insight into these issues by measuring the maturity of the broker's internal controls (Rice & Tenney, 2007).

The above proposed indicators are mostly focused on reducing the consequences. The reduction of the likelihood of the causes is mostly done by measuring the broker's maturity level, which will be further elaborated upon in the upcoming section. As successful implementation of this offsets many of the causes

that influence the defined risks, the maturity levels deserve extra attention and should be separately discussed with the customs brokers.

## 6.4 CAUSES

The second step in the development of the control framework is the identification of the relevant causes (Table 2). This inventarization is done via desk research and conducting interviews with the aforementioned experts.

Consequently, these insights will be used to develop an internal control indicator that will give reasonable assurance regarding the state of the broker's internal processes.

| Risk Area | Risk | Representation Target | Cause |
|---|---|---|---|
| General Compliance | Internal processes | Internal control | *Not the right measurement systems in place and no realization of the importance of internal controls* |
| | Billing | Billing accuracy | *(Inadequate financial administration) Inexperienced personnel/inadequate work description and attempt at making additional (unjustified) profit* |
| | Relations with customs authority | Brokerage Quality | *Not adhering to customs rules and regulation or inexperienced personnel* |
| Operational Compliance | Declaration data entered by broker | Data consistency | *Inexperienced personnel/inadequate work description, due to customs request, due to personal opinion/gain or discrepancy from* the high-tech firm |
| Service Compliance | Inquiry handling (the high-tech firm<>Customs) | Service adequacy | *Inexperienced personnel or no structured customer service in place.* |
| Administrative Compliance | Record retention of import/export declaration | Record retention | *Inexperienced personnel/inadequate work description or no structured record keeping in place.* |

**TABLE 2 OVERVIEW OF CAUSES**

### 6.4.1 Application of the Supply Chain Maturity Levels

As is identified in the preceding section, the primary cause of the defined risks is the internal process of the broker. It does not matter if it is record keeping, customer service or declaration handling. If there are unqualified people at work, with inadequate work descriptions or in an environment that is limiting then the probability of the risks occurring is high. In other words: If the customs broker is not managing its own processes pro-actively, all the delivered services carry a high risk of being faulty (failing) (Schlegel & Trent, 2014).

In order to circumvent this problem and thus to treat the causes, it is necessary to develop a uniform agreement regarding the performance level of the checks that the customs broker performs internally. To facilitate this, the theory of "Supply chain risk management maturity levels" is applied below (Rice & Tenney, 2007).

Level 1 - Pre-compliant

At this level the broker is not meeting the compliance criteria defined by the customs authority and also not those defined by the high-tech firm. This level carries high risk as the broker cannot provide adequate service and is highly likely to incur sanctions or have its operation license revoked.

Level 2 - Compliant

This level carries moderate risk as all the rules and regulations that are requested by the customs authority are adhered to. It is reasonably safe to engage with such a broker as they benefit from fewer inspections and shorter border delays. However, the mentality is mainly about seeing compliance as a cost and not as a means of improving ones' own processes. This means that when unforeseen disruptions occur, such brokers incur heavy delays due to the absence of preventive measures.

Level 3 - Secure

It is safe when a firm engages with a broker that is operating on this maturity level. Such brokers have an internally developed set of standards that is additional to what the customs authority prescribes. At this level of maturity, the broker seeks to preventively deal with potential risks and is thus actively collaborating with parties such as its customers (the high-tech firm) and the customs authority.

Level 4 - Resilient

A broker on this level is what a firm should strive to find. Such brokers have a comprehensive and well evolved risks management structure in place that:

- Handles avoidable disruptions preventively
- Has a sound action plan to deal with unavoidable disruptions

The proposed collaboration with the broker should ideally lead to this maturity level at which the high-tech firm as well as the broker can confidently engage in customs activities without fearing for disruptions as (almost) all eventualities have been taken into account.

### 6.4.2 Formulation of internal controls

The previously defined maturity levels serve as an adequate template for assessing the internal controls already employed by the customs broker. However, without defining the specific areas that the high-tech firm would like to see monitored, the result does not provide the required insight. This section aims to formulate standard controls that the customs broker can perform internally and which should be included in the report in which its maturity level is determined. While the internal process of the broker is not in the scope of this thesis, a control measure for insight is still provided for sake of completeness. Even though the internal control approach is elaborate, the high-tech firm could fine tune it further if indications are seen that additional control is necessary.

- Employees
  - Adequate certification to fulfil customs duties.
  - Internal training by seasoned experts for new employees
  - Timely refresher course offered or requirement set to guarantee up-to-date brokerage knowledge.
  - Detailed work description.
  - Safe and healthy working environment.
- Licensing
  - Checks if the license renewal process is started 3 months before expiration. Confirmation letter should be received 2 months before expiration.
- Corporate Security
  - Adequate security measures in place to guarantee confidentiality; no unauthorized entry permitted and no unauthorized data access is possible.
  - IT systems up-to-date and renewed at regular intervals to avoid performance and interfacing issues.

## 6.5 Conclusion

In this section the formulation of key performance indicators has been discussed. After gaining initial insight from literature, the bow-tie method has been used to define the causes and consequences of the risks defined in the previous section. Consequently, indicators have been formulated that largely measure the consequences and thus are reactive. In order to reduce the likelihood of the causes, it is necessary to examine the methods that measure the degree to which the internal processes of the broker are being regulated. This has been done by utilizing the theory of Supply chain risk management maturity levels and providing an overview of what certain levels entail.

The initially formulated indicators were not all equally realistic to implement due to budgetary constraints, confidentiality agreements, governmental regulations etc. Thus, an additional session was conducted, with the experts and the customs broker DHL, to come to a realizable set of indicators. As the risks are equally adequately managed, this is not included as a limitation.

# 7 ANALYSIS OF OPERATIONAL DATA

The section utilizes the operational brokerage data from the high-tech firm in order to perform a data analysis and make inferences with the attained results. The highlighted area in figure 15 illustrates that this encompasses the third and fourth steps in the process improvement chain model that was introduced in chapter 3. It is important to conduct an in-depth analysis in order to identify the root-causes of certain issues.

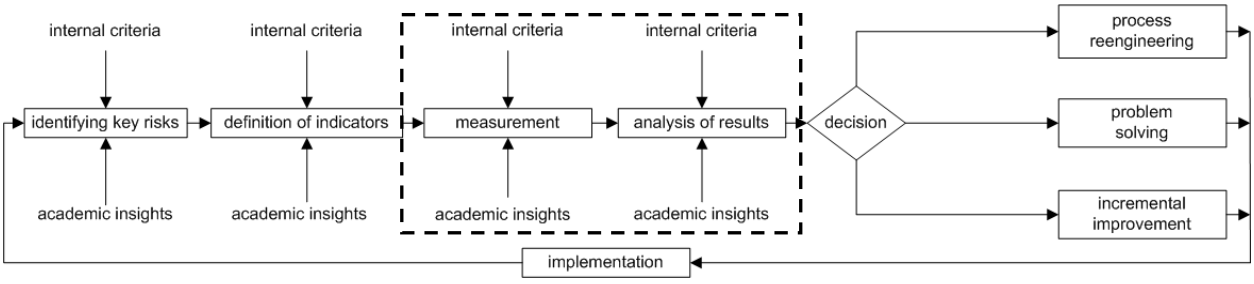



**FIGURE 15 ANALYSIS OF OPERATIONAL DATA (RESEARCH METHODOLOGY)**

When data discrepancies occur, it can be difficult to directly discern the cause and solutions, for this data analysis is required. This section focusses on delving deeper into the data consistency, while utilizing the operational data that is readily available. To facilitate and automate this process an Operational Data Analysis Tool (ODAT) is created using Excel VBA with which data analysis can be automated. The code is located in appendix 1 and will be referenced where necessary as the process is described in section 7.2.

The first step is to determine if there is a problem at all. If the descriptive analysis shows a problem, it is interesting to see what kind of data is most prominently being altered. Consequently, it is useful to discern if there is an identifiable overarching issue that can be proven (SCRLC, 2011). This second part will be done via analytical analysis by utilizing Venn diagrams and Bayesian networks.


**FIGURE 16 DEFINITION & EXAMPLE FOR U.S. HTS CODES (PAGELL, 2013)**

## 7.1 HTS Classification Explanation

Products in the databases are identified using the World Customs Organization's internationally agreed "Harmonized Tariff System" (HTS). Under the system, the broadest categories of products are identified by two-digit "chapters" (e.g. 04 is dairy products, eggs and other edible animal products). These are then sub-divided by adding more digits: the higher the number of digits, the more detailed the categories. For example the four-digit code or "heading" 0403 is a group of products derived from milk. At six digits, 0403.10 is the "sub-heading" for yoghurt; at the eight-digit level, 0403.10.11 could be low-fat yoghurt "tariff line".

The codes are standard up to six digits, the most detailed level that can be compared worldwide. Beyond that, countries are free to use their own definitions according to their individual requirements.

The data analysis is performed while developing a tool in Microsoft Excel using VBA, in which a comparison is made between the high-tech firm SAP data with data provided by the customs broker Il-Shin in South Korea. The aim is to highlight the discrepancies regarding the HTS-codes, the country of origin (CoO) and the value. The summary of the technical details regarding the data analysis are provided in table 3.

| | |
|---|---|
| Involved Parties | The high-tech firm in NL <> Brokerage Firm in Korea |
| Sample Size | 6411 |
| Period | Oct 2015 – March 2016 |

**TABLE 3 DATA ANALYSIS SUMMARY**

## 7.2 The Operational Data Analysis Tool (ODAT)

The first step in designing a tool is defining the structure. Figure 17 illustrates the sheet structure that forms the basis for the model: Send, Receive, SAP and Summary sheets. The accompanying code can be found in appendix 1.


**FIGURE 17 SHEET STRUCTURE**

The send-sheet contains data of the outgoing country, the receive-sheet contains data of the incoming country, the SAP-sheet contains the classification data for the Netherlands and the summary-sheet shows the summarized result of the analysis.

While the Send, Receive and Summary sheets might seem intuitively logical, the SAP sheet might not. The SAP sheet contains data like the HTS code, the CoO and the Value. These data have to be separately extracted from SAP that is the reason why there is a separate sheet to match the data in the SAP sheet with the one in the Send sheet.

In order to perform the analysis (after the sheets are correctly populated), the following steps must be undertaken:

1. Press the “Insert Unique Identifier” button in the receive sheet.
    a. Press the reset button to revert to the begin state
2. Press the “Perform Analysis” button in the send sheet.
    a. Press the reset button to revert to the begin state
3. Press the “Create Table & Charts” button in the summary sheet.
    a. Press the reset button to revert to the begin state

It should be noted that before new data can be input, all three sheets must be reset else the tool will provide an incorrect analysis.

Below, a short explanation will follow regarding the separate sheets and additionally a short explanation regarding the data representation.

### 7.2.1 The Send sheet

As mentioned earlier this sheet contains the data from the outgoing flow. Taking the broker in South Korea as an example, the outgoing flow is from the Netherlands.

The unique identifier facilitates the data matching, through which the Value, the CoO and the HTS-codes can be verified as follows:

- Value: The net value is the total value of all pieces of a certain product in a single shipment that is why it must be divided by the number of products to attain the piece value. The piece value is matched with the piece value from the Korea sheet and a True/False check is done.

- CoO: The same steps are followed as with the Value check, besides the fact that CoO has no quantity.
- HTS-code: For the HTS codes only the first 6 digits are matched as they should be uniform worldwide (World Trade Organization, 2005).

### 7.2.2 The Receive sheet

This sheet contains the data from the party that receives the goods. It has all the columns of the Send sheet, with additionally the SAP data columns included as the customs broker provides this information in a single sheet.

### 7.2.3 The SAP sheet

As mentioned in the introduction of this chapter, this sheet contains data that has to be separately extracted from the SAP system. As SAP does not order this data it is necessary to match the HTS-code, CoO and Value by using the Material number (12NC) as the key value.

### 7.2.4 The Summary sheet

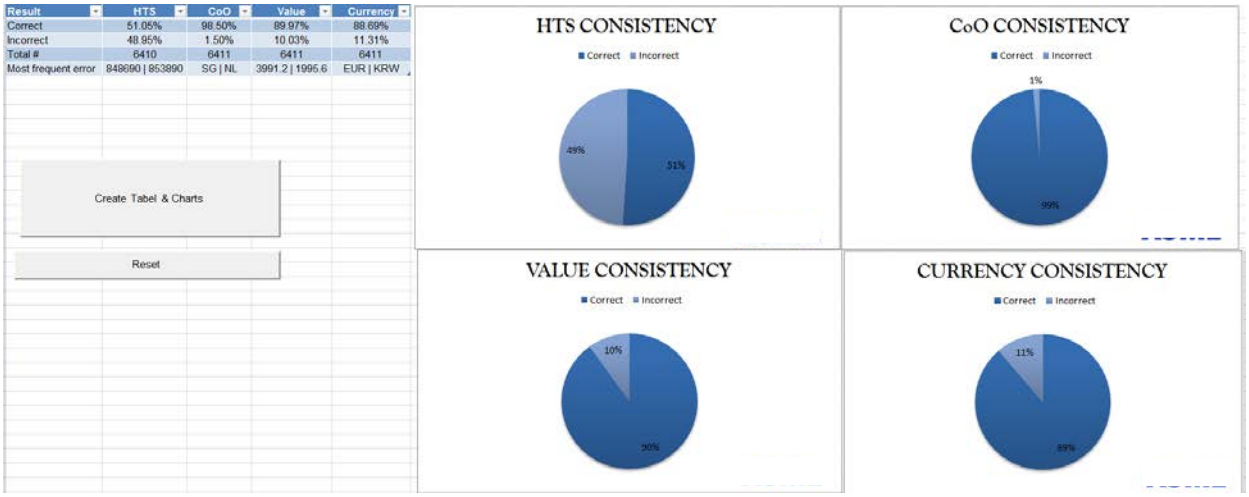



**FIGURE 18 SUMMARY SHEET ODAT-TOOL**

The setup of the Summary sheet can be seen in Figure 18. The templates for the charts are linked to the table. When pressing the button “Create Tabel and Charts” the table is generated and the graphs are created. The input data comes from the matches made in the Send sheet.

Consistency check: When the data between the two sheets is matched, there is a column created with TRUE and FALSE designations. This is used to make the consistency check for the HTS-codes, the CoO and the Value. Additionally, in the last row of the table the most frequent occurring discrepancies are shown in order to facilitate a root-cause analysis.

The above format is uniformly aligned with the high-tech firm, meaning that data from all regions worldwide can be delivered in this format. This will enable the high-tech firm to gain insight into the operations of the customs broker at any time and with minimal effort. Furthermore, this tool can provide assistance during quarterly reviews and during new contract negotiations. The provided functionality can

even be used to compare brokers and thus greatly assist in identifying the right broker for the performance demanded.

## 7.3 Descriptive Analysis

The following analysis is done by utilizing the ODAT-tool. At the moment of analysis the high-tech firm only has structured data from the customs broker in South Korea. So, this data will be used for the analysis in this section. The table and charts below are taken from the summary sheet of the ODAT-tool and will be used as basis to conduct a root-cause analysis which is the goal of this section.

| Result | HTS | CoO | Value | Currency |
|---|---|---|---|---|
| Correct | 51.05% | 98.50% | 89.97% | 88.69% |
| Incorrect | 48.95% | 1.50% | 10.03% | 11.31% |
| Total # | 6411 | 6411 | 6411 | 6411 |
| Most frequent error | 848690 \| 853890 | SG \| NL | 3991.2 \| 1995.6 | EUR \| KRW |

**TABLE 3 SOUTH KOREA DATA SUMMARY ODAT-TOOL**

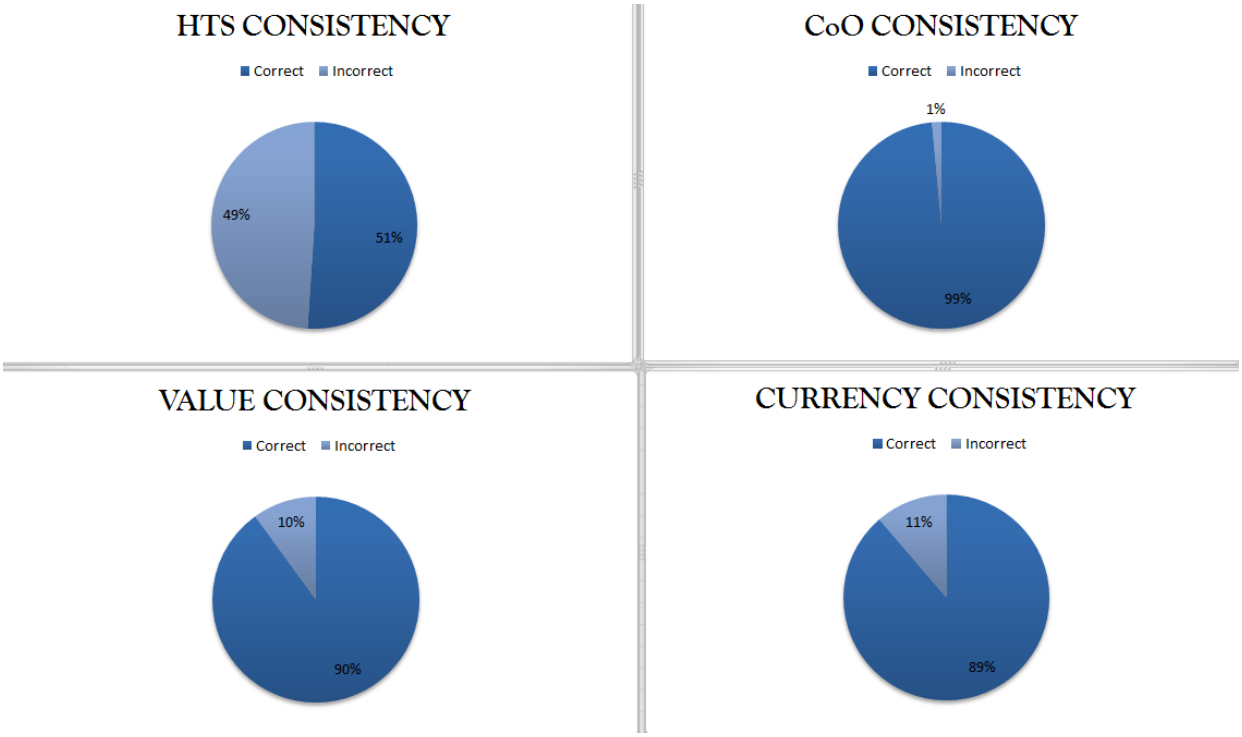



**FIGURE 19 SOUTH KOREA DATA SUMMARY ODAT-TOOL**

Table 4 and figure 19 show that the CoO's are copied correctly 98.50% of the times, that the Value is copied correctly 90% of the time and currency is consistent 89% of the time. As the high-tech firm's norm for these areas is at 90% correctness, these will not be the focus of the data analysis.

An important conclusion that can be drawn from the "HTS Consistency" pie chart above is that just 51% of the codes are completely correct, which means that there is a sufficient basis to perform further

research. The aim of this further research is to try and determine the causes as to why the codes are being altered.

The following section aims to outline an approach to further analyze the data and to deduce the cause of the identified discrepancies.

## 7.4 Analyzing Discrepancies

As discrepancies are being made, it is initially interesting to know which discrepancy is made most often. In order to do this, the changes in the HTS codes are computed and filtered by "most common". The total result and the accompanying major category are shown below.

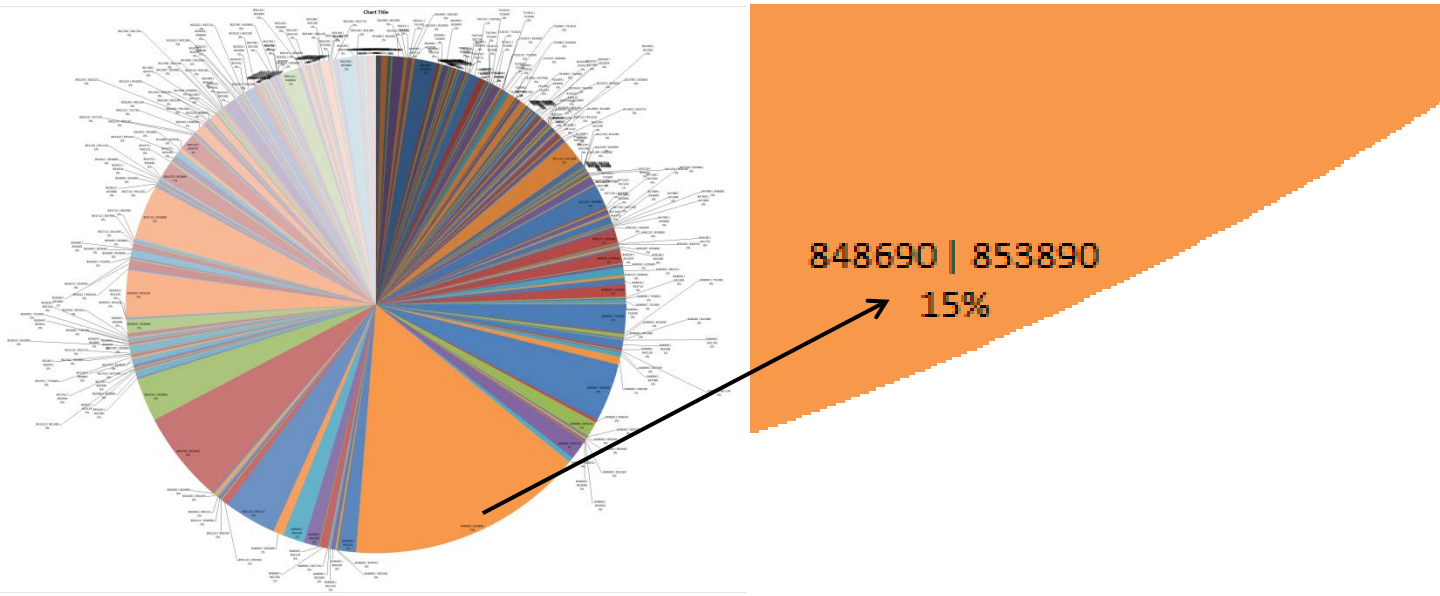



**FIGURE 21 HTS DISCREPANCY ANALYSIS**

Figure 21 illustrates the fact that alteration of code 848690 (from the Netherlands) into code 853890 (in South Korea) accounts for 15% of the total number of alterations.

Before conducting further analysis, it is useful to understand the meaning of the two codes.

- 848690 (0% duty)
    - Machines and apparatus of a kind used solely or principally for the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays; machines and apparatus specified in Note 9 (C) to this chapter; parts and accessories.
- 853890 (8% duty)
    - Parts suitable for use solely or principally with the apparatus of heading 8535, 8536 or 8537
        - 8535: Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, fuses,

lightning arresters, voltage limiters, surge suppressors, plugs and other connectors, junction boxes), for a voltage exceeding 1,000 V.

- 8536: Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, relays, fuses, surge suppressors, plugs, sockets, lamp-holders and other connectors, junction boxes), for a voltage not exceeding 1,000 V; connectors for optical fibers, optical fiber bundles or cables.
- 8537: Boards, panels, consoles, desks, cabinets and other bases, equipped with two or more apparatus of heading 8535 or 8536, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of chapter 90, and numerical control apparatus, other than switching apparatus of heading 8517.

The following deduction can be made from the above listed information:

- The 8486 (0% duty) classification is solely for components that are used for the manufacturing of wafers, while 8538 (8% duty) specifies a range of 'general' electronic components which do not need to be specifically used for the manufacturing of wafers.

After having defined the meaning of the original code and the altered code, it is important to understand what kind of components are most prominently classified under the 848690 code. This will assist in determining the reasons of the alteration.

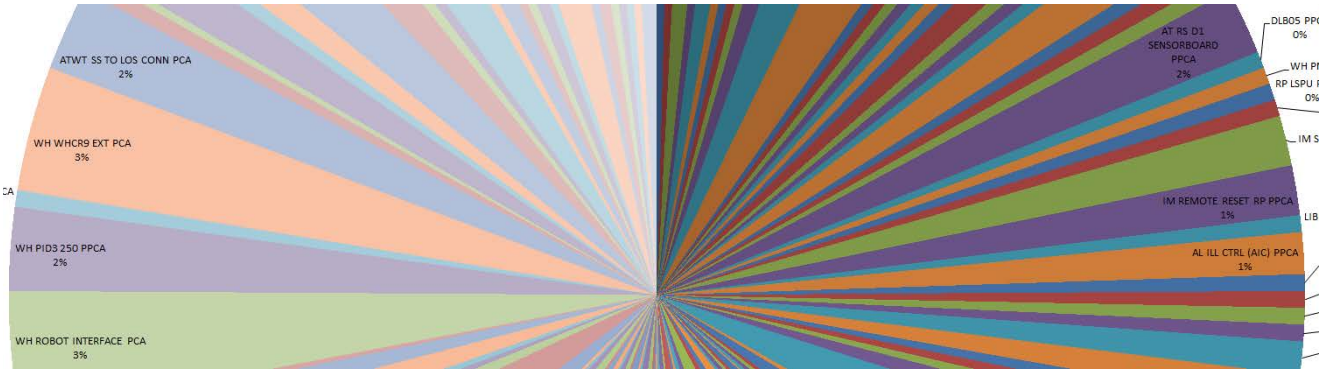



**FIGURE 22 THE PRODUCTS CORRESPONDING TO THE DISCREPANCIES**

The figure above is created by filtering the products that are most often classified with the 848690 HTS code. It shows that the term "PCA", which means "Printed Circuit Assembly", is most prominent. The relevant design specifications show that these are printed circuit boards that after specifically built for the manufacturing of high-tech machines.

While figure 22 shows that items described as PCA are predominantly being altered this does not mean that these are the only cause. The classification expert at the high-tech firm has seen from experience that items designated by "ASSY" which are mostly semi-finished products are also frequently altered. For

this reason, this section will analyze products containing these words in their descriptions. Figure 23 shows how often the items that have “PCA” or “ASSY” in their description are changed.

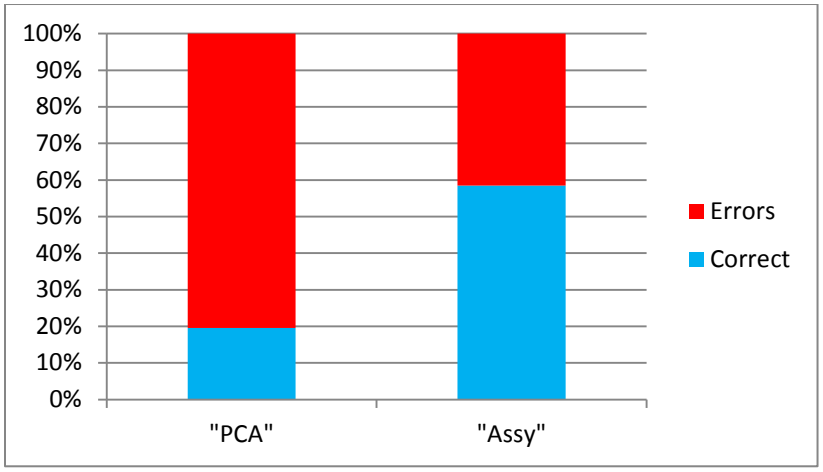



**FIGURE 23 ERRORS PER DESCRIPTION**

After having determined the above listed facts, the following reasons are hypothesized as potential causes of the alterations:

Disagreement between the high-tech firm and the broker regarding the classification of certain products.

1. The broker/customs change the classification to receive additional duty payments.

However, there are a few counter arguments that disqualify one reason more than the other:

1. The broker does not have classification experts so is not able to make this judgment, the same applies for customs as only technical engineers working in the high-tech industry have knowledge about such components.
2. One of the goals of customs in certain countries is to “raise substantial revenue” (De Wulf et al, 2015) which would imply that there is a substantial incentive for customs to instruct the broker to alter the code.

## 7.5 Analytical Analysis

The previous section has provided evidence that the 848690 code is most often being changed in the 853890 code. While this information coupled with the insights regarding the product types are interesting, they fail to provide an overall overview regarding the complexity of the problem. Building upon this, the focus of this section will be on connecting discrepancies on a high level to the specific discrepancies that were analyzed in the previous section.

This analysis is done by utilizing pivot tables in Excel and the visualization will be done by using Venn diagrams and Bayesian logic. These diagrams efficiently illustrate the relationships of specific results to the overall picture, thus making them ideal tools for the analysis that this section is focusing on.

First the various variables will be defined. Secondly the theory regarding Venn diagrams and Bayes' theorem will be combined to provide a clear visual overview of the situation with the accompanying probabilities (Venn, 1880). Lastly all the previous elements will be combined to form a Bayesian network in order to make useful inferences.

The following variables will be considered:

$P(A) =$ Probability that HTS code is altered

$P(B) =$ Probability that category is 8486

$P(C) =$ Probability that description contains "PCA"

$P(D) =$ Probability that description contains "ASSY"

### 7.5.1 Overall Discrepancies

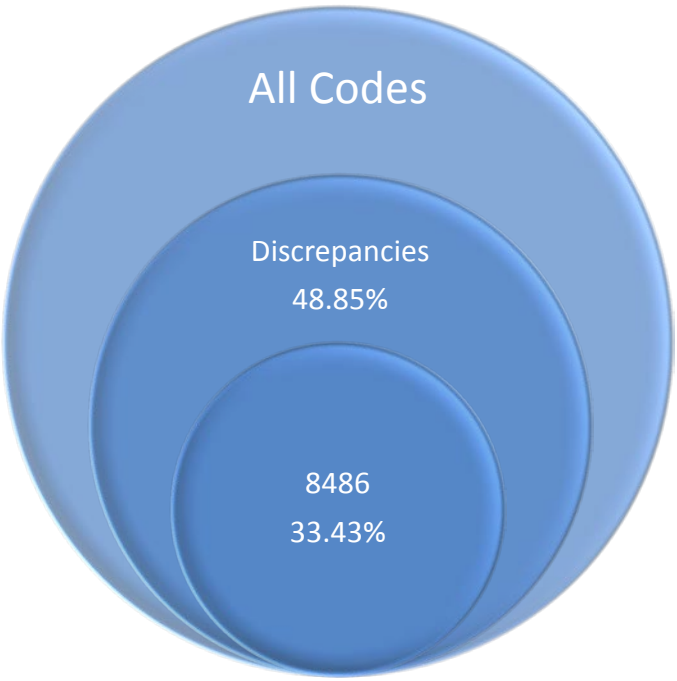



**FIGURE 24 OVERALL DISCREPANCIES**

$$P(A) = 0.4885$$
$$P(B|A) = 0.3343$$

The Venn diagram above (figure 24) illustrates that in total 48.85% of the codes are being altered (P(A)). From this total the codes starting with 8486, which are products solely used for the production of high-tech machines, encompass 33.43% ($P(B|A)$). In other words, P(B) is a subset P(A). This provides evidence that in Korea the 8486 codes form the source of the HTS code discrepancies. This provides further incentive to analyze a few levels deeper.

In section 7.4 it became clear that products carrying the description of "PCA" were most often receiving a different classification. This gave an indication that the description could provide a basis for the customs broker to make the alteration, as the product is packaged and the only relevant information the broker has is from the product description.

**Conjecture 1: A product in the HTS code category 8486 increases the relative likelihood of alteration compared to P(A)**

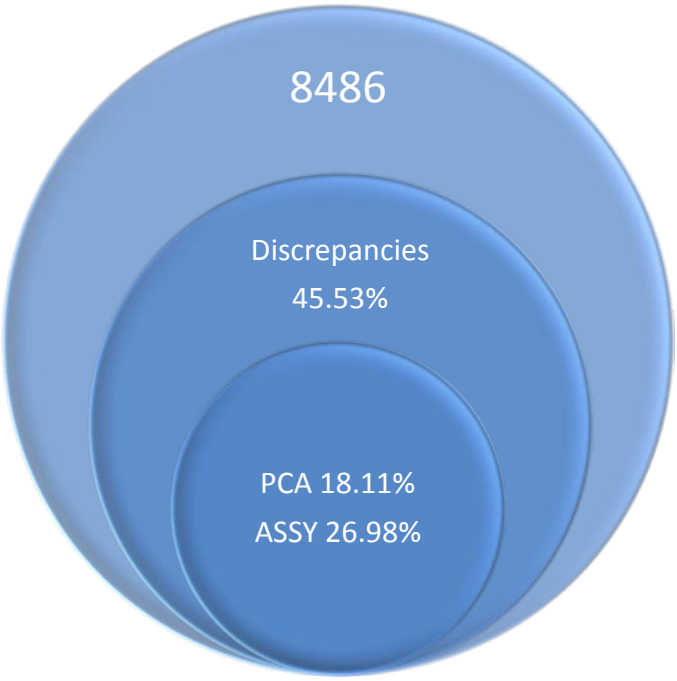



**FIGURE 25 VENN DIAGRAM DISCREPANCIES PER CATEGORY**

$$P(A|B) = 0.4553$$
$$P(C|A,B) = 0.1811$$
$$P(D|A,B) = 0.2698$$

Figure 25 shows that from the total discrepancies the products contained "PCA" or "ASSY" in their descriptions are the ones that are most often altered. "PCA" stands for Printed Circuit Assembly which consists primarily of circuit boards and "ASSY" stands for Assembly which in turn are semi-finished products.

The diagram shows that in the category of HTS codes starting with 8486 the amount of discrepancies are 45.53% (P(A|B)). Within the aforementioned discrepancies, 18.11% of the items contains "PCA" in their description (P(C|A,B)) and 26.98% contains "ASSY" in their description (P(D|A,B)). The aforementioned categories are the largest within the discrepancies, which confirms that certain descriptions lead to an increase of the amount of discrepancies. The next step is to understand how many alterations are being made per category.

**Conjecture 2: A product carrying the description "ASSY" or "PCA" increases the relative likelihood of alteration**

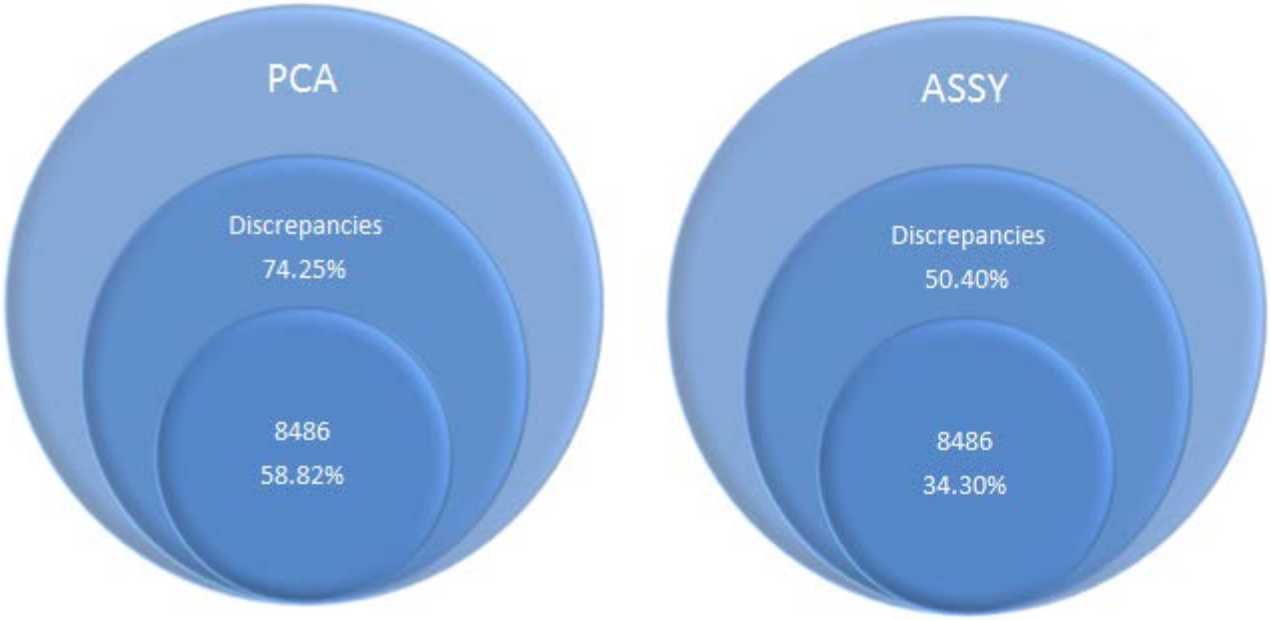



**FIGURE 26 DISCREPANCIES PER CATEGORY**

$$P(A|C) = 0.7425$$

$$P(B|A,C) = 0.5882$$

$$P(A|D) = 0.5040$$

$$P(B|A,D) = 0.5040$$

The above Venn diagrams (figure 26) illustrate that 74.25% of all products carrying the description "PCA" are being altered, while this is 50.40% for products carrying the description "ASSY". It also shows that 58.82% of the "PCA" alterations are made within the 8486 code and for "ASSY" this is 34.30%. This further solidifies the claim that the 8486 category is the most prominent regarding alterations. And connectedly, shows that the description has a direct effect on the amount of discrepancies made as both P(A|C) and P(A|D) are larger than P(A).

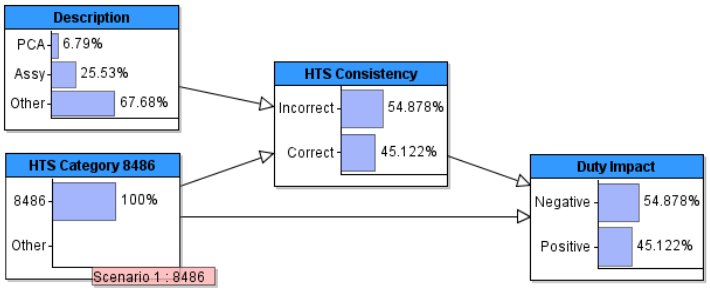
This analysis proves that the description of the product is a leading indicator in predicting if the HTS code will be altered by the customs broker in South Korea. The reason behind could be the ambiguity that exists in the classification of such products due to which an alteration cannot easily be contested by the high-tech firm.

**Conjecture 3: A product in the HTS code category 8486 and carrying the description "ASSY" or "PCA" increases the relative likelihood of alteration**

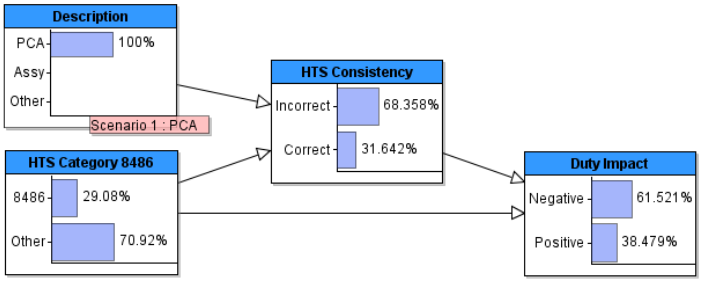
### 7.5.2 Bayesian Analysis

The previous chapters have provided insights into the various scenarios that can occur; products carrying a certain description and/or products classified in a certain category. This part aims to combine these insights into several Bayesian networks in order to check if the conjectures made in the previous section are indeed reliable.

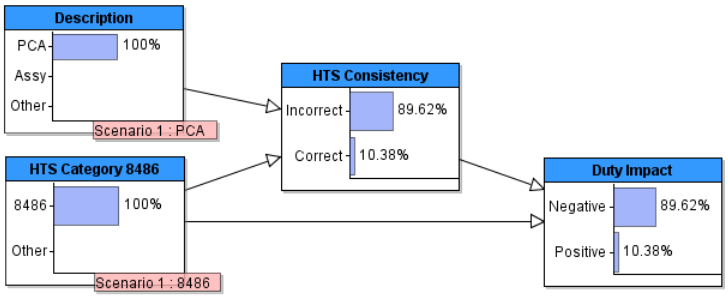
1




2




3

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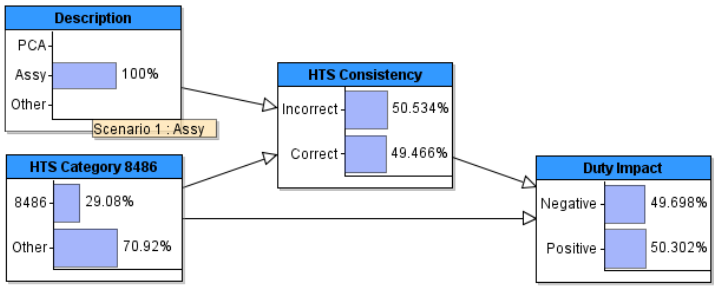


5

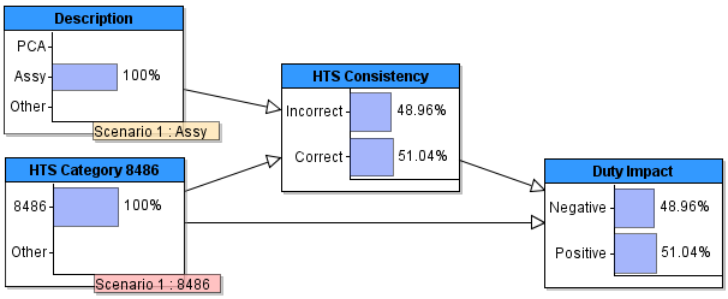


**FIGURE 27 BAYESIAN SCENARIO ANALYSIS**

The first Bayesian network in figure 27 provides proof for the first conjecture. In section 7.4 it was shown that 49% of all the codes were being altered. The first Bayesian network shows that this percentage increases from 49% to almost 55% which confirms the first conjecture.

The second conjecture stated that if the description of an item contained the words “ASSY” or “PCA” it would have an increased probability of being altered. This is tested by networks 2 and 4. These illustrate that for PCA the probability of alteration increases from 49% to 68% and for ASSY from 49% to almost 51%. Even though this increase is only slightly for ASSY items it still confirms the conjecture.

The last conjecture stated that the combination of the HTS category being 8486 and the items having “ASSY” or “PCA” in their description would have an increased probability of alteration. Networks 3 and 5 test this conjecture. From these networks, it can be concluded that this conjecture holds for products containing “PCA” in their description as their likelihood increases from 49% to almost 90%, while for ASSY items the percentage stays almost constant (rounded at 49%).

The Bayesian networks in figure 27 confirm the insights from the descriptive analysis done in previous sections; that 8486 is the HTS category that should demand the most focus and that non-specific descriptions are most likely forming the basis for the alterations done by the customs broker.

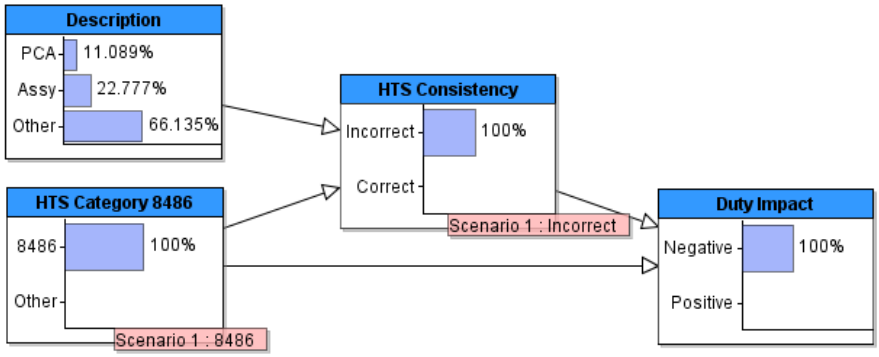


**FIGURE 28 DUTY IMPACT HTS ALTERATIONS**

Additional to the above analysis it is also worthwhile to attempt to quantify the (negative) impacts in financial terms. All the changes in 8486 code result in an increase in the duty percentage paid by the high-tech firm as the Bayesian network in figure 28 illustrates. This amounts to €1.41 million euro for the period analyzed.

This is a considerable amount, even though it cannot be guaranteed that all the alterations are incorrect as certain HTS classifications do involve a “grey area”, meaning that with a correct accompanying explanation multiple classifications could be deemed as ‘correct’. But with the documentation available and the expert insight of the high-tech firm’s classification expert it can be stated with reasonable conviction that a large part of this amount would not have been paid, had the customs broker and the customs authority agreed to the classifications made by the high-tech firm’s experts.

## 7.6 Classification of Errors

The preceding sections identified the amount of discrepancies that are being made, the relevant customs documentation and the possible reasons behind the discrepancies. This section aims to categorize the discrepancies into one of the three categories identified in chapter 2 and add categories if necessary. Due to the fact that it is not possible to verify these claims with the customs broker, the analysis will be done by utilizing the insights gained by conducting interviews with customs- and classification experts.

The three pre-defined categories were (Doolen, 2006):

1. Manual Error (typo)
2. Difference in opinion (broker disagreement)
3. Upon request from customs (force of law)

### 7.6.1 Manual Error

These types of errors can be made due to a lot of reasons, such as tiredness, temporary loss of concentration, etcetera. The important thing to mention is that these discrepancies are not on purpose, so logically there should be no clear pattern in these errors.

For the above mentioned reason the smaller percentages are either products that are very infrequently transported or typo's. As a typo discrepancy, can be made at random, it is hard to pinpoint. Another possibility is to identify the other types of errors first and see the remaining portion as typos, this because there is no clear explanation for the remaining errors, so one cannot claim that those are made on purpose.

### 7.6.2 Difference in Opinion

This scenario implies that the customs broker has a different opinion regarding the classification of products sent by the high-tech firm. From interviewing the the high-tech firm classification expert it has become clear that the broker has a separate database in which the classifications, that it uses, are stored. It is unknown if this is done due to a request from customs or if it is a private initiative by the broker. Customs involvement is pretty logical given the fact that the duties are collected by them, so the broker has no apparent gain from altering the data.

An additional explanation is that due the fact that the customs broker has multiple customers, it is wise to keep customs satisfied. That is an understandable reason for why the change in classification by customs is not contested by the customs broker.

### 7.6.3 Upon request from customs

From the preceding sections, it has become clear that this is the most plausible explanation for the high percentage sections shown in Figure 20. This is further supported by the claim made by De Wulf et al, 2015 in which they claim that one of the goals of customs is still to "raise substantial revenue". While it is possible that customs mandates that these classifications be changed due to rules and regulations, the above statement makes it much more likely that this (also) done from an aspect of financial gain.

## 7.7 Limitations of the Analysis Approach

The approach that is described above can be standardized to analyze such type of data, structurally and consistently, over time. However, there are a few requirements that the input data needs to adhere to in order to be analyzable via this approach. These requirements are as follows:

1. Reference key: This is a means of finding a single instance of a product in a particular delivery. In the above example this is done by concatenating the delivery number with the product number. This is necessary for the country sending the products and the country receiving the products, as else no match can be made.
2. HTS-code, value and the CoO: To check the product classification it is essential that the HTS-code given when sending and the HTS-code assigned by the customs broker, are both present. The same applies for the value, with an added note regarding the right currency. If another currency is used, then there could be a reference problem due to the changing exchange rates. Lastly the CoO also needs to be present for both the party sending the products as well as the customs broker which declares the products at the destination country.

The above information is vital when attempting to perform a reference check of the brokerage data. While most Asian brokers have the tendency to maintain a separate administration which has all the above information digitally stored, the brokers in the US are less consistent. The above-mentioned data is stored across multiple documents in the US, making referencing a more time consuming activity. Additionally, a lot of data that is manually entered on a declaration is not digitally stored, this creates the need to separately check each declaration manually and in fact make a separate digitized administration in order to perform the above-mentioned checks.

Due to the aforementioned reasons, this checking is only done in Korea. However, there are plans to implement a uniform data storage approach in the US in the near future. This should facilitate the possibility of conducting referencing checks in the US as well. This is however uncertain and thus out of scope for this research project.

## 7.8 Conclusion

The aim of this section was to analyze the quantitative brokerage data that was readily available to ascertain where and why discrepancies were being made. Initially the setup approach was explained and by means of the developed ODAT-Tool the HTS-codes were identified as the main issue, as just 51% was rightly being declared to customs.

Consequently, the HTS-code that was most frequently being altered was analyzed. This process showed that products containing the classification of “PCA” in their description were most often being altered while the universal customs rules indicate that the alteration was unnecessary.

Afterwards, categories were found in which the most alterations occurred and it was inferred that due to the ambiguity of the rules, these items could be changed and additional duties could be received by the customs authority.

Lastly, the necessary requirements to implement such an analysis approach worldwide were formulated and it was shown that due to the current absence of structured data storage in the US this exercise could not be repeated for the data from the customs brokers located there.

The following section attempts to use these and previous insights, to find ways of prioritizing the previously defined indicators. This is done in order to facilitate a structured measurement approach.

# 8 INDICATOR PRIORITIZATION AND IMPLEMENTATION

The section attempts to prioritize the indicators formulated in chapter 6 so that emphasis can be placed on the issues that carry the highest (potential) impact to the firm. The highlighted area in figure 29 illustrates that this encompasses the final steps in the process improvement chain model that was introduced in chapter 3. It is important to prioritize and setup an implementation plan as without actionable steps, a monitoring approach is meaningless.

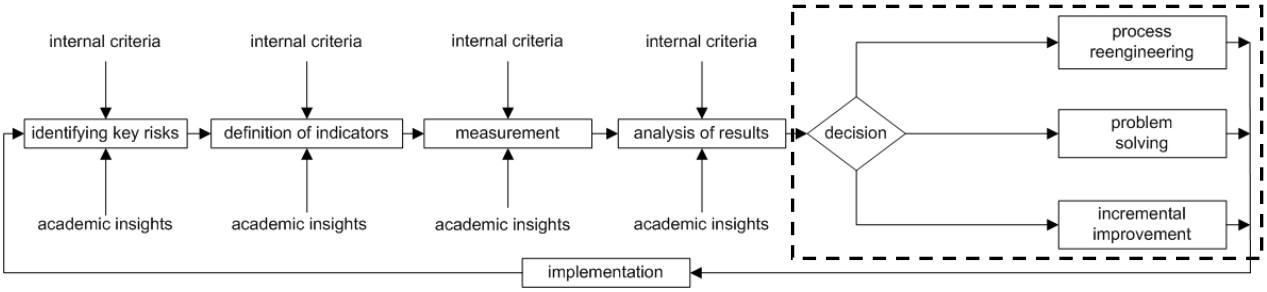


**FIGURE 29 INDICATOR PRIORITIZATION AND IMPLEMENTATION (RESEARCH METHODOLOGY)**

When looking at the potential consequences of the risks defined in chapter 2 it is important to understand the severity of the impact but also when the impact is occurring. While attempting to make a distinction in the time of impact, supply-chain experts are consulted and it is concluded that there are two scenarios regarding risk impact duration: live-impact and post-impact risks.

The aforementioned concepts are constructed by using inspiration from the Finance terms; diversifiable and undiversifiable risk (Besley & Brigham, 2013). Diversifiable risk is risk that is not 'fixed' and thus can be reduced with an efficient portfolio of stocks. Whereas undiversifiable risk (or systematic risk) is dictated by the market, thus cannot be reduced.

The consequences (the impact) of live impact risks is short term thus they can be compared to systematic risk which cannot be reduced and is dependent on external factors (the customs broker). On the other hand, the post impact risks occur later and thus the high-tech firm has enough time to formulate countermeasures, this can be compared to diversifiable risk that can be influenced directly. There is of course not a direct similarity as live impact risks are not fixed and post impact risks are not avoidable with certainty. However, this comparison does give insight into the nature of the risks and the way in which to approach them (Doolen, 2006).

## 8.1 Live Impact Risks

Live impact risks are categorized by having a direct impact on the high-tech firm. The operational risks that are tied with filling out an incorrect declaration are such kind of risks. Also, the service inquiries that are not handled efficiently can cause delays. This has the following consequences:

- Customs stoppage of good → extra troubleshooting cost
- Time delay for customer → compensation for time delay
- Loss of image towards customs → additional checks

The danger of such risks is that the goods flow is immediately interrupted and the resulting costs have to be paid immediately (or very shortly).

## 8.2 Post Impact Risks

Post impact risks have a delayed impact on the high-tech firm. These are often periodic activities which need to be verified afterwards and thus, the resulting decision can carry consequences along with it. Risks such as record keeping, service adequacy and billing are examples of post impact risks. The impact of such risks does not directly disrupt the goods flow but can still carry major ramifications:

- Incomplete record keeping → Sanctions/fines due to unverifiable information
- Unsolved inquiries → Sanctions/fines due to missing information
- Incorrect amount billed → Unnecessary high labor cost

Even though such risks don't impact the goods flow directly, a post clearance audit conducted by customs could result in high cost for the high-tech firm afterwards. There is however, more time to control these risks than the live impact risks.

## 8.3 Indicator Prioritization

From the above gathered information, it becomes clear that risks that impact the goods flow directly should be prioritized above others. This complies with what is mentioned in section 1.1.1 regarding the cost of downtime being €72.000,- per hour. This amount of cost is not (directly) incurred when a post impact risk is not managed.

Thus, the indicators with the following representation targets will be prioritized:

- Brokerage Quality
    - The checks performed by customs can cause a shipment to be severely delayed, while the number of declarations processed per hour provides an indication regarding the broker efficiency.
- Data Consistency
    - If the declaration that is submitted is incorrect, it will not get accepted, thus delaying the entire shipment.

The above formulated indicators have a direct connection with the live impact risks mentioned in section 5.1 and can affect the high-tech firm immediately. This is not to undervalue the post impact risks as they can have a substantial monetary effect on the high-tech firm (Deepen, 2007).

While incurring consequences from discrepancies is not ideal for the high-tech firm, it is still clear that a compliance risk propagates a financial risk. So, while ideally having no risks, the high-tech firm's prime focus is to reduce risk consequences for its customers. For example: having to pay a sanction due a filing discrepancy or an inquiry question that is inadequately answered is comparatively low when compared with the €72.000,- per hour loss (potential loss of customer), bad image with customs (eliciting tighter and more rigorous checking) and/or losing licenses to operate due to consistently inaccurate reporting (De Wulf & Sokol, 2005).

## 8.4 Implementation Considerations

As formulated in the research boundary section, the implementation part is out of the scope for this thesis. However, this research has provided several insights that could prove useful for a successful implementation. First the insights from the risk analysis and the measurement model will be presented. Consequently, the insights from the in-depth data analysis will be discussed. Taking both facets together the high-tech firm will be able to determine a suitable implementation strategy.

Risk analysis

The risk analysis yielded a set of risks that could potentially result in the following consequences for the high-tech firm:

Additional costs, additional delays and negative image for the broker, and for the high-tech firm.

Indicator formulation

In order to mitigate the above-mentioned consequences, preventive and reactive indicators were formulated:

- Preventive: Internal controls maturity report checking
- Reactive: General, Operational, Service and Administrative indicators

Data analysis

The in-depth data analysis of the declaration data yielded the insight that categories were found in which the most alterations occurred and it was inferred that due to the ambiguity of the rules, these items could be changed and additional duties could be received by the customs authority.

### 8.4.1 Actionable points

Looking at the summary above, it becomes clear that the next step is implementation. Without testing the formulated solutions in a real-life situation, it is hard to determine the usefulness (Brooks et al, 2003). When problems occur post implementation, the high-tech firm can reassess if an occurring issue is related to an existing risk or to a yet unidentified risk.

If the problem is related to an existing risk, then it is possible that an existing indicator is measuring something other than what is needed to manage the respective risk or that the risk requires an additional indicator to be fully controlled.

On the other side if the problem is related to a non-existing risk then the risk overview needs to be updated and the relevant indicator(s) for the added risk have to be redefined.

Looking at the insights gained from the data analysis, it is important to understand the cultural and business implications of having a customs broker. From the analysis, it has become clear that customs disagree with certain classifications and that the customs broker is unwilling to contest these claims. The drive for customs is primarily the revenue from duty payments, while the customs broker does not want to disagree with customs, fearing that this could destabilize their relationship. As the customs broker also has more clients (besides the high-tech firm), contesting customs' claims could warrant additional checking and further complications (De Wulf & Sokol, 2005).

It is difficult to change the customs vision on wanting to gain duty revenue. It is however possible to make clear contractual agreements with the customs broker regarding which classification (and why) is acceptable. Even though this might result in the high-tech firm having to change the classification of certain products just for Korea, but this filters out this "unavoidable" issue and makes it possible to focus on avoidable problems.

## 8.6 Conclusion

First of all, this chapter looked at making the distinction between live impact risks and post impact risks. As the live impact risks, could cause products to be stopped during the customs process it was decided to prioritize the related indicators. Additionally, as the post impact risks have a long-term impact which can potentially endanger the continuity of the high-tech firm (losing operational licenses), they need to be addressed as well.

Secondly, the insights from the previous chapters have been summarized and are used to understand which points warrant consideration during implementation. It has been determined that post implementation, the high-tech firm can use future issues to keep updating the basic model proposed in this thesis.

Lastly, the data analysis insights are used to understand that the HTS alteration issue can be addressed by making clear contractual agreements, even if these agreements entail agreeing to an unjustified classification, as this allows the high-tech firm to focus on problems that are solvable.

# 9 CONCLUSION

This chapter concludes this master's thesis. First, a summary is provided. Then, the main conclusions follow, including the answers to the research questions. Additionally, the limitations of the thesis are stated in combination with directions for future research.

## 9.1 SUMMARY

The main issue facing the analyzed high-tech firm was the lack of insight into the process of the customs broker. This introduced certain risks that firstly needed to be identified and subsequently managed. Relatedly there was operational data available with which the high-tech firm wanted to perform a root cause analysis regarding the occurring discrepancies.

Firstly, a risk analysis was done to identify the key risks facing the high-tech firm in the context of customs brokerage. The risk assessment was done via an iterative process of consulting customs experts and consolidating the findings from these interview sessions. Subsequently, measurement indicators were formulated to mitigate the aforementioned risks. As means of validation the indicators were then discussed with the customs experts to achieve agreement and alignment.

Then, a descriptive analysis was performed with the available operational data by constructing and utilizing an analysis tool in Excel VBA. Subsequently, via the means of pivot tables, data was obtained to perform an analytical analysis using Venn diagrams and Bayesian networks.

The results from the analysis showed that items classified as being "solely usable for the manufacturing of high-tech machines" were most often being altered. Additionally, the description added to the items showed that keywords such as "PCA" and "ASSY" were giving a false indication regarding how specific the utilization of these components was. The advice given was to re-evaluate the classifications and additionally make clear agreements with the customs brokers regarding these types of products.

Lastly an implementation plan was made for the various indicators by making a distinction in "time of impact". The indicators that could cause direct impact were advised to be prioritized, while indicators whose impact was long term were given lower priority. With the crucial side note of not forgetting the latter as the long-term effects could ultimately outweigh the short-term ones.

## 9.2 Research Questions and Recommendations

The first research question is formulated below:

1. **What are the key compliance risks in the customs brokerage process?**

| **Risk Areas** | General Compliance | | | Operational Compliance | Service Compliance | Administrative Compliance |
|---|---|---|---|---|---|---|
| **Risks** | Internal processes | Billing | Relations with customs authority | Declaration data entered by broker | Inquiry handling (the high-tech firm<>Customs) | Record retention of import/export declaration |

**TABLE 5 RISK AREAS AND RELEVANT RISKS**

Table ~~4~~ 5 summarizes the risks that were the output of the risk assessment. The risk areas and the corresponding risks were identified in collaboration with customs experts and the findings from these interviews were consolidated into the table above.

An important thing to note is that the above risks cannot be considered as 'final'. Risk assessment is a continuous process, so it must be repeated after changes in the designated environment. For example; if the customs broker is changed, the customs authority enforces new regulations and/or the high-tech firm's requirements for customs brokerage change. The aforementioned reasons warrant a reassessment of the key risks to ensure that the high-tech firm is compliant in its operation.

2. **Which indicators adequately capture the control discrepancy which follows from the identified risks?**

Table 1 & 2 summarize the identified indicators that help monitor the previously identified risks. These tables have been validated by conferring with the customs experts and consolidating the critiques received.

Relatedly to the point made regarding risk assessment being a continuous process, indicator definition has to follow the same procedure as it is the functional aspect of the monitoring approach. If the indicators are not anymore in line with the risks, the monitoring approach loses its effectivity and thus makes the high-tech firm prone to compliance deficiencies.

3. **How to classify the causal relationships discovered by analyzing the available operational brokerage data and what are the potential solutions?**

This initial analysis was done with the help of descriptive statistics. To facilitate this process for the high-tech firm in the future the Operational Data Analysis Tool (ODAT) was created. This tool assists in performing the analysis. Consequently, the analytical analysis is done by for example utilizing Bayesian networks or Venn diagrams

The results from the analysis showed that items classified as being “solely usable for the manufacturing of high-tech machines” were most often being altered. Additionally, the description added to the items, showed that keywords such as “PCA” and “ASSY” were giving a false indication regarding how specific the utilization of these components was. The advice given was to re-evaluate the classifications taking into account the above-mentioned critiques and additionally make clear agreements with the customs brokers regarding these types of products.

- **How to assess and mitigate compliance risks related to customs brokerage?**

Conclusively, the focus is on the main question identified at the beginning of this research paper which is formulated above. After conducting various analysis throughout this thesis, it is intuitively clear that the answer to this question cannot be a simple one. Yet, the message that this thesis wishes to convey is in fact quite straightforward.

Awareness is the key word in solving any and all issues. If a company is aware about problems, only then can they be solved. So, the answer to this question is that in order to mitigate compliance risks there first of all needs to be an awareness regarding the process, how it operates and what factors/stakeholders have influence on it. The next step is outlining the points where discrepancies can occur, this can most effectively be done by consulting individuals that are working at an operational level as well as individuals working at a managerial level. Ideally, the identified risks would be discussed with the customs broker to come to a final subset with which measurement indicators can be formulated in close collaboration between the two parties.

Additionally, data analysis can be a powerful tool with which companies can facilitate the identification of potential risks. But, this can only be done if structured and reliable data is available. The data analysis approach can in turn also function as a way of checking the productivity of the employed risk management measures, as is done in this thesis.

The high-tech firm should therefore continue using this approach, while also pro-actively thinking about ways to improve upon it. As companies continue to evolve, so do risks and so must also the risk management approaches.

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