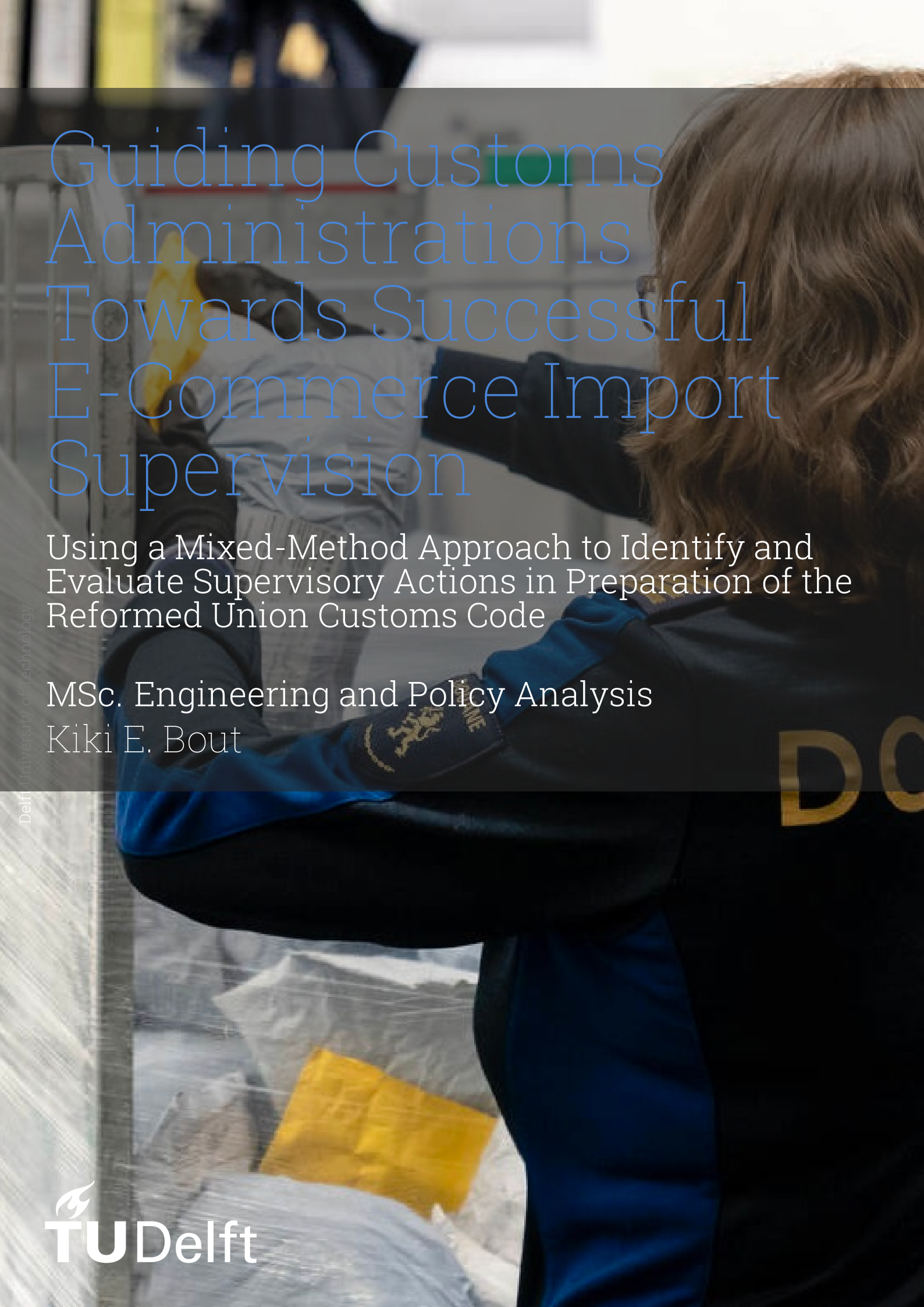




Guiding Customs Administrations Towards Successful E-Commerce Import Supervision

Using a Mixed-Method Approach to Identify and Evaluate Supervisory Actions in Preparation of the Reformed Union Customs Code

MSc. Engineering and Policy Analysis
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by

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Preface

The report you are about to read marks the completion my Master of Science program in Engineering and Policy Analysis at the Delft University of Technology.

During my search for a graduation internship, I focused on four elements: passion, mission, profession and vocation. These elements may remind you of the Japanese concept of "Ikigai", which translates to "reason to live". Being given the opportunity to research the supervision of e-commerce imports at the Customs Administration of the Netherlands, I realized that this opportunity fulfils all four elements I was seeking as I can contribute to solving a complex social problem using simulation and data analysis at an important governance body.

I would like to thank the Customs Administration of the Netherlands for giving me this opportunity. In particular, I would like to express my gratitude to my external supervisor Mariska Mirer (Customs Administration of the Netherlands), for the support and her tireless efforts to help me carry out my initial research plan to the fullest extent possible. I would also like to thank my first supervisor and chair Alexander Verbraeck (Delft University of Technology) for his support, for challenging me to look at things from a different angle and for guiding me through some surprising and challenging events. Furthermore, I would like to extend my gratitude to my second supervisor Nitesh Bharosa (Delft University of Technology) for his invaluable feedback on my drafts and keeping me sharp with his questions and enthusiasm. Lastly, I would like to thank my friends and family to support me when I could not see the way forward, for forcing me to take a coffee break in times when I was consumed by writing and never complaining about last-minute cancellations.

After loving my time as a student, I am ready to find a new "Ikigai" in the next phase of my life. Although the exact interpretation is still unclear, but I am determined and grateful to be able to utilise all the knowledge, experiences and network that I have gained from my studies and side activities in an exciting new challenge further down the road.

I hope you enjoy reading this thesis.

*Kiki E. Bout
Rotterdam, April 2024*

Summary

As a member of the European Customs Union, the Customs Administration of the Netherlands has the primary responsibility for ensuring the safety and security of the European population. The Netherlands has experienced a significant increase in cross-border e-commerce imports, which, combined with outdated European customs legislation, the Union Customs Code (UCC), has made it challenging to achieve successful supervision of e-commerce imports. However, in 2023, the European Commission proposed a reform of the UCC to address the supervisory challenges faced by the Customs Administrations of the Member States. This study aims to identify and investigate the effects of potential supervisory actions to be taken before or at the time when the reformed UCC comes into effect. These study findings represent the initial stage of investigating the potential use of adaptive strategies to enhance the success of e-commerce import supervision.

This study employs a mixed-method approach to identify and investigate actions for strengthening e-commerce import supervision. The term 'successful supervision' is first defined through interview and document analysis. These qualitative methods are then also used to analyze the uncertainties in the customs supervision system and to highlight the current supervisory challenges. Based on these findings, supervisory actions for e-commerce imports are identified. In addition, qualitative observation analysis, quantitative data analysis, and simulation modelling tools are used to determine the estimated effects of supervisory actions on the successful supervision of e-commerce imports in the current and potential future situations. Moreover, a feasibility study highlights key considerations to be taken into account for further analysis of the supervisory actions or strategies and their potential implementation.

The interviews and literature provide insight into the broad context of customs supervision. This study highlighted that successful supervision of e-commerce imports should ensure efficient, fair, and effective enforcement while fostering trust, integrity, and accountability within the customs operations. A wide range of key factors including trade-offs reflects the complexity of the customs landscape. Therefore, this study employed a prioritisation of key performance indicators (KPIs) to evaluate the e-commerce import supervision. The prioritisation outlines the effectiveness of the supervision, the presence of a supervision policy, logistical delay, especially for AGS declarations, the diversity of supervision approaches and the objective inspection chance of shipments declared as the most important KPIs to achieve their success values.

Furthermore, this study elaborates on six aspects of uncertainty. The most significant uncertainty for e-commerce supervision is the UCC reform, identified in the uncertainty aspect of European governance. This reform implies a significant change in import procedures, inspection processes and the roles and responsibilities of parties in the e-commerce supply chain. Therefore, the UCC reform proposal is translated into a future scenario for further investigation in this study. However, this study highlights that uncertainties related to the potential effects of the UCC reform are also connected to the trade market, e-commerce supply chain, and technology advancements.

The UCC reform could potentially address several challenges faced by customs officers. The proposal suggests that the renewed legislation will partly resolve issues related to supply chain, data collection, data assessment, and inspection performance. Nevertheless, the increase in the volume of e-commerce imports, which has been identified as one of the main challenges, remains unaffected. On the contrary, the UCC reform may aggravate some of the current challenges, such as the high inspection rate due to the improved selection mechanism combined with scarce inspection capacity. The simulation study's result confirms the possibility of this effect.

The simulation study in this research evaluates actions that could strengthen e-commerce import supervision. There are five supervisory actions investigated in two scenarios, namely the current situation (S0) and a future situation in which the reformed UCC has come into effect as interpreted from the proposal (S1). In the current situation, proposed supervisory actions show promising results, such as A1, the automation of customs processes and the stimulation of customs officers' curiosity, but require

careful capacity considerations and further research to improve their feasibility. The reformed UCC addresses existing issues, such as data quality and inspection effectiveness. However, it may worsen logistical challenges without addressing the root cause, which is the increase in import volumes. Automation of custom processes and stimulating curiosity among custom officers can still be effective. To ensure effectiveness, supervisory actions should align with evolving legislative frameworks and consider feasibility, legislative changes, technological advancements, and IT capacity.

Based on the study findings, five recommendations have been formalised to enhance e-commerce import supervision. These recommendations address core challenges and exploit opportunities for improvement while taking into account feasibility constraints and potential uncertainties. The five recommendations are as follows:

- *Confidential*
- Strategically approach automation of customs processes
The approach should aim to identify and automate high-impact processes that reduce the workload for DECO employees. It is important to consider the resource constraints presented by the limited IT capacity. By doing so, successful supervision can be achieved, and challenges in inspection performance can be addressed.
- Investigate methods to stimulate curiosity among custom officers.
An analysis of various approaches to promote curiosity among customs officers to potentially increase inspection effectiveness should be conducted. This action also has the potential to enhance job satisfaction, mitigating potential problems caused by a tight labour market.
- Ensure clear communication and transparency during the implementation phase
Clear communication and transparency widen the window of opportunity for the implementation of supervisory actions. Customs officers should be provided with concrete explanations of the methods, expected results and potential changes associated with each supervisor's action to increase the feasibility.
- Expand research to complete the Dynamic Adaptive Policy Pathways (DAPP) analysis
Further research is recommended to extend the study to include the remaining steps of the DAPP approach beyond the initial four steps completed in this study. This will provide a comprehensive framework that facilitates the development of robust adaptive supervision strategies in a system with expected increased legislative grounds in the future

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Abbreviations

Abbreviation	Definition
AB	Department 'Aangifte Behandeling'
AP	Adaption Pathways
B2B	Business-to-Business
B2C	Business-to-Consumer
CC	Centralised Clearance
CDS	Custom Declaration System
CESOP	Central Electronic System of Payment Information
CUP	Custom Union Performance
DAP	Dynamic Adaptive Planning
DAPP	Dynamic Adaptive Policy Pathways
DCI	Data Collection Indicator
DECO	Douane E-Commerce
DLTC	Douane Landelijk Tactisch Centrum
DMA	Digital Markets Act
DMDU	Decision-Making under Deep Uncertainty
DR	Douane Regeling
DSA	Digital Service Act
EC	European Commission
ECDH	European Customs Data Hub
ENS	Entry Summary Declaration
FT	Department 'Fysiek Toezicht'
GDP	Gross National Product
GPSR	General Product Safety Regulation
HARP	Hit and Run Postteam
IDEFO	Integration DEFinition for Function
IGJ	Inspection of Healthcare and Youth
IOSS	Import One Stop Shop
KPI	Key Performance Indicator
NVWA	Nationale Voedsel en Waren Autoriteit
ODD	Overleg Departement Douane
PEN-CP	Pan-European Network of Customs Practitioners
PPM	Performance Measurement Mechanism
SMP	Strategic Multi-annual Plan
SQ	Sub-question
UCC	Union Customs Code
UML	Unified Modelling Language
VAT	Value Added Tax
VIDA	Vat In the Digital Age
VLOP	Very Large Online Platform
WCO	World Customs Organisation

1

Introduction

The customs administrations of the Member States of the European Union (EU) are primarily responsible for ensuring the safety and security of the European population (Customs Administration of the Netherlands, 2022). The increase in EU imports by 16.5 % is attributed in part to the growth of e-commerce trade (Wise Persons Group, 2022). The rise of e-commerce has resulted in almost 500 million e-commerce declarations in the EU during the first half year of 2021, compared to 220 million traditional declarations (Wise Persons Group, 2022). Consequently, customs administrations face a challenge in supervising and ensuring safety and security. In a recent collaboration between the Customs Administration of the Netherlands, from now on the Dutch Customs Administration, and the Inspection of Healthcare and Youth, over 700 packages were intercepted in just one week at the international post centre of PostNL. This resulted in the seizure of 77,000 illegal medicines, highlighting the need for change (Ministry of Health, Welfare and Sport, 2023).

1.1. Research Problem

The Dutch Customs Administration is dedicated to protecting the EU for safety and security purposes. According to a 2021 report by the Dutch Customs Administration, the organisation handles 35 % of all declarations submitted in the EU, resulting in a declaration volume of around 335 e-commerce products in 2022 (Customs Administration of the Netherlands, 2021a). For 2023, the estimated declaration volume has doubled. The large declaration volumes led to various issues for the Dutch Customs Administration, such as an increase in employee workload due to the need to inspect more e-commerce declarations before releasing them into free circulation within the EU (Customs Strategy Team, 2021); and challenges in estimating the value and collecting the Value Added Tax (VAT) and customs duties due to limited data availability resulting from the involvement of multiple parties in the e-commerce trade (Customs Administration of the Netherlands, 2021b). The issues complicated the Dutch Customs Administration's ambition to facilitate legal trade optimally while adequately protecting society and collecting taxes within the framework of the legislation (Customs Strategy Team, 2021).

The European Commission (EC) acknowledges that the current European legislation, the Union Customs Code (UCC), requires renewal to enable customs administration to enforce e-commerce trade efficiently and effectively. Hence, on 17th May 2023, the EC published a proposal to restructure the UCC. This proposal is expected to enter into force in 2028 (European Commission, 2023a). For the Dutch Customs Administration to be able to comply with and benefit from the new guidelines resulting from the upcoming legislation, the Dutch Customs Administration need to start preparing. With the new legislation set to take effect in 2028, the customs administrations can investigate what changes can be expected and which supervisory actions may help strengthen the supervision process. As such, this research aims to help understand the potential impact of the new UCC on supervision activities and identify various supervisory actions for e-commerce imports innovatively.

1.2. Research Objective

This research addresses a significant issue within customs administrations, which requires a problem-based approach. The study investigates the implications of the new UCC and various supervisory actions implemented to prepare for its enforcement. Due to the uncertainties in the field, this study takes the first steps to design adaptive strategies. Adaptive strategies aim to enable alterations of the strategies according to more certain future scenarios. The Dutch Customs Administration formulated a strategic multi-annual plan (SMP) that outlines the primary objectives for the next five years (Customs Strategy Team, 2021). However, the organization-wide objectives are broadly defined. The 2020-2025 SMP lacks clear targets for successfully supervising e-commerce imports. Additionally, modern decision-making tools, such as simulation models, are not utilized. A relevant question is whether modern decision-making tools contribute to the current strategic development process. The literature lacks information on (multi-annual) customs administration strategies, as searching for relevant articles only leads to those about intelligent enforcement methods.

1.3. Research Questions

The research problem and research objective are translated into a main research question that will fill the identified knowledge gap. The research question is formalised as follows:

What is the expected impact of the proposed Union Customs Code on the realisation of successful supervision of e-commerce imports by the Dutch Customs Administration, given the challenges and uncertainties in the future?

Following the main research question, five sub-questions are formulated. The sub-questions (SQs) are formalised and explained below.

1. *What is successful e-commerce import supervision?*

This sub-question aims to define the concept of 'successful supervision' to understand the main objective of supervision by the Dutch Customs Administration. The concept is decompartmentalised in supervision aspects, which are used to formulate a definition. Additionally, key factors and corresponding key performance indicators (KPIs) values of success are identified. These will be used to evaluate supervisory actions.

2. *What uncertainties and evolving developments can be identified in the timeframe of the UCC implementation?*

This sub-question aims to pinpoint uncertainties in the research area. These uncertainties may be found within or as a result of the UCC, but other future uncertainties and developments will also be considered. To assess the impact of the new UCC, the possible evolution of the uncertainties and developments will be mapped through different future scenarios.

3. *What are the challenges in the current e-commerce import supervision process?*

This sub-question aims to identify the current challenges that customs officers face in the supervision process. These challenges will help define the opportunities and weaknesses of the Dutch Customs Administration in successfully supervising e-commerce imports. They will serve as the basis for the identification of supervisory actions.

4. *What e-commerce supervisory actions can be identified to enhance the successful supervision of e-commerce imports?*

This sub-question aims to identify and evaluate supervisory actions that have the potential to enhance e-commerce import supervision in the identified future scenarios. The evaluation provides insights into the effects of the supervisory actions on the KPIs of successful supervision.

1.4. Research Approaches

The previously defined research questions require a theoretical decision-making approach at the base. To implement the theoretical decision-making approach, this study also employs several practical research approaches. This section outlines the theoretical and practical approaches and describes the research methods that will be used to apply them.

1.4.1. Theoretical Decision-Making Approach

The literature highlights various decision theories, including Chorus' Regret Minimalism theory, Information Processing Theory and Utility Theory (Chorus et al., 2008; Swanson, 1987; Fishburn, 1968). Nevertheless, these traditional approaches to decision-making typically involve predicting the future with a moderate level of certainty (Stanton & Roelich, 2021). Since some uncertainties are identifiable for which the future cannot be predicted, a Decision-Making under Deep Uncertainty (DMDU) methodology should be applied to this study.

Uncertainty can be defined as: "limited knowledge about future, past or current events" (Walker et al., 2012). Deep uncertainties arise when we consider the state of the world and human factors for which no probability distribution can be applied, and little is known about the possible outcomes (Walker et al., 2012). Examples of deep uncertainties in this research area comprise international laws and technological advancements. A book written by Marchau et al. (2019) identifies five DMDU approaches for research with deep uncertainties: Robust Decision Making, Dynamic Adaptive Planning (DAP), Dynamic Adaptive Policy Pathways (DAPP), Info-Gap Decision Theory and Engineering Options Analysis are all key to make informed decisions. DAPP combines DAP and Adaption Pathways (AP) in the sole DMUDU approach that takes time into account when making decisions. Concerning the stated research problem, effective and adaptable planning will be necessary for the execution of the supervision process of e-commerce imports with the new UCC and other evolving developments to allow for the most optimal preparation when the new legislation is enforced.

DAPP is a renowned decision-making analysis that presents a methodical approach to creating robust decisions for worlds with deep uncertainties. DAPP combines the DAP framework that outlines a planning process composed of various types of actions and guidelines for monitoring whether adaptation is needed, and the AP base for designing strategies (Haasnoot et al., 2019). This study incorporates the first four steps of the DAPP methodology (see Table 1.1) by defining the definition of successful supervision, identifying the customs uncertainties, challenges, weaknesses, opportunities and actions and evaluating the effect of these actions in various future scenarios.

Table 1.1: Overview of included DAPP Steps

	Step	Description	SQ	Chapter
1	Describe the status	Description of the current status of the supervision strategy, including the characteristics of supervision, supervision constraints, uncertainties in the supervision area, definition of successful supervision	1 – 2	2 – 4
2	Analyse the problem	Description of the current and future supervision challenges and a description of the opportunities and vulnerabilities of the supervision process	3	5 – 6
3	Identify the actions	Description of the possible actions to achieve successful supervision, based on the opportunities and the vulnerabilities	4	6
4	Evaluate the actions	Description of the evaluation of the actions based on the definition of successful supervision.	4	8 - 10

1.4.2. Practical Research Approaches

This study employs three practical research approaches. Specifically, a mixed-method approach is adopted that combines qualitative, quantitative and modelling approaches to address the research questions. Each research approach has one or more methods that are used to research this study area.

Qualitative Approach

The first practical research approach is qualitative. A qualitative approach is selected to investigate the current e-commerce supervision processes, and vital elements and recognize uncertainties (Creswell & Creswell, 2017). The report is viewed as a qualitative study, offering an opportunity to acquire an in-depth understanding of the system and enabling a thorough exploration of scenarios (Crowe et al., 2011; Yin, 2009). Due to lacking applications of modern decision-making tools in the strategy formulation process of the Dutch Customs Administration, this study is most suitable for comprehensively examining e-commerce supervision complexities (Yin, 2009), as well as examining the applicability of

the DAPP approach as support for strategy formulation within the organisation. One limitation of the qualitative study that Willis (2021) identifies is the lack of generalisability. Every supervision area has its supervision structures. Therefore, the research findings cannot be directly applied to other supervision areas. The same applies to the application of this study to other Customs administrations, due to the presence of their supervision values and supervision values. One factor that partially mitigates these limitations is the exploratory nature of this study. Although the dynamic adaptive plan is solely relevant to the Dutch Customs Administration, the outcomes will also contribute to the literature gap on implementing adaptive decision-making theories to aid the formulation of strategies.

Qualitative research methods are utilized to collect the qualitative data required to answer the research questions. The data includes the key components of successful supervision, challenges in the current supervision process, as well as the uncertainties linked to the UCC and other future developments. This study makes use of four qualitative research methods: semi-structured interviews, document analysis, observation analysis, and a feasibility study. Table 1.2 outlines the qualitative research methods and their descriptions.

Quantitative Approach

The quantitative approach has further strengthened the study. The declaration data provided by the Dutch Customs Administration facilitates the research of declaration patterns, such as time patterns of submission of declarations, distributions in weight, values and origin of the e-commerce shipments. Additionally, the data allows for an understanding of the parties involved in the declaration process, as well as the inspections performed by Dutch Customs officers. However, the quantitative approach has limitations in providing underlying reasons (Taherdoost, 2022). The results of data analysis may not reveal the reasons behind the data structures and patterns. Taherdoost also notes that the quantitative approach is inadequate for describing the shape of social realities, such as connections in the e-commerce supply chain. The mixed-method approach can mitigate this limitation by incorporating qualitative data to supplement any lacking information. The quantitative research method is utilised to collect information regarding the trade characteristics, involved parties and inspection outcomes. The research method applied in this study is statistical analysis. Table 1.2 describes this quantitative research method.

Modelling Approach

The research subject adopts the modelling approach as its final approach. The model, which is a representation of the real world, helps investigate the possible impact of the new UCC with the identified uncertainties and evolving developments while maintaining control of the experimental conditions (Robinson, 2014). The use of models also allows the researcher to experiment with various enforcement actions and strategies without causing harm to the real world or being constrained by time restrictions. However, the model is a depiction of the real world and is thus unable to comprehensively encompass every aspect of the system, leading to possible uncertainties in research findings. To mitigate these uncertainties, customs experts will validate the model. The study employs simulation modelling as a research method to calculate and visualise the impact of individual supervision actions and strategies (see Table 1.2).

Table 1.2: Overview Research Approaches and Methods

Research approach	Ap- proach	Research Method	Description	Research tion	Ques- tion
Qualitative proach	Ap- proach	Semi-Structured Interviews	Semi-structured interviews offer a way to explore a topic while maintaining focus. Customs experts will be interviewed regarding the key factors of 'successful supervision', challenges, uncertainties, opportunities, and vulnerabilities of the current e-commerce import supervision process, to map design and key factors. The interview design for this research is located in Appendix A.	RQ 1 – 4	
		Document Analysis	Document analysis complements the data collection by providing insights into the e-commerce supervision design, e-commerce supply chain, and possible development of uncertainties and opportunities. This includes the potential influence of technological innovation, as well as actions that can facilitate a strategic approach (Bowen, 2009). In addition, this method aids in gathering comprehensive information regarding (inter)national legislation.	RQ 1 – 4	
		Observation Analysis	Observation analysis enhances the semi-structured interviews and document analysis by providing specific information about the inspection methods used by the Dutch Customs officers. In this study, a partially participating observer collects information about the inspection routine, as well as any challenges, opportunities, and weaknesses of the inspection process without burdening the Dutch Customs officers (Ciesielska et al., 2017). The observation design can be seen in Appendix B.	RQ 2 – 3	
		Feasibility Study	The last qualitative approach is the feasibility study to determine the extent to which the investigated supervision actions are realistically implementable by the Dutch Customs Administration. Feasibility is analysed using seven areas of focus – (1) acceptability, (2) demand, (3) implementation, (4) practicality, (5) adaptation, (6) integration, and (7) expansion (Bowen et al., 2009; McLeod, 2021). The feasibility study is performed using expert sessions (see Appendix C for the session design).	RQ 4	
Quantitative proach	Ap- proach	Statistical Analysis	Statistical analysis is conducted on pre-existing e-commerce import databases. This analysis serves the purpose of enabling the calculation of descriptive statistics, such as identifying small and large submitting parties and time patterns of declaration submissions.	RQ 4	
Modelling proach	Ap- proach	Simulation Modelling	Simulation modelling can provide access to a scenario for researching the impact of the new UCC, as well as facilitating the investigation of the effects of particular actions identified in step 3 of the DAPP analysis.	RQ 4	

1.5. Reading Guide

The report is structured as follows: Chapter 2 provides background information about the e-commerce trade market and the Dutch Customs Administration. Chapter 3 defines the term 'successful supervision' for the Dutch Customs Administration. Chapter 4 discusses the future of the e-commerce trade market and the supervision process. Chapter 5 outlines the challenges of the supervision process. Chapter 6 presents the supervision actions for e-commerce imports. In Chapter 7, the supervision system for e-commerce is described. Chapter 8 presents the quantitative results of the analysis of supervisory actions. Chapter 9 presents the model validation of the simulation models. Chapter 10 describes the study discussion. Finally, chapter 11 presents the conclusion. Figure 1.1 represents the report structure.

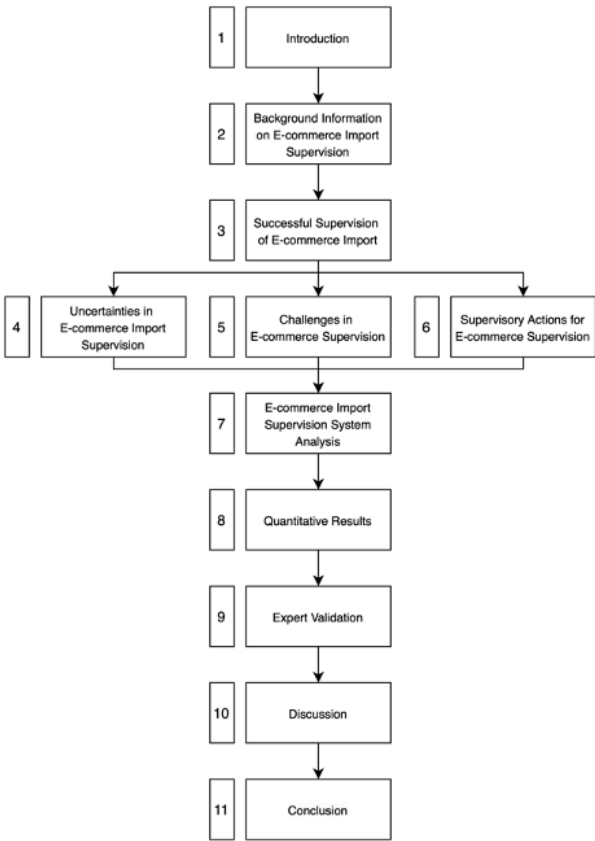


Figure 1.1: Report Structure

Background Information on E-commerce Import Supervision

This chapter provides background information about the study area. First, the e-commerce trade market is outlined by defining e-commerce, describing the market aspects and characteristics, explaining the e-commerce supply chain and highlighting the main legislation regarding e-commerce. Moreover, this chapter elaborates on the supervision processes of the Dutch Customs Administration. This includes an explanation of the main objectives and tasks, as well as a description of the inspection processes.

2.1. E-Commerce Trade Market

The term e-commerce is a widely used term in all aspects of retail in which various definitions are applied. This study defines the term e-commerce as: *“All cross-EU-border Business-to-Consumer (B2C) shipments imported into the EU with a value of less than 150 euros”* (Customs Administration of the Netherlands, 2021a). Shipments sent by webshops or platforms from third countries to EU residents are thus classified as e-commerce shipments.

2.1.1. E-Commerce Trade Market Aspects and Characteristics

The e-commerce trade market can be described by four market aspects and their corresponding characteristics. The four market aspects are market area, market volume, commodity and the playing field. The paragraph below elaborates on the four aspects and characteristics identified. An overview of the characteristics can be seen in Figure 2.1.



Figure 2.1: E-Commerce Market Characteristics

Market Area

The first aspect is the market area. As the definition of e-commerce suggests, this market operates globally, allowing businesses to reach customers all over the world. E-commerce shipments are mainly manufactured in other continents after which they are imported to private persons in the EU, crossing the EU borders. Another characteristic is the B2C stream. E-commerce trade involves the shipment of products from businesses to consumers. It is a growing B2C stream that goes beyond traditional Business-to-Business (B2B) trade and physical shop locations. This market is primarily online, allowing for online transactions.

Market Volume

The volumes of the e-commerce trade market are rapidly increasing. Haji (2021) reported that global e-commerce trade grew at an average annual rate of 15.86 % between 2021 and 2023. In Europe, e-commerce turnover was 889 million euros, which accounted for 4.68 % of the European Gross Domestic Product (GDP) (Lone & Weltevreden, 2023). China, the largest e-commerce transaction generator, has over 710 million digital buyers (China – eCommerce, 2023). Drigas & Leliopoulos (2013) link the growth of e-commerce volume to the internet growth of the EU. According to Lone & Weltevreden (2023), 84 % of internet users in Western Europe purchase goods and services online, making them e-shoppers. This percentage has increased to 87 % of the total European population in just one year (Lone & Weltevreden, 2023).

Commodity

A vast number of online transactions are physically delivered through a high volume of low-value shipments. As the definition suggests, shipments are only classified as e-commerce if they have a value of less than 150 euros. Furthermore, the products ordered are very diverse. 68 % of e-shoppers buy clothing online. Other product categories are 27 % cosmetics, 23 % sports goods, 19 % toys and 17 % buys consumer electronics (Lone & Weltevreden, 2023). This indicates a high degree of heterogeneity in the e-commerce trade market. Even within these categories, the range of products available is not limited. The final characteristic is the expected logistical values by the consumers. According to Ramanathan et al. (2014), the importance of logistics services is important for low-risk products, such as e-commerce products. This means that the right product should be delivered by the promised date.

Playing field

The e-commerce trade market is dominated by a few large e-commerce platforms, such as Alibaba and Amazon. However, the market can be described as dynamic. The dynamic nature can be seen in the rise of the platform TEMU, which has become the largest e-commerce platform in the world since its inception in 2022, with a turnover of more than 20 billion USD (CNBC, 2023). The digital marketing platform Tiktok, with an average of 139.5 million monthly active users is another example of the dynamic nature of the e-commerce trade market, as it is designated as a Very Large Online Platform (VLOP) by the EC (European Commission, 2023b). In short, a new player can become one of the biggest players in the market within less than 2 years. Another characteristic is the non-transparency of the e-commerce market. A 2020 study by Abdelrhim & Elsayed identifies Amazon, Alibaba, Rakuten, Zalando and ASOS as the five largest e-commerce platforms with revenues of respectively 107, 12.29, 6.3, 3.28, and 1.4 billion USD. In contrast, a study by Wang et al. (2020) identifies the Chinese company SHEIN as a high-profile e-commerce brand with a revenue of more than 10 billion USD. The differences between these two studies show that the e-commerce market is non-transparent. Finally, the playing field is characterised by a low entry threshold. Parties can sell e-commerce goods without incurring high entry costs or having to maintain large inventories (Hadasik & Kubiczek, 2022).

2.1.2. E-Commerce Supply Chain

Figure 2.2 shows a simplified version of the e-commerce supply chain. The supply chain knows three flows: the payment flow, the physical flow, and the information flow. The chain starts with the electronic transaction of an e-commerce good from the consumer located in the EU to the platform located outside of the EU (link 1). In this transaction, the consumer pays to the platform and the platform sends order information to the consumer. In some cases, the platforms sell their own products. Platforms like this are SHEIN and partly Amazon. Other platforms, such as AliExpress, mainly sell products from other webshops. After the transaction, these platforms will order the products from the smaller webshops. This is shown at number 2 in the figure.

From this point, the product is ready to be shipped to the consumer. There are two main ways in which the transport is carried out. The first method, shown by numbers 3 to 7 in the diagram, is via a third party called a consolidator. The consolidator is responsible for transporting the goods from the country of origin to the consumer. An economic operator is also active in this flow. The economic operator is responsible for the customs formalities, and thus the lodging of the import declaration. From a customs point of view, the economic operator is seen as one of the main actors in customs processes. As can be seen, the information flow goes through at least 3 other parties before the information is received by the Customs Administrations.

The second method requires fewer parties to be involved in the physical flow. In this method, there is one party, the carrier, who acts as a system integrator. This party will take care of the transportation from the country of origin and the last-mile delivery, as well as the customs formalities. Examples of companies are FedEx and DHL. During this method, the information flow only requires one other party before the relevant information is submitted to customs.

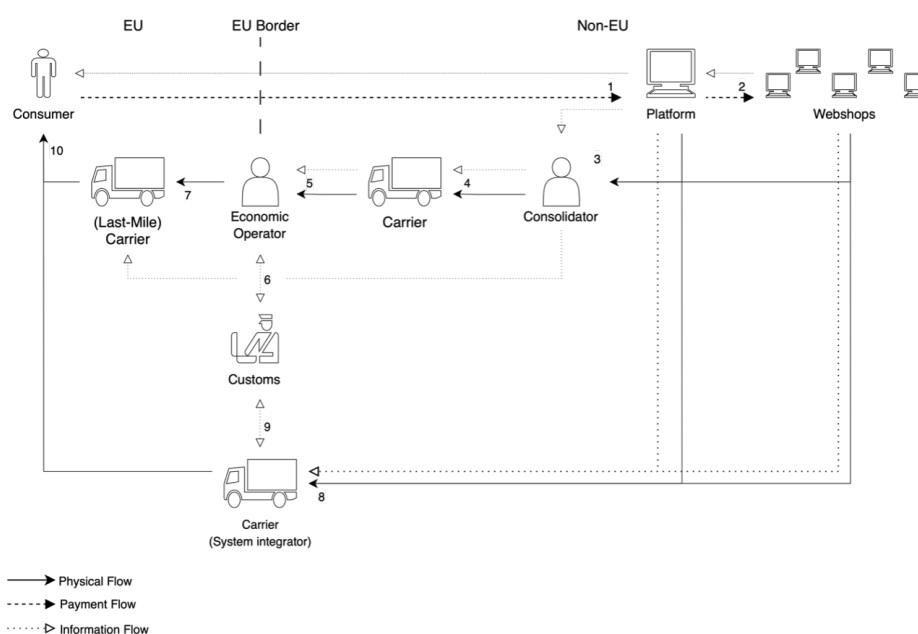


Figure 2.2: Simplified Representation of the E-Commerce Supply Chain

2.1.3. Legislation

Customs Administrations play an important role in ensuring the safety and security of the EU population as well as collecting the customs duties for the EU itself. To act as one within the EU, the main customs legislation is enshrined in one European legal framework: the Union Customs Code (UCC). This framework sets out the customs rules, procedures, responsibilities and agreements, to protect the flow of goods transiting in and out of the EU, to safeguard the financial interest of the EU and its Member States, as well as the guarantee the safety and security of EU citizens. Other objectives of the UCC are to provide greater legal certainty and uniformity for businesses and to enhance the competitiveness of EU businesses. The UCC entered into force in 2016, before the enormous increase in e-commerce imports (European Commission, 2022a). As mentioned in Chapter 1, the current UCC is not up to date to provide the Customs Administrations with the required procedures and opportunities to control the e-commerce flow. However, there are developments in legislation attempting to provide Customs Administrations to better control the e-commerce stream. One of these developments is DAC7. This legislation makes it from 2023-01-01 for platforms mandatory to collect and verify sellers' information. Also, the Digital Service Act (DSA) and Digital Markets Act (DMA), are legislation to increase transparency and prevent misinformation for the biggest platforms.

2.2. The Dutch Customs Administration

This section provides background information about the objectives, tasks and supervision activities related to the e-commerce import. First, the objectives of the organisation are described. Then, an introduction to supervision activities is given.

2.2.1. Objectives of the Dutch Customs Administration

The Dutch Customs Administration has three main goals: (1) remittance, (2) protection and (3) a level playing field (Customs Administration of the Netherlands, 2023) as shown in Figure 2.3. The organisation strives to ensure that the import duties and taxes are collected as correctly, timely and completely as possible. Taxes consist of excise duty and consumption tax levied on tobacco, mineral oils, and alcohol. The collected taxes are a source of income for the Dutch government. In addition to taxes, the Dutch Customs Administration collects customs duties, which consist of import duties, countervailing duties and anti-dumping duties. Of the custom duties, 75 % are transferred to the EU. The remaining 25 % of the collected duties, the perception costs, are kept by the Dutch Customs Administration and are used to finance the organisation. Financial customs tasks are the main consequence of this objective. The second objective is to protect society from unsafe and unwanted goods. To achieve this, the organisation monitors goods that are not allowed to enter or leave the country. There are five categories in which the unsafe and unwanted goods are monitored: safety, health, economic, environmental and cultural. Protection is the main objective of all the non-fiscal tasks of the Dutch Customs Administration. The last objective is to strengthen the competitive position of the Netherlands and the EU. In this way, the organisation contributes to economic growth in the Netherlands and the EU. This is achieved, among other things, by combating counterfeit products and facilitating trustworthy business by minimising delays caused by shipment inspections in the logistics chain.



Figure 2.3: Objectives of the Dutch Customs Administration

The priorities in tasks to achieve these objectives are determined together with the commissioning departments. These departments are the Ministry of Finance, the Ministry of Economic Affairs and Climate Policy, the Ministry of Agriculture, Nature and Food Quality, the Ministry of Infrastructure and Water Management, the Ministry of Foreign Affairs, the Ministry of Justice and Security, the Ministry of Health, Welfare and Sport, the Ministry of Education, Culture and Science, and the Ministry of Social Affairs and Employment (Customs Administration of the Netherlands, 2023).

2.2.2. Inspection Types

The prioritisation process results are set out in the annual enforcement plan. The Enforcement Plan contains the focus of the year’s supervision and concrete inspection targets per customs region. These figures are a translation of the prioritisation and the available capacity of the organisation. Next to general inspections, two main types of inspection can be identified during the Process Import, namely physical inspection and document inspection.

A physical inspection consists of inspecting the selected article itself. To do this, the customs officials go to the location where the inspection can take place, which is indicated in the declaration. They open the package and inspect the contents. These inspections are carried out by the customs department called ‘Fysiek Toezicht’ (FT). If an article is selected for document selection, the customs department ‘Aangifte Behandeling’ (AB) will inspect the declaration and the additional documents, if available. An additional document can be an invoice, required licenses or health certificates (Customs Administration of the Netherlands, 2023).

2.2.3. Supervision Flows

The supply chain flows can be translated to a more detailed version, namely the supervision flows from a customs perspective (see Figure 2.4). Two of the supply chain flows are shown in a step-based approach. A description of the flows can be found underneath the figure.

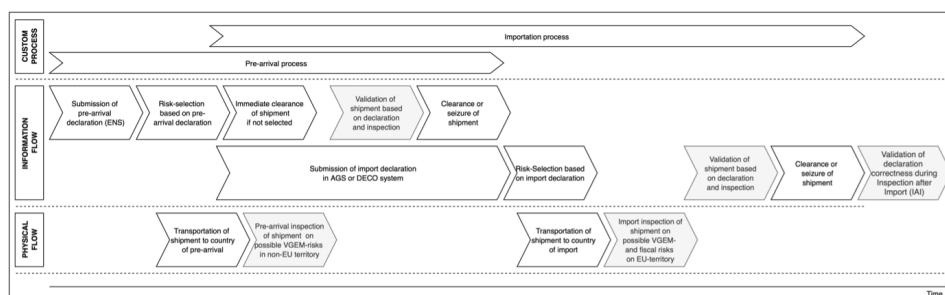


Figure 2.4: Customs Supervision Flows

Information Flow

The information flow represents all information related to e-commerce goods movements. From a customs point of view, the information flow can start with the pre-arrival process and thus with the submission of the Entry Summary Declaration (ENS). If the Netherlands is the first EU country of entry, the pre-arrival process takes place in the Netherlands. The ENS contains information about the mode of transport, cargo details and arrival information. This declaration must be completed before the goods are loaded onto the transport vehicle. Based on this declaration, a risk selection is made. The selection is mainly focused on reducing security risks. Once a declaration has been selected and the inspection has been carried out, the declaration is validated based on the inspection results. Validation is colour-coded (grey) in Figure 2.4 as it only applies to shipments selected by risk selection. The final step in the pre-arrival process is the release or seizure of the shipments. If the shipments are not selected for inspection or are validated based on the inspection results, the shipments are released. If the shipments are selected for inspection and not validated based on the inspection results, the shipments are seized.

Before the goods to be released for free circulation arrive in the Netherlands, the import declaration must be completed. There are two customs declaration systems (CDSs) for submitting import declarations for e-commerce shipments. The first CDS is AGS/DMS, where declarations are submitted using a full dataset (H1). DECO is the second CDS and requires only a reduced dataset (H7) for submission. In contrast to the pre-arrival inspection, the import inspection focuses on fiscal risk reduction in addition to security risk reduction. This means that customs officers check whether the declared values correspond to the estimated value of the shipment. After submission, a risk selection is made based on one of the specified data sets. In this process, the inspection results are also validated. In the final part of the import process, the consignment is either seized or released for free circulation in the EU based on the validation result. After the shipments are released into free circulation, another inspection can take place, namely the Inspection After Import (IAI). This inspection focuses on the accuracy of the declarations filed by declarants, electronic operators and/or platforms (based on IOSS number). When findings are made during these inspections, this can potentially lead to an additional risk profile for further shipments or a fiscal correction for the unpaid VAT and/or customs duties.

Physical Flow

The physical flow represents the logistical chain of e-commerce shipments and articles. As mentioned above, the first two steps, transport of the shipment and pre-arrival inspection, take place in the pre-arrival process when the Netherlands is the first country of entry into the EU. In both the pre-arrival and the import process, physical inspections are carried out to investigate security risks (in the pre-arrival and import process) and fiscal risks (only in the import process).

Payment Flow

The payment flow is not included in Figure 2.4. The reason for this is that the two relevant aspects, customs duties and VAT, are in most cases not paid during this process. E-commerce goods are exempt from customs duties (Belastingdienst, 2024). It is only when an inspection reveals that the value of the shipment exceeds the exemption threshold (EUR 150) that the payment flow for customs duties becomes relevant.

3

Successful Supervision

This chapter provides a definition of successful supervision, which is necessary to identify and evaluate the supervisory actions formulated in Chapter 6. This chapter answers the first research question of this study, namely: *“What is successful e-commerce supervision?”* The first paragraph provides insights into the broad concept of supervision that customs administrations undertake, namely governmental supervision. The second section provides insights into the identified aspects of successful supervision. The third section describes the Key Performance Indicators (KPIs) against which the extent of successful supervision can be measured. This section also includes the quantification of success values for the KPIs to call the supervision process successful.

3.1. Governmental Supervision

The Dutch government recognises three types of supervisors: government inspectorates, public supervisors and private supervisors. According to Velders & Brunia (2013), the Dutch Customs Administration is considered a public supervisor, an organisation that is responsible for supervising compliance with legal regulations. The Dutch Customs Administration primarily carry out compliance supervision, ensuring that all parties involved comply with the rules. The main objective of this supervision is to achieve compliance, which has a socially desirable effect. This effect can be identified as the protection of the population and ensuring the collection of appropriate taxes and duties. In the case of the Dutch Customs Administration, compliant actors are those who provide accurate declaration data, do not use the system to import prohibited or unsafe goods and pay the required taxes and duties.

Supervision, as defined in this report, involves the collection of information to determine whether an actor or an object meets the requirements imposed, to form an opinion about it and, if necessary, to intervene as a result (Velders & Brunia, 2013). The definition identifies three key activities, namely information collection, information assessment and intervention (see Figure 3.1).

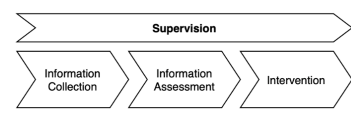


Figure 3.1: Key Activities of Supervision

Information collection is the process by which supervisors gather the information necessary to assess whether an act or object meets the requirements imposed. In the case of the Dutch Customs Administration, information can be collected from various sources, including submitted declarations and inspection observations in the form of documents or physical inspections.

Information assessment can be divided into two parts: set requirements and requirements to be assessed. Fixed requirements are laid down in legislation, such as the UCC and the Douaneregeling (DR), and include the amount of import duties or taxes to be paid, as well as safety requirements for

imported goods. The expertise of the customs official plays an important role in the assessment of requirements. The assessment of the requirements in comparison with the set standards determines the assessment of the information. This process is crucial for the Dutch Customs Administration to determine the safety of imported products in the EU and to ensure the correct payment of taxes and duties. Intervention refers to the action taken when an information assessment leads to a specific and unwanted finding. Most actions taken as interventions can be understood as supervisory activities.

Enforcement covers the full range of activities aimed at ensuring that the requirements of an object or action are met. Examples of interventions include compliance communication, sanctions or simply stopping the unsafe goods at the EU border.

3.2. Aspects of Successful Supervision

To determine the potential success of an e-commerce import monitoring strategy for the Dutch Customs Administration, it is crucial to have a clear understanding of the criteria for successful supervision. Therefore, it is important to define what constitutes successful supervision. According to literature research, supervision is described in terms of 'good' and 'effective'. This report uses the term 'successful' to identify the extent to which a supervisory action contributes to the objectives of supervision. This term is preferred to 'good' as it is more objective and measurable. In addition, 'effective' supervision does not cover all aspects of supervision. This report focuses on effect-oriented supervision, where the main objective is to achieve a long-term socially desirable effect, also called effectiveness. However, to develop effective strategies, supervision should also consider the efficient allocation of resources and the economic design of processes. Successful supervision covers all of the above, from efficiency and economy to effectiveness. A full explanation of the aspects identified in the sections below can be found in Appendix D.

3.2.1. Aspects in the Literature

Literature research has identified twelve aspects of successful supervision. The Kaderstellende Visie Toezicht sets out the basis for successful supervision by Dutch supervisors and identifies six aspects that a supervision strategy should meet to be considered good: selective, decisive, collaborative, independent, transparent and professional supervision (Ministry of Justice and Security, 2005). In a study by Hu et al. (2023) on the competitiveness of customs supervision, three key factors were identified as crucial for a successful playing field: streamlined, fiscal and qualified supervision. The Strategic Multi-annual Plan (SMP) of the Dutch Customs Administration identified the last three aspects: unified, data-driven and strategic supervision (Customs Strategy Team, 2021).

Successful supervision of e-commerce imports is a synthesis of key principles that ensure the seamless operation of supervision key activities. Selective supervision is the fundamental principle, which is based on the strategic allocation of resources based on unbiased risk analysis. Complementing this, decisive supervision offers a balanced approach, combining assertive supervision strategies with timely interventions tailored to the severity of non-compliance. Collaboration emerges as a central principle in the field of supervision, promoting cooperation between supervisors to reduce the burden on all parties involved through the collective use of resources. Meanwhile, independent supervision emphasises the importance of unbiased information assessment that builds public trust through transparent and accountable activities. Transparency is fundamental to supervision methods, characterised by open communication and transparent policies that promote clarity and collaboration. Supervision is committed to professionalism and includes a dedication to flexibility, integrity and continuous development, ensuring the adaptability of supervision mechanisms. Streamlined supervision reflects this commitment, prioritising efficiency through technological integration and proactive planning methods. Fiscally-oriented supervision not only aligns customs operations with broader economic policies but also serves as a foundation for national development initiatives. At the same time, qualified supervision emphasises the need for skills development and anti-corruption measures to strengthen the professionalism and effectiveness of customs staff. Unified supervision argues for consistency, integrity and digitisation, and promotes inclusiveness in supervision frameworks. Guided by these principles, strategic supervision uses data-driven risk management to increase efficiency, minimize delays and adapt to emerging challenges. Supported by comprehensive and timely information, data-driven supervision promotes informed decision-making, regulatory integrity and trust. Together, these principles form a framework that ensures the harmonious flow of goods while upholding the principles of supervision integrity and

public trust.

Based on the aspects above, the following definition of successful supervision can be formalized: *Successful supervision involves a multi-faceted approach that integrates selective allocation of resources, prompt and effective intervention, collaborative efforts, impartial judgement, transparent communication, professional integrity, fiscal integrity, a skilled workforce, organizational unity, strategic planning and data-driven decision making. A successful strategy ensures efficient, fair and effective enforcement and fosters trust, integrity and accountability within Customs operations.*

In short, according to the literature, supervision can be categorised as 'successful' when the supervision is selective, decisive, collaborative, independent, transparent, professional, fiscal-oriented, qualified, unified, strategic and data-driven. Some of the aspects mentioned above overlap at some points. An example of this is the aspects of professional, qualified and unified supervision, as they both mention the integrity of the workforce as a key factor. Another intersection can be found in aspects such as collaborative and data-driven supervision, as they both outline data exchange as a key factor for successful supervision. Another insight based on the aspects found in the literature is that these aspects contain a broad definition of successful supervision.

3.2.2. Aspects in the Interviews

The twelve aspects of successful supervision identified in the literature are supplemented by findings based on the interviews. The interview analysis identifies three main aspects of successful supervision, namely fulfilling the supervisory task, which is translated into the main objectives of the organisation, striving for a compliant market and optimising the supervisory process. These three aspects can be further disaggregated into 11 additional aspects of successful supervision.

Successful supervision of e-commerce imports requires a combination of key principles to guarantee the effective execution of supervisory activities. Fiscal-completeness supervision is a crucial aspect, ensuring the accurate collection of taxes and duties in the import stream, which translates the core objective of 'Remittance' (Interviewees 6, 7, 9, 10, 11 and 16). Interceptive supervision, also known as the 'Protection' objective, involves stopping illegal goods from entering the EU and protecting against unsafe and undesirable products (Interviewees 6, 7, 8, 9, 11 and 16). Equal supervision aims to create a level playing field by minimising disparities between B2C and B2B flows (Interviewees 7 and 8). Actor-oriented supervision distinguishes between compliant and non-compliant parties, with a focus on stimulating compliance and deterring negligence (Interviewees 9 and 12). Declaration-accurate supervision enhances the reliability of declarations to mitigate misuse of information and increase inspection efficiency (Interviewees 2, 6 and 12). Abuse-suppressing supervision discourages the import of prohibited goods through visible inspections and clear communication of import rules and consequences (Interviewees 1, 3, 9 and 16). Delay-suppressing supervision minimises logistical delays by conducting effective inspections that are synchronised with business processes (Interviewees 3 and 5). Outcome-maximising supervision ensures the efficiency and effectiveness of supervision activities, maximising output while maintaining quality (interviewee 4). Policy-driven supervision includes a well-communicated enforcement plan to enhance organisational adaptation and preparedness for regulatory changes (Interviewee 9). Risk-based supervision considers all possible risks when formulating enforcement plans and prioritises actions to effectively address the highest risks (Interviewees 3 and 5). Reactive supervision involves a rapid learning cycle to respond effectively to risk signals, taking into account inspection findings and irregularities identified by the relevant services (Interviewees 10 and 13).

Based on the aspects above, the following definition of successful supervision can be formalized: *Successful supervision involves a comprehensive approach that ensures accurate tax collection, prevents the entry of unsafe goods and promotes fairness between trade flows. It tailors strategies based on compliance levels, improves declaration accuracy and discourages abuse of import regulations. Optimisation focuses on minimizing delays, maximizing efficiency and responding quickly to risks.*

Concluding, according to interviews, successful supervision should achieve certain values in 11 identified aspects: fiscally-complete supervision, interceptive supervision, equal supervision, actor-oriented supervision, declaration-accurate supervision, abuse-suppressing supervision, delay-suppressing supervision, outcome-maximising supervision, policy-driven supervision, risk-based supervision and reactive supervision. It is very unlikely that a supervision strategy can apply to all the aspects mentioned

above. Therefore the aspects and corresponding key values will be prioritized in the last section. When supervision strategies contain the key factors of the highest-prioritised aspects mentioned, a supervision strategy can be categorized as successful.

3.3. Definition of Successful Supervision

The previous sections identify 23 aspects of successful supervision by the Dutch Customs Administration based on the literature and interviews (see Figure 3.2). The analysis of the literature and the interviews resulted in two different definitions of successful supervision.

Four similarities between the definitions can be identified. The first similarity is that both definitions emphasise the importance of a multifaceted approach. This suggests that supervision is not a straightforward task but should strike a balance between all the identified aspects. This also means that possible trade-offs can be identified. The second similarity is the importance of prompt and effective intervention. The organisation should be able to act reactively, and the actions taken should result in an inspection finding or increased market compliance, indicating a high degree of accuracy in inspection and enforcement planning. Both definitions also emphasise the objective of efficient, fair and effective supervision. These can be seen as the main objectives of successful e-commerce supervision. Finally, both definitions emphasise the promotion of integrity and accountability within customs operations. This is a logical consequence of the public mission of the Dutch Customs Administration.

There is one difference in key factors between the definitions. This difference is the requirement for a skilled workforce and is derived from the definition based on the literature review. This requirement is not mentioned by the interviewees. However, as mentioned in the first section of this chapter, the definition derived from the literature is more general than the one based on the interviews. This is because the interviewees are asked to define successful supervision of e-commerce imports specifically, whereas the aspects of successful supervision identified in the literature are considered for all types of supervision that should lead to success. Nevertheless, skilled staff also play an important role in the supervision of e-commerce imports.

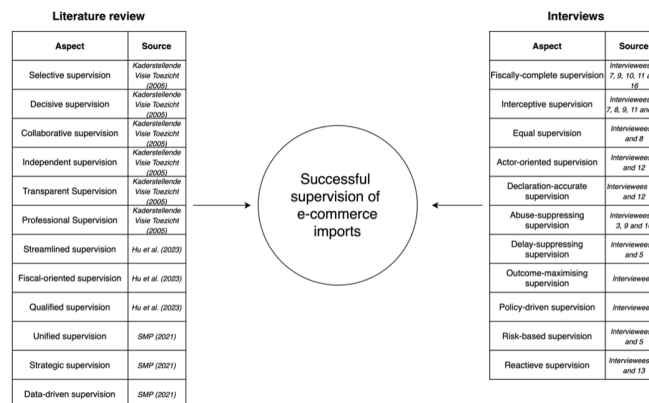


Figure 3.2: Overview of Successful Supervision Aspects

In this report, the final definition of successful e-commerce imports supervision is formalized as follows: *“Successful supervision involves a comprehensive approach integrating resource allocation, prompt intervention, collaboration, impartiality, transparency, integrity, skilled workforce, organizational unity, strategic planning, and data-driven decision-making. It ensures accurate tax collection, prevents unsafe goods entry, and promotes fairness. Tailored strategies based on compliance levels improve declaration accuracy and deter import regulation abuse. Optimization minimizes delays, maximizes efficiency, and addresses risks promptly. Overall, it ensures efficient, fair, and effective enforcement, fostering trust, integrity, and accountability within Customs operations.”*

3.4. Key Factors and Success Values

Identifying the issues and formalising the definition of successful supervision already provides a first indication of the key factors (KFs) associated with successful supervision. This section describes the

key factors used for further analysis in this report. In addition, the key factors identified are assigned a 'success value'. If the factor reaches this value, it can be said that success has been achieved for that supervision factor.

3.4.1. Key Factors

The key factors of successful supervision are identified through literature study, interviews and expert opinions and are based on the supervision aspects identified in the previous sections. Table 3.1 provides an overview of all the key factors.

Table 3.1: Key Factors of Successful Supervision

	Key factor	Description
1	Level of Data Exchange	Extent to which data is shared with other organisations or data platforms
2	Level of Data Quality	Extent to which data is accurate, complete, granular, on-time, and standardized
3	Importation Threshold Height	Extent to which the importation process contains simplified procedures
4	Speed of the Learning Cycle	Extent of time in which a risk signal leads to a risk identification process
5	Completeness of the Learning Cycle	Extent of which a risk signal leads to a risk identification process
6	Effectiveness of the Supervision	Extent to which an inspection leads to an inspection finding
6a	<i>Fiscal Effectiveness of Supervision</i>	<i>Extent to which an inspection leads to a fiscal inspection finding</i>
6b	<i>Safety Effectiveness of Supervision</i>	<i>Extent to which an inspection leads to a safety inspection finding</i>
7	Risk-based Inspections	Extent to which declarations are risk-based selected for further inspection
8	Presence of a Supervision Policy	Extent to which a clear-communicated and organisation-wide supervision policy is in place
9	Efficiency of Inspection Resource Allocation	Extent to which the available inspection resources are efficiently allocated
10	Efficiency of Supervision Tasks	Extent to which the supervision tasks are efficiently designed
11	Logistical Delay of Inspected Shipments	The extent to which a selected shipment is delayed in the logistical process
12	Diversity of Supervision Approaches	The extent to which different supervision approaches for compliant and non-compliant parties are in place
13	Objective Inspection Chance of Shipments Declared	The objective extent to which a declared shipment is selected for further inspection
14	Subjective Inspection Chance of Shipments Declared	The subjective extent to which a declared shipment is selected for further inspection

3.4.2. Key Performance Indicators and Success Values

To determine whether an e-commerce import control strategy can be considered successful, one or more KPIs and corresponding success values are identified for each key factor (see Table 3.2). The proposed KPIs are based on the metrics formulated in the World Customs Organisation (WCO) Performance Measurements Mechanism (PPM) (World Customs Organisation, n.d.a) and the Customs Union Performance (CUP) Data Collection Indicators Performance Measurements (European Commission, n.d.a). After formalisation, the KPIs are quantified into success values based on expert opinions. However, a full impact-based measurement system is not yet in place at the Dutch Customs Administration. Therefore, the experts could not quantify all KPIs and most KPIs are based on assumptions made by the experts.

In addition, the previous section identified possible trade-offs between the different key factors when trying to achieve successful control of e-commerce imports. To avoid the existence of these trade-offs that do not lead to successful strategies, the KPIs are prioritised using the MoSCoW method. The KPIs are categorised as follows (Van Vliet, 2000):

- M - KPIs success value must be satisfied to achieve successful monitoring,
- S - KPIs success value should be satisfied to achieve successful monitoring,
- C - KPIs success value could be satisfied to achieve successful supervision.

Table 3.2: KPIs and Success Values

	Key Factor	KPI	Unit	Success Values	Prio
1	Level of Data Exchange	Minimum percentage of automated data exchange	%		S
2	Level of Data Quality	Average percentage declarations containing Irregularities	Declarations / week	$X \leq 5\%$	S
		Average percentage declarations containing fiscal inspections	Declarations / week	$X_f < X - X_s$	S
		Average percentage declarations containing safety irregularities	Declarations / week	$X_s < X - X_f$	S
3	Height of importation Threshold	Maximal difference between the number of simplified procedures for B2C and B2B imports	#		C
4	Speed of the Learning Cycle	Average lead time from risk signal submission until finalizing the risk identification process	Hour		C
5	Completeness of the Learning Cycle	The minimum percentage that risk signal submissions leads to the finalization of the risk identification process	%		C
6	Effectiveness of the Supervision	Minimal percentage of incorrect declarations found	%	$X > 95\%$	M
		Average inspection percentage	%	$X > \text{HHP}$	M
		The minimal percentage of risk-based declarations hit	%	$X > 80\%$	S
6a	Fiscal Effectiveness of Supervision	Minimal percentage inspection findings	%	$X > 80\%$	C
		Minimal percentage of fiscally incorrect declarations found	%	$X > 95\%$	M
6b	Safety Effectiveness of Supervision	Minimal percentage of safety incorrect declarations found	%	$X > 95\%$	M
7	Risk-based Inspections	Average percentage risk-based selected inspections	%	$X > 80\%$	S
8	Presence of a Supervision Policy	Presence of a Supervision Policy	Yes / No	$X = 1$	M
9	Efficiency of Inspection Resource Allocation	Average daily occupancy of inspection resources	%	$X > 90\%$	C
10	Efficiency of Supervision Tasks	Average percentage of administrative time in supervision tasks	%		C
11	Logistical Delay of Inspected Shipments	Maximum shipment delay due to inspections per week	hours		S
		Maximum percentage of shipments with exceeded reaction time	%	$X = 0$	M
12	Diversity of Supervision Approaches	Number of actor-driven approaches in place	#	$X > 0$	M
13	Objective Inspection Chance of Shipments Declared	Real inspection chance of shipments declared	%		M
14	Subjective Inspection Chance of Shipments Declared	Inspection chance of shipment declared deemed by the submitting party, declarant and/or importer	%		C

4

Supervisory Uncertainties

This chapter highlights the uncertainties identified in the import supervision of e-commerce goods. This section responds to the second research question: *What uncertainties and evolving developments can be identified in the time frame of the UCC implementation?* First, a brief introduction of the theoretical levels of uncertainties is provided. Then, the six uncertainty aspects are elaborated on. Finally, plausible future scenarios are formalised and described.

4.1. Levels of Uncertainty

Before identifying the uncertainties in the supervision of e-commerce imports, this chapter provides a brief explanation of theoretical uncertainty levels. As in Chapter 1, the supervision of e-commerce imports takes place in an uncertain world, as there is limited knowledge about future, past or current events (Walker et al., 2012).

Uncertainty can have several sources. In addition, different types of uncertainty can be identified. An example of a type of uncertainty is deep uncertainty, which arises in situations where a probability distribution cannot be applied, and little is known about the possible outcomes. Uncertainties can also be categorised according to their level of uncertainty. Five levels of uncertainty have been identified and are listed below (Walker et al., 2012).

- Level 1 uncertainty: semi-clear future with sensitivity
- Level 2 uncertainty: alternative futures with probabilities
- Level 3 uncertainty: alternative futures with rankings
- Level 4 uncertainty: multiplicity of unranked plausible futures
- Level 5 uncertainty: unknown future

4.2. Uncertainty Areas

Several uncertainty factors were identified in the literature and interviews. These factors are summarized in six uncertainty areas. These areas are shown in Figure 4.1. The factors within these areas influence the extent to which successful supervision of e-commerce import can be achieved. The uncertainty areas are discussed in more detail in the following paragraphs.



Figure 4.1: Uncertainty Areas

4.2.1. European Governance

The Dutch Customs Administration is an organisation with public duties that go beyond national borders. As a member of the EU Customs Union, the Dutch Customs Administration cooperates with the other members as one customs administration to ensure the security of the EU and to collect the same number of customs duties (European Commission, n.d.b). This is also reflected in two of the three main objectives of the Dutch Customs Administration, namely remittance and protection. European governance plays an important role in the way the Dutch Customs Administration carries out its supervisory tasks. European decisions cannot be directly influenced by the Dutch Customs Administration, which makes future developments uncertain from the perspective of the Dutch Customs Administration. There are two main sources of uncertainty resulting from European governance, namely European legislation and EU developments. This uncertainty area can be identified as a level 4 uncertainty as there are multiple plausible governmental developments which are very dependent on the visions and strategic moves of the EU member states.

European Legislation

As a European Member State, the Dutch government should follow rules and regulations made by the EU. For the customs administrations, the general rules and procedures applicable to goods imported into the customs territory, adapted to modern trade models and communication tools are established in the Union Customs Code (UCC) (European Commission, 2022b). This is the most important regulation that aims to simplify customs rules and procedures to facilitate more efficient customs transactions, reinforce swifter customs procures for compliant and trustworthy businesses as well as safeguard the financial and economic interest of the EU and the safety of EU citizens.

The motivation for research, as introduced in Chapter 1, is the EC's proposed UCC Reform. The EU recognises that the current UCC is no longer up to date with the volume of trade entering and leaving the EU and the need to modernise the customs procedures set out in the UCC. The proposal contains three pillars, focused on electronic data exchange (Antov, 2023a & European Commission, 2023b): a new partnership with businesses, a smarter approach to custom checks and a modern approach to e-commerce. All three pillars can make a significant difference in the working method of the Dutch Customs Administration. This is shown in Figure 4.2.

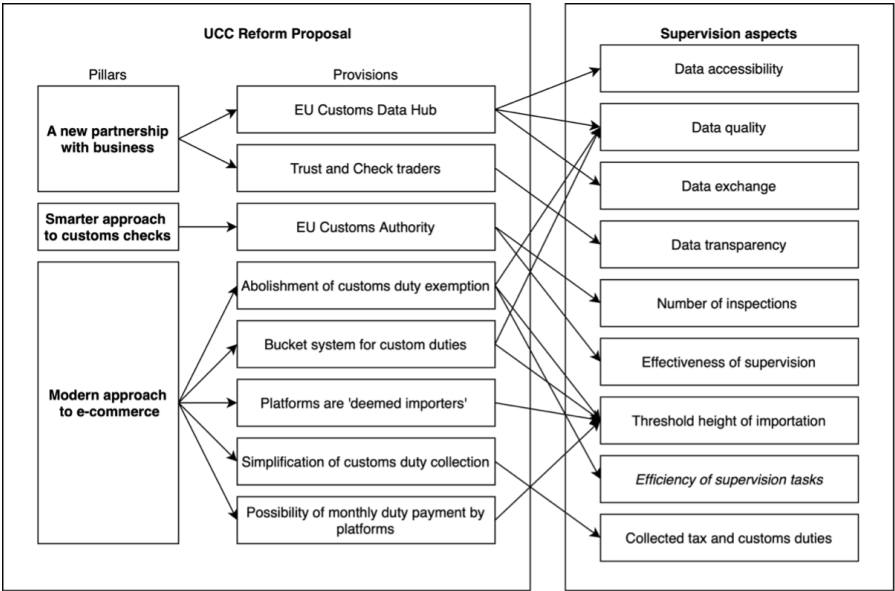


Figure 4.2: Effects of UCC Reform Pillars

This section contains a brief explanation of the UCC reform pillars. A full description of the UCC reform pillars can be found in Appendix E. The European Union's new customs reform is based on three pillars aimed at improving customs control and efficiency, particularly in the context of e-commerce. The first pillar focuses on establishing a new partnership with businesses through the EU Customs Data Hub

(ECDH), a centralised IT environment to facilitate customs formalities. The ECDH aims to improve data integrity, traceability and accessibility by moving from declaration-based to event-based information transmission, thereby improving timeliness. In addition, the introduction of Trust and Check Traders aims to increase data transparency by allowing customs to access traders' systems for compliance checks in exchange for accelerated customs clearance. The second pillar introduces the creation of the EU Customs Authority to oversee the ECDH and centralise customs management at the EU level. This shift will allow prioritisation of security risks and potentially lead to more effective supervision through risk management mechanisms and recommendations to Member States. The third pillar addresses the modernisation of e-commerce practices with five provisions. Firstly, the abolition of duty relief for e-commerce goods aims to improve data quality and accuracy by reducing the risk of undervaluation. However, this may increase the complexity of customs supervision tasks. Second, a bucket system for duty calculation simplifies the process but may lead to unfair advantages. Third, the treatment of e-commerce platforms as "deemed importers" increases their responsibility for customs duties and their ability to intervene. Fourthly, the extension of the Import One-Stop Shop (IOSS) simplifies the collection of duties but could have an impact on the revenue of customs authorities. Finally, allowing platforms to make monthly duty payments aims to streamline import processes.

In addition to the main legislation, other European legislation may also impact how the Dutch Customs Administration carries out its tasks. For instance, there are several legislation developments or recent additions, such as the Central Electronic System of Payment Information (CESOP), VAT in the Digital Age (VIDA), Centralised Clearance (CC), General Product Safety Regulation (GPSR), Digital Service Act (DSA), and the Digital Marketing Act (DMA) (Interviewees 8, 10, 11). This legislation aims, among other things, to gain more control over the e-commerce stream. According to Interviewees 6 and 15, the legislation, in conjunction with European Circular Economy legislation, has the added benefit of producing more data for risk management and enhancing supervision effectiveness. Implementation of European Circular Economy legislation, including the Product Passport, may result in a reduction in e-commerce import volumes as more products will be manufactured within the EU (interviewee 15).

Table 4.1: Causal Relations of Root Uncertainties in the European Governance Area

Plausible uncertainty direction	Number of inspections	Data availability	Collected tax and custom duties	Threshold difference
Creation of the EU Customs Authority	+			
Integration of the EU Customs Data Hub		+		
Custom dept is relocated to Member State of Identification			-	
Platforms are states as deemed importers		+		
Custom duty exemption is abolished	+			
Bucket-system for custom duties				-
Monthly payment of custom duties by platforms				-
Check and Traders-regulation in place				-
Growth of the EU	+			
Other data-generating legislation is in effect		+		

Developments of the European Union

The supervision policy and thereby the working methods of the Dutch Customs Administration can be affected not only by EU legislation but also by developments within the EU Customs Union. Examples are wars, the addition of new member states, or a scenario similar to Brexit (Interviewees 6 and 10). The main expected consequence is an increase in the volume of e-commerce imports processed by the Dutch Customs Administration. According to Interviewee 10, an 'NLExit' could potentially result in a slight decrease in import volume, as was the case for Great Britain (Office for Budget Responsibility, 2022). It is worth noting that wars also have consequences on trade. For example, during the Ukrainian conflict, e-commerce volume decreased significantly in Ukraine, while surrounding countries experienced slight additional growth (Zatonatska et al., 2023). Based on this research, a war can have varying effects on the volume of imports for the Dutch Customs Administration depending on its location within the EU.

The division of trade hubs in the EU Customs Union is another important factor. According to interviewee 12, 95 % of EU e-commerce imports occur in six countries: The Netherlands, Belgium, Germany, France, Spain and Hungary. The Netherlands, which is responsible for 30 % of the e-commerce imports, owes this number to the presence of two trading hubs, Schiphol Airport and the Port of Rotterdam. The creation of a new hub in another member state could redistribute the percentages of e-commerce imports and decrease the share of the Netherlands.

4.2.2. National Governance

National governance is another area of uncertainty identified in e-commerce supervision. The influence of the national government can be divided into two categories: national legislation and the prioritization of enforcement areas considered to be important.

National Legislation

National legislation determines the working methods and abilities of the Dutch Customs Administration. Legislation concerning customs activities is the Algemene Douane Wet, Wet Politie Gegevens and Algemene Douane Regeling. The Dutch Customs Administration is an implementing agency and thereby responsible for the execution of the tasks defined in legislation (Interviewee 4). This legal framework in which the Dutch Customs Administration operate currently causes difficulties in the information exchange and thereby also the enforcement (Interviewee 3). Changes in the legal framework can affect the working methods and possibilities of the Dutch Customs Administration. An example of a recent development in legislation is the creation of the 'Hit and Run Postteam' (HARP), which is a collaboration between the Dutch Customs Administration, Police and the Public Prosecution to fight against drug smuggling in postal flows (Ministry of Finance, 2024). Furthermore, national legislation can also assign additional supervision tasks next to the tasks assigned by the EU, resulting in more inspections to be performed. An example of a national supervision task is the recent ban on vapes (Netherlands Food and Consumer Product Safety Authority, 2024). National legislation thus can influence the design of supervision and the number of inspections to be performed. This uncertainty source can also be identified as a level 4 uncertainty.

Distribution of Supervisory Capacity

The second uncertainty, categorized as a level 1 uncertainty, within the national governance area is the distribution of supervisory capacity. As mentioned in Chapter 2, the Dutch Customs Administration prioritises its supervisory tasks together with the commissioning departments. The extent of the importance of e-commerce supervision determines the supervisory capacity for e-commerce imports that the Dutch Customs Administration has (Interviewees 1, 2, 3 and 4). The agreements made at the Overleg Departement Douane (ODD) roundtable are laid down in covenants (Interviewee 4). These covenants determine the supervisory focus of the Dutch Customs Administration and thus also the focus of the annual enforcement plan, which contains all the inspection targets for that year. In the case of limited enforcement capacity to carry out all the desired inspections, the allocation of capacity focuses on the prioritisation made in the enforcement plan. The tightness of the labour market also plays a role in the allocation of inspection capacity.

Table 4.2: Causal Relations of Root Uncertainties in the National Governance Area

	Number of inspections	Supervision capacity
Plausible uncertainty direction		
Additional national supervision tasks	+	
National legislation creates space for information exchange		+
E-commerce focus directed on e-commerce import		+

4.2.3. E-Commerce Supply Chain

The third uncertainty area identified is the E-Commerce Supply Chain. In this area, two aspects can be identified, namely the compliance of the parties in the supply chain and the dynamic of the supply chain. This uncertainty area is categorized as a level 4 uncertainty.

As stated in chapter 2, the Dutch Customs Administration aims to enhance supply chain compliance through supervision. According to Interviewee 9, parties involved in the supply chain can achieve compliance by adhering to regulations, paying the appropriate customs duties and taxes, and refraining from importing prohibited or unsafe goods. According to Interviewee 2, ensuring correctness is crucial for both safety and customs duties collection. Non-compliant parties in the supply chain can lead to incorrect declarations, which in turn can result in the entry of unsafe goods into free circulation and a decrease in collected customs duties.

In the e-commerce trade market, compliance is not the only issue causing uncertainty in supervision. The supply chain involves multiple parties who submit declarations on behalf of others, the submitting parties (Interviewee 9). The dynamics of flows in e-commerce are influenced by the high adaptability of declarants in choosing submitting parties, resulting in a lack of transparency in the supply chain. The routing of shipments for a specific declarant can therefore be easily changed (Interviewee 3). According to Interviewee 2, the dynamic flow causes complications in finding the source of the incorrect data for the declarations submitted.

Table 4.3: Causal Relations of Root Uncertainties in the E-Commerce Supply Chain

Plausible uncertainty direction	Data quality
Parties in the supply chain exhibit compliant behaviour	+
Lowered adaptability in submitting parties	+

4.2.4. Trade Market

The trade market represents the fourth area of uncertainty. Several root causes of uncertainty can be identified in the trade market. The first root cause of uncertainty is the trading strategy and relations with countries that produce e-commerce goods. Countries that produce e-commerce goods play a significant role in the trade market. According to Interviewees 6 and 11, the volume of e-commerce trade heavily depends on China's trading strategy, as it is the largest producer of e-commerce products. However, the details of this trading strategy are unclear. Interviewee 6 suggests that the production of e-commerce goods may decrease in the upcoming years, while Interviewee 11 notes that it could potentially grow up to five times the current volume. It is not only the volume of e-commerce trade that matters to China, but also the number of correct declarations. Interviewee 6 suggests that collaboration and information sharing between the Netherlands, the EU, and China could reduce incorrect declarations.

Geo-political design developments cause uncertainty in the trade market. EU developments are an uncertainty that affects e-commerce supervision. The size of the EU and the distribution of e-commerce hubs across the EU affect the number of e-commerce declarations submitted in the Netherlands (Interviewees 6, 10, and 15). Geo-political design can be categorized as a level 3 uncertainty.

The distribution of hubs also depends on the transportation costs of the goods, which is as a level 1 uncertainty the last source of uncertainty in this area. Currently, most e-commerce goods are transported by air due to their affordability and speed. According to Interviewee 6, an increase in transportation costs will lead to a rise in the price of e-commerce goods, which may result in a decrease in volume as consumers become less willing to pay the higher prices. One potential development is a shift from air cargo to sea cargo to maintain low e-commerce prices. However, this may increase transportation time, which is identified as an important characteristic of e-commerce trade in chapter 2 and could also lead to a decrease in the importation of e-commerce goods. Finally, this shift may also lead to a re-distribution of e-commerce hubs within the EU. Airports will no longer serve as e-commerce hubs, and instead, the importation of e-commerce goods will be shifted to one of the major harbours in the EU.

Table 4.4: Causal Relations of Root Uncertainties in the Trade Market

Plausible uncertainty direction	Data quality	Volume	Collected tax and custom duties
Diplomatic relationship between EU/NL and China	+		
E-commerce-focused trade strategy of China		+	
Growth of the EU		+	
Creation of new e-commerce hubs in other member states		-	-
Air-transportation costs increase		+/-	

4.2.5. Technological Advancements

According to Interviewees 1 and 5, technical advances can aid the Dutch Customs Administration's risk selection mechanism. These advances can be categorized into six categories: robotisation, automation, detection, sensorisation, interpretation, and artificial intelligence. According to Interviewee 13, robotisation can reduce the administrative burden of full-time employees, particularly when the workforce is ageing. Detection possibilities can improve the effectiveness of restricted goods, but this is not necessarily the case for unsafe products being imported, as they are more difficult to detect on a scan result. Technological advancements are categorized as a level 5 uncertainty.

Table 4.5: Causal Relations of Root Uncertainties in the Technical Advancements Area

Plausible uncertainty direction	Selection mechanism's accuracy	Effectiveness of inspections	Efficiency of supervision tasks
Technical advances in general	+		
Detection scans are in place		+/0	
Robotization used for FT-purposes			+

4.2.6. Labour Market

The ultimate area of uncertainty is the labour market, which primarily affects the completeness of the learning cycle. This area is a level 3 uncertainty. The inability to fill many vacancies leads to a decrease in the completeness of the learning cycle. According to interviewees 6 and 14, vacancies are increasing due to the ageing of the Dutch workforce and are highly dependent on the availability of jobs in the labour market. Technological advancements also play a role, as they can reduce the size of the workforce and job satisfaction. Job satisfaction can lead to a decrease in vacancies as employees are more likely to remain working at the Dutch Customs Administration.

Table 4.6: Causal Relations of Root Uncertainties in the Labour Market

Plausible uncertainty direction	Effectiveness of inspections	Completeness of the learning cycle
Ageing of the workforce	-	-
Technological advances in general		+/0/-
Tight labour market		-

4.3. Overview of identified Uncertainties

The previous paragraphs have identified several uncertainties in customs supervision in six areas: European governance, national governance, the e-commerce supply chain, the trade market, technological advancements, and the labour market. Uncertainties in European governance arise from EU legislation and developments, particularly the proposed UCC reform. National governance presents uncertainties in terms of legislation and the allocation of supervisory capacity. The e-commerce supply chain is subject to uncertainties related to compliance and dynamic flows. Uncertainty in the trade market arises from the trade strategies of countries producing e-commerce goods and geopolitical design. Technological advances, such as robotics and AI, introduce uncertainties in the supervision methods of customs administrations. Finally, uncertainties in the labour market stem from an ageing workforce and technological advances that affect job satisfaction and vacancies. Table 4.7 provides an overview of the uncertainties identified in the supervision of e-commerce products being imported into the Netherlands. These uncertainties highlight the complexity of the supervision system of e-commerce imports.

Table 4.7: Overview of Uncertainty Aspects and Roots

Uncertainty aspect		Uncertainty (roots)	
U1	European Governance	U1.1	European Legislation
		U1.2	Developments of the EU
U2	National Governance	U2.1	National Legislation
		U2.2	Distribution of supervisory capacity
U3	E-commerce Supply Chain	U3.1	Supply chain compliance
		U3.2	Dynamic flows
U4	Trade Market	U4.1	E-commerce exporter's strategies
		U4.2	E-commerce hub division
U5	Technological Advancements	U5.1	Robotisation
		U5.2	Automation
		U5.3	Detection
		U5.4	Sensorisation
		U5.5	Interpretation
		U5.6	Artificial Intelligence
U6	Labour market	U6.1	Labour market space

4.4. Future Scenario

This section describes a plausible future scenario that will be used for the further development of the e-commerce import supervisory actions. The scenario is highlighted by the focus of this study as well as is derived from the uncertainty analysis.

The future scenario is the proposed renewal of the UCC. As mentioned in the paragraph above, the proposal for the renewal of the UCC is the reason for this study, as the Dutch Customs Administration wants to explore possible supervision strategies for the timeframe when the renewed UCC comes into force. According to the proposal, the renewed UCC should enter into force for e-commerce in 2028 (European Commission, 2023b). The EC, the authors of the proposal, are highly motivated to improve the following aspects: data availability, data quality and therefore the selection mechanisms in place. This could mean that the achievement of the first two objectives of the Dutch Customs Administration would benefit. However, the difference between the thresholds for B2C and B2B importers may increase, resulting in a trade-off between the first two objectives and the last objective.

5

Challenges in E-Commerce Supervision

This chapter elaborates on the challenges that can be or are experienced in the customs supervision of e-commerce imports. This chapter answers the third research question of this study. The research question is formulated as follows: *“What are the challenges in the current supervision process?”*. First, the challenges identified in the literature are discussed. Next, the challenges identified in the interviews are elaborated on.

5.1. Challenges in the Literature

This section discusses the challenges of customs supervision in e-commerce as identified in the literature. The challenges are categorized into five sections. The first section elaborates on the challenges related to the e-commerce supply chain, followed by challenges related to the volume of imports. The third category of challenges is related to organizational factors. Challenges are also identified in the field of data collection and assessment, which is the fourth category. Additionally, European legislation is recognized as a source of challenges.

5.1.1. E-Commerce Supply Chain Challenges

The e-commerce supply chain presents significant supervisory challenges. The first challenge is caused by the increasing number of individual traders involved in the supply chain (World Customs Organization, 2017). These traders contribute to a less transparent chain, which in turn creates multiple challenges. Low transparency in the supply chain makes it more difficult to assess information as the quality of the data decreases (Rukanova et al., 2021). This lack of transparency is caused not only by individual traders but also by the low percentage of known traders in the stream (Männistö et al., 2021a; Rukanova et al., 2021; World Customs Organization, 2017). Known traders facilitate transactions (World Customs Organization, 2017), improve data quality, and thus enable more effective information assessment. Customs administrations face difficulties in linking shipments to potentially non-compliant parties due to a lack of compliance patterns (Männistö et al., 2021a). Some of these parties are occasional traders who do not have a compliance history and therefore have a lower chance of compliance as they may be unfamiliar with the rules and regulations (World Customs Organization, 2017). As a result, occasional traders also contribute to a more complicated information assessment.

Furthermore, the behaviour of parties in the supply chain causes three additional challenges for e-commerce supervision, as identified in the World Customs Organization report (2017). The first challenge is related to the dynamic nature of the supply chain, which is a characteristic of the e-commerce market (see Chapter 2). The dynamic nature of the supply chain causes a ‘waterbed effect’. The waterbed effect refers to the phenomenon of illicit traders shifting their transportation routes, submitting parties, and even countries when control measures are implemented. To improve the effectiveness of information assessment, a cooperation agreement between parties in the supply chain and the customs administration could be established, which would increase data availability and potentially improve data

quality. However, parties' willingness to cooperate in the supply chain can vary, with some being more willing to exchange data than others. The last challenge concerning the behaviour of parties is the high demand for fast international parcel service (Männistö et al., 2021a). This leads to customs being expected to supervise shipments without slowing down the delivery process. This demand logically follows from the e-commerce trade market analysis provided in Chapter 2. Inspections should not cause delays or stoppages at the border, which could result in a limited time frame for assessing and intervening with information.

5.1.2. Volume Challenges

Chapter 1 states that e-commerce import volume has grown exponentially in recent years. Männistö et al. (2021a) report a 104 % growth in cross-border parcel traffic over five years. The high volume of e-commerce products entering the EU presents many challenges for customs administrations. The WCO report from 2017 shows that 14 countries have already experienced facilitation challenges due to the increased volume. The import overflow in e-commerce can lead to facilitation problems (World Customs Organization, 2017) and a lack of control over the import flow (Antov, 2023b). Additionally, the 'waterbed' phenomenon can also be observed. According to Yu (2018), an increased volume of postal articles increases the potential risk of smuggling due to the fragmentation of flows, which leads to violations of intellectual property rights (IPR) and undervalued items. The final challenge identified is the splitting of shipments by parties in the flow (World Customs Organization, 2017). This not only increases the volume of e-commerce imports but is also commonly used to stay below the threshold of 150 EUR and avoid paying customs duties.

5.1.3. Organisational Challenges

Organisational challenges are identified in the literature. According to Rukanova et al. (2019), the supervision level is limited to the capacity of the customs administrations. This is, however, the biggest organizational challenge identified. Limited capacity leads to challenges in facilitation and information assessment (World Customs Organization, 2017; Rukanova et al., 2019). The lack of standardized procedures is also identified as a challenge for information assessment by the World Customs Organization (2017). The content and format of operators' manifests are an example. Manual corrections can lead to deficiencies in supervision activities. Additionally, customs experience increasing administration and clearance costs (Yu, 2018; World Customs Organization, 2017). The increase in administration costs is caused by additional clearance procedures that were put in place when the minimum threshold for VAT was eliminated (Yu, 2018).

5.1.4. Data Challenges

The challenges identified in data collection and assessment fall into the fourth category. The first source of these challenges is the collection of data. According to a study by Walsh (2022), customs administrations rely on third-party data which is passed through several parties before being submitted to customs as a declaration. Furthermore, data collection is sometimes untimely. The World Customs Organization (2017) states that the express manifest is sometimes transmitted after the arrival of shipments, resulting in incomplete or inaccurate data during the collection process. This challenge is also observed in postal flows (Männistö et al., 2021a). Poorly timed data collection can reduce the effectiveness of information assessment as it relies on the available data and can cause shipment delays. Additionally, not all important data elements may be collected. Antov (2023b) notes that the H7 dataset does not include the trade name, which can infringe on IPR rights.

Next to data collection, challenges can also arise in data quality. The literature identifies several sources of challenges related to data quality, including incorrect tariff classification, vague descriptions, and inaccurate or incomplete information (Antov, 2023b; Rukanova et al., 2021; Männistö et al., 2021a; World Customs Organization, 2017). The main challenge identified in this context is trade mis-invoicing, particularly the practice of under-invoicing imports, also known as undervaluation (World Customs Organization, 2018).

5.1.5. European Legislation Challenges

European legislation is identified as the last source of challenges in the literature. According to Walsh (2022), the main customs legislation, the UCC, is never fully completed. The current supervision activities, procedures, and methods defined in the UCC are challenged due to the rapid growth of imports

(Antov, 2023a). Furthermore, the UCC lacks definitions or agreements, resulting in an absence of uniformity in the European Customs Union (Walsh, 2022). The report by the World Customs Organization (2017) supports Walsh's statement by identifying the absence of standardized procedures. Additionally, the lack of a clear definition of 'declarant' means that anyone can assume this role. Moreover, the UCC does not specify the level of supervision required, resulting in executive federalism (Walsh, 2022). The execution of federalism does not aid in mitigating the 'waterbed effect' as offenders can easily switch to importing flows in member states with lower supervision standards.

5.2. Challenges in the Interviews

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5.3. Common Challenges in Literature and Interviews

The two paragraphs above identify several challenges that are currently faced in the supervision of e-commerce imports. Comparing the challenges identified in the literature with those gathered from the interviews, four similarities emerge, highlighting the universality of the issues facing the e-commerce supply chain and enforcement activities. The overwhelming impact of high import volumes is one of the most notable similarities that can be identified. Both literature and interviews highlight how the high volume of e-commerce imports presents significant challenges for Dutch customs Administration. Both literature and interviews emphasise that the exponential growth of e-commerce imports leads to facilitation problems and, most importantly, a lack of control over this import flow. This has implications for inspection capacity and the effectiveness of Dutch customs Administration's supervision. In addition, data-related challenges emerge strongly in both the literature and the interviews, especially in data collection and assessment. Interviews reflect the challenges of incomplete and inaccurate data by highlighting the fragmented nature of the data collected and the poor quality of the data, which affects the assessment of the information. These overlapping challenges underline the critical need for improved data collection to enhance the extent to which successful supervision can be achieved. In addition, the literature highlights limitations in inspection capacity. The interviews also shed light on similar challenges, such as high staff turnover and resource limitations. Furthermore, challenges related to the dynamic characteristics of the e-commerce market are common to both literature and interviews, in particular the high adaptability of offenders and the lack of a responsible party within the supply chain.

6

Supervisory Actions

This chapter elaborates on the possible supervisory actions identified. To identify the supervisory actions, the opportunities in the supervision system are described first. Then, the weaknesses of the current e-commerce import supervision process are elaborated on. The final section contains the identification and selection of the supervisory actions.

6.1. Supervision Opportunities

The analysis of the interviews and the literature study highlighted several opportunities. These opportunities can be divided into opportunity aspects, which are first described below. Thereafter, a comparison between opportunities found in the literature and opportunities found in the interviews is made.

6.1.1. Opportunity Aspects

The literature and interview analysis highlighted six opportunity aspects (see Figure 6.1). Each opportunity aspect is described in the sections below.

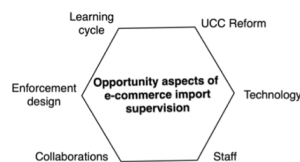


Figure 6.1: Opportunity Aspects

UCC Reform Opportunities

The first opportunity aspect is UCC reform. This opportunity aspect includes the opportunities presented by the proposed renewal of the UCC. Four opportunities can be derived from this renewal. This first opportunity is the risk management by the EU Customs Agency (interviewee 11). Other opportunities lie in the location of responsibility, such as platforms appointed as deemed importers (interviewee 8), trust- and check traders (interviewee 11) and possibly the self-declaration principle, which puts the responsibility for accurate declarations on the consumers themselves (interviewee 11). Interviewee 5 states that the reform of the UCC will contribute to a general improvement in the performance of safety inspections. In addition, a revised tariff classification such as the bucket system or the designation of a single tariff class will improve the remittance of the correct duties.

Literature complements the opportunities identified in the interviews. The extent of the trusted traders' principle to CBEC organisations could lead to expediting customs processing and thereby safe and fast movement and delivery of the e-commerce goods (World Customs Organization, 2022; Antov, 2023b). Also, simplified procedures lead to this opportunity (World Customs Organization, 2022; Antov, 2023a). The UCC pillars can also lead to improved risk management and thereby more effective inspections.

This is caused by the introduction of the single-window environment (Yu, 2018), inter-agency cooperation and information sharing in the ECDH (World Customs Organization, 2022), the introduction of the legal framework and international standards for advanced electronic data (World Customs Organization, 2022b). International standards in customs control forms also lead to an increased performance of the risk selection mechanism (Suyunov & Fakhriddinova, 2022). Additionally, the pillars strengthen the improved risk management because it implies improved data quality, caused by the introduction of the deemed importer and timely pre-arrival information availability (Walsh, 2022; WCO, 2017; Mänistö et al., 2021b). Furthermore, the shift to more system-based supervision may lead to a reduction in custom workload as manual processing is replaced by periodic supervision (Antov, 2023a). Last, the revenue collection is strengthened by the removal of the minimis threshold and advanced electronic data availability (World Customs Organization, 2022).

Technical Opportunities

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Literature adds other technical opportunities. Studies by Mässinstö et al (2021), Janssens et al. (n.d.) and Hintsa (2021) identify the use of non-intrusive detection technologies to improve the risk-selection and revenue collection, as well as reducing the custom processing time. Examples of these non-intrusive detection technologies are mobile technologies, various X-ray interpretations and a product valuation tool. Furthermore, the use of AI can enhance the level of service provided with the potential result of an increase in data accuracy and AI can be used to improve risk analysis (Mikuraya & Cantens, 2020). Finally, improved data availability can be realized by the use of an e-commerce platform evaluation which identifies the value of data on e-commerce platforms for risk analysis elements (Rukanova et al., 2019). Another method is the use of smart contracts that aggregate relevant information from blockchain-based ledges in combination with an audit mechanism which creates shared, distributed, timestamped and immutable data thereby increasing the transparency and traceability of information (Segers et al., 2019; Yaren, 2022). Big data, potentially generated by blockchain, can be used to reduce false negatives, reduce false positives and handle large increases in volumes of declarations (Rukanova et al., 2019).

Staffing Opportunities

In addition, interviewee 15 states that there should be a comprehensive and permanent recruitment of new staff to reduce the number of vacancies. Finally, rejuvenating the workforce could potentially lead to new enforcement designs and increased flexibility within the organisation (interviewee 15).

Literature adds other opportunities like increasing the proactive curiosity of the staff, which increases the inspection effectivity of unusual shipments even if the shipment is categorized in a trusted trade lane. Other opportunities are the diversity of the supervision teams increasing the knowledge variety supporting the prevention and suppression of offences. This also concerns the diversity in gender as the exclusion of women in customs administrations limits the performance capability. (Siripanukul et al. 2022)

Cooperation Opportunities

According to the interview analysis, cooperation is considered important. Dutch Customs Administration should cooperate with various parties in the area of supervision, such as other supervisory authorities (interviewees 4 and 10) and customs administrations of other Member States (interviewees 3, 4, 5, 7, 13 and 14). In addition, the division of responsibilities, i.e. cooperation with other parties in the supply chain, is also an opportunity (interviewee 15). Cooperation can take several forms, such as cooperation with platforms (interviewees 5, 15 and 17), establishment of secure trade lanes (interviewees 13, 14 and 17), exporting countries (interviewee 17) and carriers (interviewee 3). Finally, interviewees 6, 13 and 14 highlight the added value of international cooperation with global innovation organisations such as the Pan-European Network of Customs Practitioners (PEN-CP) and the WCO.

Literature indicates that cooperation can take place in many forms. The main objective of the cooperation is increased data quality which takes place in the form of trade agreements (Yu, 2018). The first cooperation form is the data exchange with the sellers of the e-commerce goods, also known as public-private partnerships (World Customs Organization, 2022). A popular example is the Vendor Collection

Model in which the sellers collect taxes and customs duties at the point of purchase of the good, similar to the IOSS regulation. This significantly improves the revenue collection (Mässistö, 2021; Rukanova et al., 2021). Other potential cooperation partners can be the e-commerce platforms. This can be achieved using voluntary data-sharing with resource-dependence platforms in which the collaboration is driven by the parties' interests and result in a win-win situation (Susha et al., 2019). This type of data can also be called external data which increases the value of pre-existed datasets by collecting more accurate information for the valuation process and information on unknown first-time importers (Männistö et al., 2021b). This cooperation form helps to increase the trustworthiness within the supply chain (Boriana et al., 2021) and creates the potential for a next-generation risk assessment (Hintsä, 2021). Cooperation with postal and express operators also increases this opportunity (Hintsä, 2021). Self

The last cooperation form is the cooperation with other (inter)national supervisory agencies (Männistö, 2021b; Customs Organization, 2022) increasing the external data availability and tackling trade mis-invoicing. This form of cooperation can be achieved by data exchange using CDSs (Yu, 2018), increasing the revenue collection using the Partner Country method (PCM) indicating the trade gap between the countries (WCO, 2018) or blocking illicit websites (WCO, 2017)

Enforcement design Opportunities

In terms of the design of enforcement itself, respondents identified several opportunities. The first opportunity is to focus on the import hubs, the warehouses where the goods are available for inspection. According to interviewees 4, 13 and 17, the hubs are limited places where everything happens, so they should be improved to improve the design of enforcement. In addition, the Dutch Customs Administration should look into methods to increase the generalisability of safety inspections as a method to reduce the number of physical inspections required (interviewees 13 and 4). This can be achieved by trying to shift from e-commerce to fulfilment (B2B2C), where generalisable safety checks take place before releasing for free circulation (interviewees 11 and 15). Other opportunities for improvement include clear (preventive) enforcement communication to each party in the supply chain (respondents 1, 3, 4 and 9).

Many opportunities identified in the previous opportunity areas also apply to the enforcement design as this is the base of the supervision policy. Walsh (2022) identifies another opportunity, namely the application of a self-assessment moment in the declaration submission process. This system provides post-ex facto checks for declarations and penalties for misdeclaration. Another opportunity is achieving a high-level maturity of risk management in the organisation (World Customs Organisation, n.d.b). Using a compliance management model, the suited level of intervention is based on the deemed risk level, and activity of supervision. Examples of interventions from the compliance management model are starting from compliance programs and education until prosecution and pre-clearance and post-clearance interventions.

6.1.2. Comparison of Opportunities in the Literature and from the Interviews

In analysing the opportunities for e-commerce supervision, both interviews and literature highlight similar themes while also revealing differences in perspectives. Similarities between interviews and literature emerge in various domains. Both sources emphasize the potential of the UCC reform to enhance risk-based selection and streamline custom processes. Also, technical advancements are seen as central to enhancing the success of e-commerce supervision. Additionally, cooperation among stakeholders is highlighted as crucial for information sharing and streamlining customs processes. However, differences also surface between the interviews and literature opportunities. On one hand, interviews tend to focus more on national and practical opportunities whilst, on the other hand, literature provides a broader perspective on overarching international cooperation frameworks.

6.2. Supervision Weaknesses

In addition to the opportunities, the interview analysis also highlighted weaknesses that can potentially reduce the success of supervision. This section does not include weaknesses from the literature as internal challenges are not published. External challenges identified in the literature can be found in Chapter 5.

The weaknesses identified in the interviews are categorized into seven aspects. The aspects are shown

in Figure 6.2

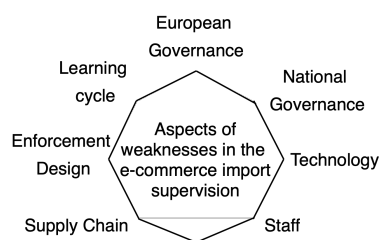


Figure 6.2: Aspects of Weaknesses

European Governance

There are several weaknesses to be noted in European governance. The first weakness identified is in European legislation. European legislation is often ambiguous and contains complex (IT) system requirements. Furthermore, the proposed renewal of the UCC is a source of weakness. Weaknesses of the proposal itself are the fact that the three pillars are presented in one package, i.e. it is all or nothing, the proposal places responsibilities on parties that are not feasible (interviewees 8 and 11), complemented by the unrealistic data semantics requirements of the ECDH (interviewee 11). Furthermore, the proposal is based on an incomplete view of the e-commerce trading market (respondent 11). In addition, the proposed renewal will not lead to a direct reduction in e-commerce imports and therefore will not alleviate the challenges posed by the increasing volumes (respondent 11). Finally, the proposals are abstract, which makes it difficult to prepare for when the legislation comes into force (interviewee 10).

Other weaknesses outside of European legislation are the extent of supervisory knowledge and knowledge sharing with and between other member states (interviewee 6). This will not mitigate the waterbed effect once the renewed UCC is in place.

National Governance

The first weakness related to national legislation is the influence of national politics on the direction and focus of enforcement by the Dutch Customs Administration (interviewee 4), complemented by the possible capacity trade-off between the different enforcement areas. In addition to the political influence on the enforcement areas, politics also plays a role in efficiency (interviewee 7). A weakness outside of national policy is the ambiguity of national legislation (interviewee 9).

Technology

This paragraph is not available in the public version for confidentiality reasons.

Staff

Staffing is identified as an opportunity but also as a source of weakness in the supervision of e-commerce imports. The main weakness is the limited capacity (interviewees 10 and 15), especially in the IT departments (Interviewees 9 and 10), which will only increase with the expected migration, causing various capacity problems (Interviewee 1). The shared sense of responsibility caused by the size of the organisation is the final weakness identified in this aspect.

Supply Chain

Many of the weaknesses in the supply chain have already been discussed in the aspects above. In addition to these weaknesses, the dynamic nature of the supply chain is a source of weakness (interviewee 3). Another weakness identified is the presence of intentional criminals in the supply chain, resulting in fiscal and safety risks (interviewee 1). Furthermore, interviewee 17 points out that the threshold for changing the Member State of identification for platforms is very low, which makes it difficult to impose further sanctions or trace high-risk shipments from non-compliant parties.

Learning cycle

The learning cycle is also a source of both opportunities and weaknesses. The learning cycle is characterised as incomplete, which reduces job satisfaction and thus the quality of work (interviewees 10, 13 and 14).

Enforcement Design

The six weaknesses relate to the design of enforcement. The process of preventive supervision is complicated by the international context of the field of work (Interviewee 14). Furthermore, the actor-oriented approach lacks popularity in other Member States and the EU (interviewee 12). Furthermore, the actor-oriented design is based on compliant actors, which is not the reality (interviewees 2 and 10). E-commerce is also not the focus of the existing enforcement policy (interviewee 3). The final weakness is the limited cooperation of the organisation with other parties in the supply chain and Member States to improve data quality or monitoring methods.

6.3. Supervisory Actions

The opportunities and weaknesses identified in the previous sections are used as input for the formalisation of supervisory actions that can be used to achieve successful supervision of e-commerce imports. Challenges identified in Chapter 5 are also a source for supervisory actions, as well as literature. The possible actions identified are briefly described in the first paragraph. The second section highlights the actions selected for further analysis and provides a more detailed description.

6.3.1. Possible supervisory actions

The opportunities and weaknesses indicate room for supervisory actions which potentially increase the extent to which successful supervision can be achieved. The actions derived from the opportunities and weaknesses are complimented with specific actions mentioned in the interviews. Table 8.1 provides an overview of the supervision actions.

Table 6.1: Overview of Supervisory Actions

	Supervisory Action	Brief description	Source
Technology	<i>Confidential</i> <i>Confidential</i> Utilize blockchain for data pipeline	<i>Confidential</i> <i>Confidential</i> Implement blockchain technology to create transparent data pipelines for monitoring e-commerce flow	<i>Confidential</i> <i>Confidential</i> Interviewee 17; Segers et al., 2019
	Employ predictive models and AI	Utilize AI and predictive models to improve risk analysis and enhance inspection effectiveness	Interviewee 5; Mikuraya & Cantens, 2020
Staff	Stimulate curiosity of customs officers	Encourage customs officers' curiosity to improve inspection effectiveness and job satisfaction	Interviewees 2, 10, 13 and 14; Siripanukul et al., 2022
Cooperation	Implement comprehensive recruitment	Recruit new staff comprehensively to reduce vacancies and improve workforce capacity	Interviewee 15
	Establish secure trade lanes	Create secure trade lanes to streamline customs processes and ensure compliance	Interviewees 13, 14, 17; Hintsa, 2021,
	Enhance cooperation with other supervisory authorities	Collaborate with other (inter)national authorities for improved information sharing and enforcement effectiveness	Interviewees 4, 10; World Customs Organization 2022
Enforcement design	Adopt preventive supervision measures	Implement preventive supervision measures to enhance compliance within the supply chain of parties and improve the data quality of the declarations	Interviewees 2, 10 and 14
Learning cycle	Automate customs processes	Implement automation in custom processes to reduce the administrative burden of inspections	Interviewees 1, 5, 9, 13 and 14
	Enhance communication between departments	Improve communication between departments to facilitate a faster and more effective learning cycle	Interviewees 2, 5, 9, 10 and 14
	Implement sanctions policy	Establish a sanctions policy to ensure accountability and follow-up on inspection findings	Interviewees 9 and 14

6.3.2. Selected Supervisory actions for further Research

In this study, five supervisory actions are selected to be further investigated on their effects in the current and future scenarios. The selection of these actions is made in consultation with custom experts. The selected actions are described in more detail in the paragraphs below.

Action 1: Confidential

This section is not available in the public version for confidentiality reasons.

Action 2: Adopt preventive supervision measures

Action 2 involves adopting preventive supervision measures to enhance compliance with e-commerce import regulations. The action consists of two sub-actions that vary in their focus on e-commerce supply chain parties. Preventive supervision measures should enhance the compliance of the parties targeted by these actions, thereby improving the data quality of the declarations.

Action 3: Confidential

This section is not available in the public version for confidentiality reasons.

Action 4: Automate customs processes

Automating customs processes involves the use of technology and automated systems to simplify and optimize various aspects of customs supervision. Through automation, the Dutch Customs Administration can reduce the administrative burden of inspections, minimize processing times, and improve the overall efficiency of e-commerce import supervision. Automation can be applied to both FT and AB inspection tasks.

Action 5: Stimulate curiosity of custom officers

Simulating curiosity among customs officers involves implementing strategies and initiatives to cultivate a proactive mindset within the customs workforce. This action aims to encourage officers to actively seek out anomalies, irregularities, or potential risks in e-commerce imports. By stimulating curiosity, customs officers become more effective in safeguarding against illicit trade and ensuring compliance with regulations.

7

System Analysis

This chapter contains the system analysis of the study area, namely the supervision process of e-commerce imports in the Netherlands, resulting in a verified simulation model. The result is a verified simulation model, which serves as the research tool to answer the fourth sub-question: *“What e-commerce supervision actions can be identified to enhance successful supervision of e-commerce imports?”* It begins with a brief system description, followed by the conceptualisation of the system. Thereafter, the model formalisation and implementation are presented. Finally, the model verification is elaborated on.

7.1. System Description

The system description consists of the system boundary definition, describing the systems' scopes and limits (Nikolic et al., 2019). Next to the system boundary definition, the modelling question is formalised. A full overview of the system description can be found in Appendix F.

7.1.1. System Boundary Definition

The scope of the system is limited to the process Import of e-commerce imports in the Netherlands and focuses on the primary supervision activities, namely physical and document inspections. This indicates a social limit, as only the AB and FT departments are considered in this system. Furthermore, a temporal limit is seen as further enforcement actions based on non-conformity are not in this system's scope. Additionally, a spatial limit is seen as the system includes the five largest e-commerce customs regions. Another temporal limit of the system is that the system behaviour and interactions of one week are considered, namely one of the busiest weeks concerning e-commerce imports. Last, the definition of e-commerce imports as provided in Chapter 2 also contains the postal flows in which shipments do not have to be declared. This system only includes e-commerce trade that is declared.

The system under investigation can be divided into two subsystems: the selection system and the inspection system. The selection system includes the submission, acceptance process and selection process of the DECO and AGS/DMS declarations in the Custom Declaration System (CDS) and risk-selection system, called PRISMA. Selected declarations in the selection system are the input of the inspection system, in which the document inspection of the declaration by AB employees or the physical inspection of the shipment by FT employees takes place. Six key system components that are identified are the declaration, the CDS, the selection mechanism used in PRISMA, the shipment, the supervision activity and the customs employees.

7.1.2. Modelling question

The modelling question that is formalised based on the system boundaries identified is based on the XLRM framework (see Figure 7.1). This framework provides an overview of the external factors (X), the policy leverages (L), the relationships in the system (R) and the performance metrics (M).

The modelling question for this modelling approach is formalised as follows: *“What is the effect of A1, adopting preventive supervision measures, A3, automating customs processes or stimulating curiosity*

of customs officers on the effectiveness of supervision, the risk-based inspection share, efficiency of the inspection resource allocation, efficiency of supervision tasks, logistical delay of inspected shipments and the objective inspection chance of shipments declared given the current supervision process of e-commerce import and the proposed UCC reform?”

Figure 7.1: XLRM-Framework

This figure is not available in the public version for confidentiality reasons.

7.2. Model Conceptualisation

This section presents the conceptualization of the system described above. First, the two conceptual models are briefly elaborated on. Then, the main model assumptions and model reductions are described. A complete overview of the conceptualisation including a detailed description of the conceptual models, input variables and model assumptions and reductions can be seen in Appendix F.

7.2.1. Conceptual Models

A conceptual model is made to represent the system in a simplified manner. According to Kotiadis & Robinson (2008), a conceptual model is: “a non-software specific description of the computer simulation model (that will be, is or has been developed), describing the objective, inputs, outputs, content, assumptions and simplifications of the model”. To optimally represent the system, two conceptual model methods are used. The first method is Integration DEFINition for Function (IDEF0). The second conceptual model method is the Unified Modeling Language (UML).

IDEF0 diagram: Custom Processes

The IDEF0 is used to provide insights into the contents and sequence of process steps of supervision of e-commerce imports. As a clear distinction is made between the selection system (indicated with the letter S) and the inspection system (indicated with the letter I), these systems will both be represented in two different processes (see Figure 7.2).

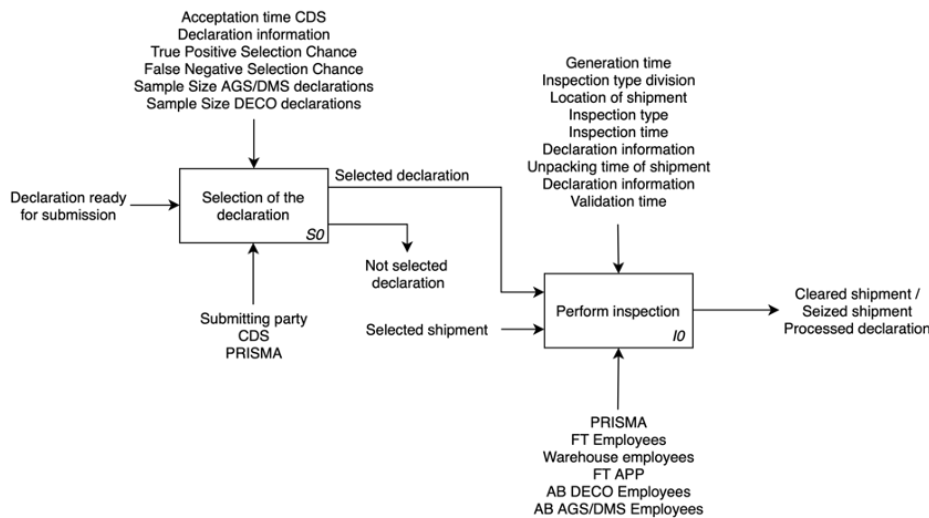


Figure 7.2: IDEF0 Diagram (Level 0)

As can be seen in the IDEF0 diagram, the process starts with a declaration that is ready to be filed in one of the CDSs. In this process the submission, the acceptance and the risk selection of the declaration take place, resulting in a distinction between selected declarations and not selected declarations. It is important to note, that only the selected declarations will go through the inspection performance process (process step I0). The reason for this is that the customs do not play any role in the logistical processes of declarations that are not selected as they will immediately be released into free circulation.

The selection performance process ends with a processed declaration and a shipment that is either cleared and released into free circulation or a seized shipment.

7.2.2. UML Diagram: interaction between components

The UML diagram illustrates the interactions between identified components within the system. There are three types of interactions present: inheritance, denoted by a hollow arrowhead, where the subclass inherits all the characteristics of the superclass; association, denoted by a solid line, where one class is connected to another; and aggregation, denoted by a hollow diamond where a class is part of another class.

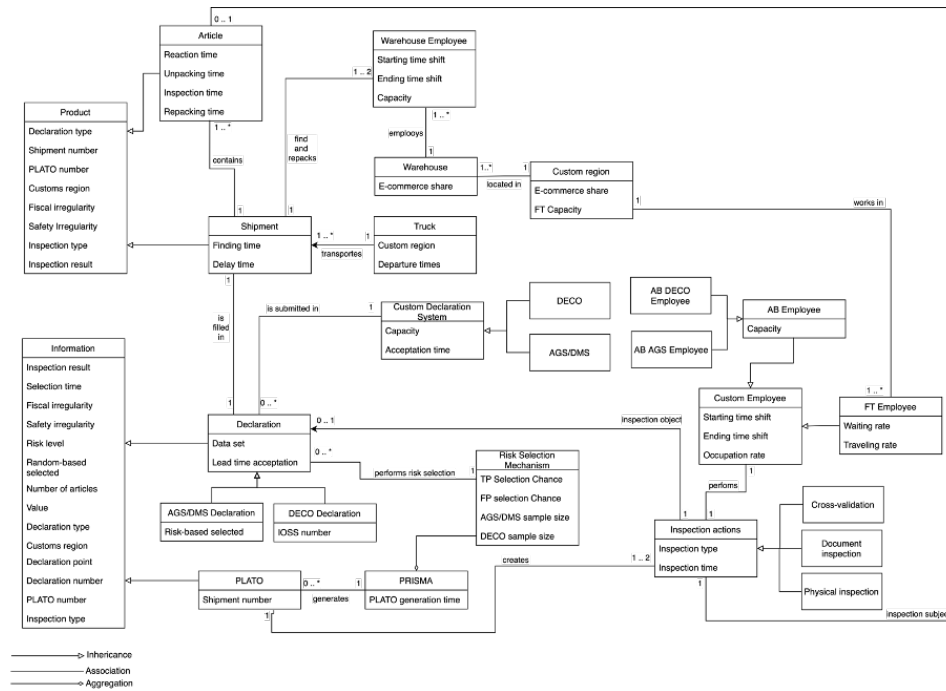


Figure 7.3: UML Diagram

Based on many inheritance relations between classes in the UML diagram, it can be concluded that customs supervision contains a lot of decompartmentalised elements. Furthermore, the cardinality is in association relations 1. This indicates the product-level supervision approach that exists in the supervision process. The UML also shows the extensive amount of data elements and characteristics of the information and product class. Based on this observation, it can be confirmed that data has a key role in the supervision process.

7.2.3. Conceptual model assumptions and reductions

A few model assumptions and reductions are made to conceptualise the system. The main assumptions and reductions can be seen in Table 7.1.

Table 7.1: Conceptual Model Assumptions and Reductions

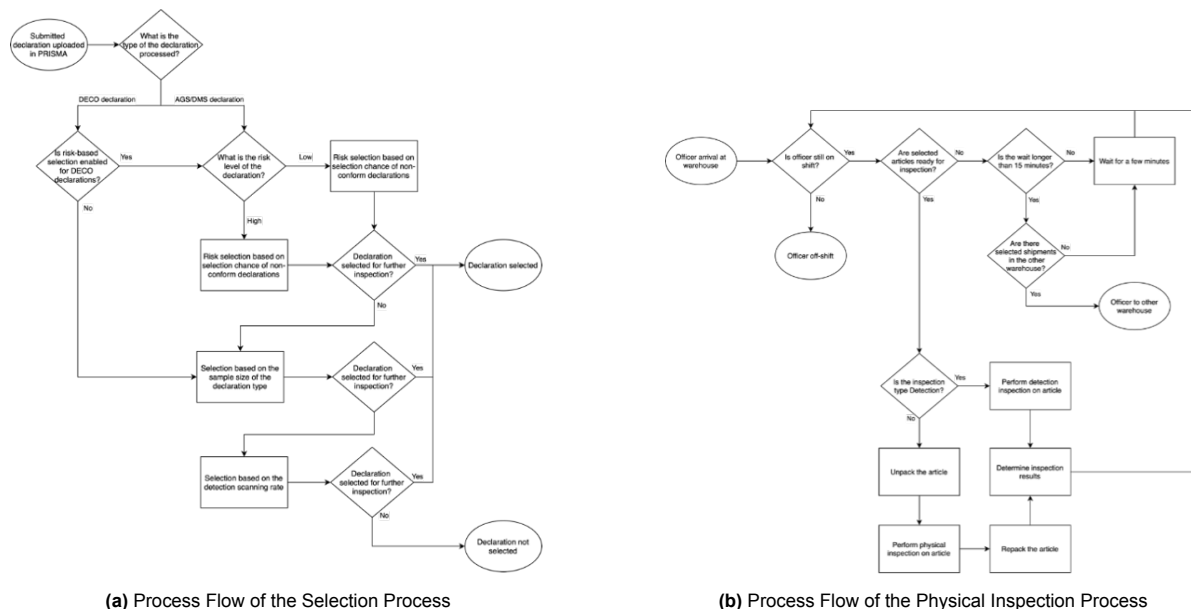
		Selection System	Inspection System
Model Assumptions		The selection chance of non-conform declarations is equal for every non-conform declaration. The same applies to the selection chance of conforming declarations. The CDSs and PRISMA perform optimally all the time and can process an infinite number of declarations.	All the selected articles are inspected by customs officers.
Model Reductions		The manual risk-selection time of customs officials is not included in the model. Declarations can only be selected by the probabilities of the selection mechanism in place, limiting additional inspection requests by commissioning departments, Member States or the EU.	The FT night shift is not included in the model as most warehouses are closed at those times. A document inspection cannot lead to an additional physical inspection of the shipment.

7.3. Model Formalisation

The formalisation is the translation of the conceptual model to formal computational representations. This includes a description of the main processes, input variables, and main model assumptions and reductions made in this modelling phase.

7.3.1. Main processes

In both systems, processes affect the systems' state and behaviour. The selection system contains one core process, namely the selection process. As the process name indicates, this process determines whether a declaration is selected for further inspections (see Figure 7.4a). Contrary to the selection system, the inspection system contains multiple important processes. The first process is the PLATO generation process, which creates a PLATO based on the selected declaration. In this process, the inspection activity type is determined. The second process is the physical inspection process (see Figure 7.4b). This process starts once an FT employee arrives at a warehouse. After the physical inspection, the third main process starts, namely the cross-validation of the declaration and inspection result performed by AB employees. This is the final process before the declaration leaves the system.

**Figure 7.4:** Process Flows of Main Processes in the Models

7.3.2. Input Values

The values of input variables and parameters used to formalise the model are based on data analysis results (1), document analysis (2), observation analysis results (3) or assumptions (4) (see Table 7.2). The data analysis is performed on available data from the CDSs. As the e-commerce trade has a dynamic character and knows exponential growth, the values are based on 2023 as this is the most recent year of which a complete dataset can be derived. Appendix F provides a full overview of the data analysis. Other input values resulted from the observation analysis, in which three observation days were encountered (see Appendix B). In the case that neither the data analysis, observation analysis or document analysis resulted in usable input values, various custom employees were approached to provide an assumption.

Table 7.2: Sources of Input Values

	Input variable or Parameter	Sources			
		1	2	3	4
1	Customs region distribution	X			
2	Fiscal irregularity rate	X	X		
3	Safety irregularity rate	X	X		
4	Dutch IOSS	X			
5	Submitting party number	X			
6	Acceptation time CDSs	X			
7	Sample size		X		
8	PLATO generation time				X
9	Document Inspection Rate	X			
10	Cross Validation time				X
11	Departure time trucks				X
12	Work schedule warehouse employees				X
13	Finding time			X	
14	Warehouse distribution	X			
15	Unpacking time			X	
16	Inspection time			X	X
17	Irregularity finding chance				X
18	Repacking Time				X
19	Work schedule AB employees				X
20	Work schedule FT employees				X

7.3.3. Formalised model assumptions and reductions

Tables 7.3 contain the main model assumptions and reductions made in this modelling phase for both systems. A full overview of the model assumptions and reductions can be seen in Appendix F.

Table 7.3: Formalised Model Assumptions and Reductions

	Selection System	Inspection System
Model assumptions	The accuracy of the risk-based selection mechanism is the same for AGS/DMS and DECO declarations. There is no time required between the declaration acceptance in the CDS and the selection of the declaration in PRISMA.	The custom officers finish their inspection tasks before going off-shift.
Model reductions	Declarations can only be selected based on one selection criterium The system is limited to the five biggest e-commerce custom regions.	Inspection types are determined when creating the PLATO instead of during the selection mechanism.

7.4. Model Implementation

This section contains a description of the implementation of the model formalised in the paragraph above, in which the formalised model is translated into a computational model using the simulation software. The simulation software used in this study is the discrete-event simulation software Simio. The reason for the discrete-event simulation is the systems view, namely the transaction-flow worldview. Schriber et al. (2012) describe a transaction-flow worldview as follows: *“a system is visualized as*

consisting of discrete units of traffic that move (flow) from point to point in the system while competing with each other for the use of scarce (capacity-constrained) resources.” (p. 23). In this study, the declarations and shipments are the discrete units of traffic that move through the information systems or locations.

7.4.1. Selection System

The selection system is translated into the first Simio simulation model. The facility view of the computational model is shown in Figure 7.5. The declarations are created on the left-hand side and are accepted in the CDS by the first servers. After the acceptance, the declarations are selected in the last server before leaving the system. Selected declarations move to the dark grey-coloured sink and non-selected declarations are released into free circulation, represented by the light grey-coloured sink.

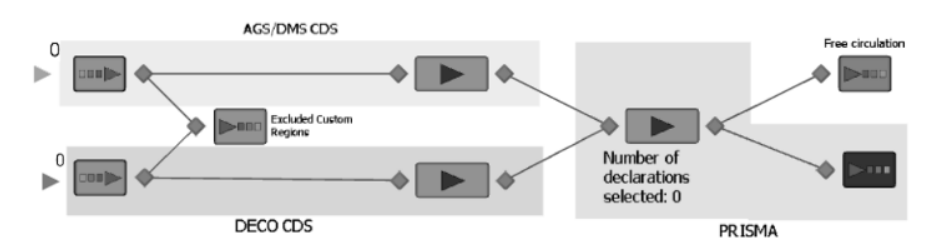


Figure 7.5: Facility view of the Selection System

7.4.2. Inspection System

The inspection system is translated into a separate Simio model. The selected declarations retrieved from the selection model are recreated in this model after which a PLATO entity is created. In the case, that the PLATO contains a physical inspection, a shipment is created and will be transported to one of the five customs regions for further inspection. The customs regions are represented using sub-models. The facility view of the custom region can be seen in Figure 7.6. A full view of the Inspection model can be seen in Appendix F. After inspection, the shipments leave the sub-models whereafter they leave the model through a sink.

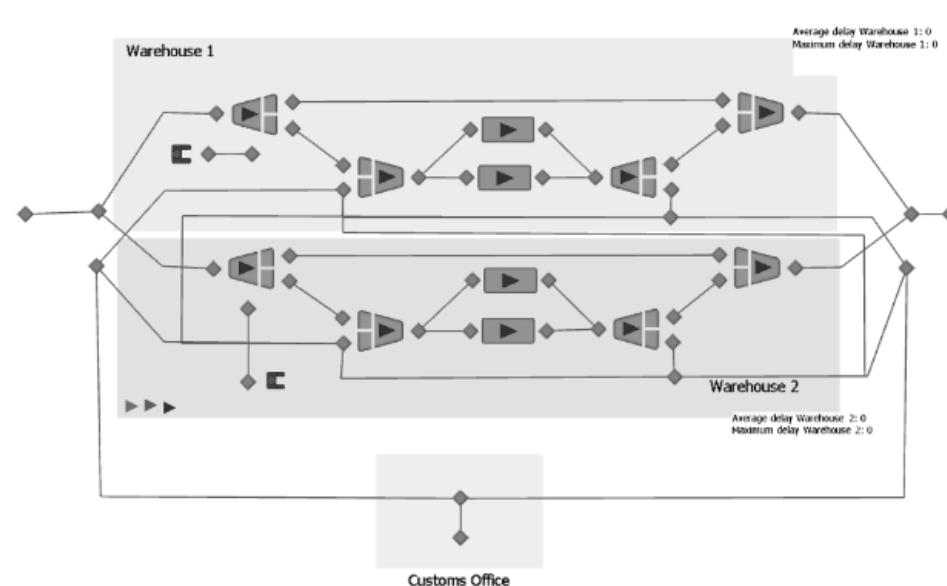


Figure 7.6: Facility view of the Customs Region in the Inspection Model

7.5. Model Verification

After implementation, both models are verified. The verification of the model is of great importance as it ensures that the model implementation accurately represents the conceptual model and thus the model is correct and matches the specifications and assumptions (Thacker et al., 2004; Carson, 2002). The simulation models used in this study are both verified by applying static and dynamic testing using two verification techniques, namely debugging and standard data set results (Whitner & Balci, 2009; Nikolic et al., 2019). Both techniques are elaborated on in the paragraphs below.

7.5.1. Debugging

The first verification activity is the description of the debugging process. Some debugging measures are implemented in both simulation models. The first debugging measure is the addition of 'notify' steps to the designed add-on processes. The notify step can be used to output a user-defined warning. If an undesirable system behaviour, system state, entity behaviour or entity state occurs, the notify step will stop the simulation and output a warning. For example, the inspection model will issue an alert if a customs officer attempts to enter the warehouse via the paths defined for shipments or articles. To complement the debugging process, each process starts with a decide step to check that the correct entity type is performing the add-on process. Other measures include the use of status and floor labels to create the ability to suspect unwanted or unrealistic system behaviour during a simulation run. The final measure is the use of a model trace. A model trace is a user-defined output that tracks the behaviour or states of models or the movement of entities as they progress through the simulation. Analysis of the trace can help to identify unwanted behaviour or model states.

7.5.2. Standard data set result

The second verification method is a standard data set result. The information model of the sources used to generate the declarations is fed with a small standard data set of 50,000 declarations corresponding to the initial input parameters, such as the AGS/DMS safety irregularity rate. The risk selection process is verified as the number of selected declarations should be the same as the calculated number based on the selection metrics. In addition, the selected declarations are saved and exported to an Excel file. The Excel file generated in the run using the standard dataset result shows that the selection mechanism worked as the expected number of high and low-risk declarations were selected. The same is done for the inspection model and separately for the sub-model. The models are verified based on several runs with the standardised dataset.

7.6. Experimental Design

The experimental design describes the experimental setup used to evaluate the actions. This is step 4 of the DAPP method (see Table 1.1). This paragraph first provides the experimental setup. Furthermore, the input parameters (controls) and output variables (responses) are described. The complete description of the experimental design including the scenario description, specification of input values per experiment and expressions used to calculate the responses can be seen in Appendix F.

7.6.1. Experimental Setup

The experimental setup provides information about the run length, number of replications and the warm-up period used when running the experiments. The experimental setup per simulation model is shown in Table 7.4.

Table 7.4: Experimental Setup

		Selection Model	Inspection Model
Warm-up period	[hours]	0	48
Run length	[hours]	168	120
Minimum number of Replications	[#]	7	7

Since the selection system can be classified as a closed system with a limited throughput time, the warm-up period of the Selection Model is set to 0 hours as there is no time required for the system to achieve a stable state. On the contrary, the Inspection system is an open system that requires a warm-up period. The warm-up period of the Inspection model set deviates from the rule of thumb

due to computational time restrictions. The run length of the Selection Model covers 7 days as it is undesirable to run the Selection Model for more than 7 days due to time and computational limitations. For this reason, the run length of the Inspection Model is set to 5 days as the input provided by the Selection Model is used for the warm-up period and the run length. Finally, the number of replications of the Selection Model is also lower than the number of replications of the Inspection model, due to the same computational limitations.

7.6.2. Controls and Responses

For the regulation of the experiments, input parameters (controls) are specified that vary in the case that various future scenarios and supervision activities are in place, which translate the policy lever-ages and external factors formalised in the conceptualisation phase (see Figure 7.1). To measure the performance metrics, output variables (responses) are also formalised per simulation model. Controls C1 - C10 and Responses R1 - R12 are controls and Responses used in the Selection Model. The other controls (C11 - C15) and responses (R12 - R26) are used in the Inspection Model. The controls and responses are shown in Table 7.5 and Table 7.6.

Table 7.5: Overview of Controls in the Simulation Models

	Control	Description
C1	DECO sample size	Represents the sample size determining the share of DECO declarations that are selected for by random sampling during the selection process
C2	DECO Fiscal Irregularity Rate	Represents the fiscal irregularity ratio of DECO declarations submitted in the CDS
C3	DECO Safety Irregularity Rate	Represents the safety irregularity ratio of DECO declarations submitted in the CDS
C4	AGS Fiscal Irregularity Rate	Represents the fiscal irregularity ratio of AGS/DMS declarations submitted in the CDS
C5	AGS Safety Irregularity Rate	Represents the safety irregularity ratio of AGS/DMS declarations submitted in the CDS
C6	High Risk Selection Chance	Represents the risk-based selection probability of a declaration classified as 'high risk' during the selection process
C7	Low Risk Selection Chance	Represents the risk-based selection probability of a declaration classified as 'low risk' during the selection process
C8	<i>Confidential</i>	<i>Confidential.</i>
C9	<i>Confidential</i>	<i>Confidential</i>
C10	Preventive Supervision Switch (Submitter)	Represents whether preventive supervision measures on submitting parties are in place
C11	<i>Confidential</i>	<i>Confidential</i>
C12	Automation Switch	Represents whether the inspection activities of the employees are partially automated
C13	FT Automation Factor	Represents the automation factor of the inspection activities deployed by FT employees
C14	AB Automation Factor	Represents the automation factor of the inspection activities deployed by AB employees
C15	Irregularity Finding chance	Represents the probability of FT employees detecting a present irregularity during the physical inspection

Table 7.6: Overview of Responses in the Simulation Models

	Response	Description
R1	Risk-based inspection share	Represents the ratio of risk-based selected declarations out of all selected declarations
R2	Risk-based inspection share DECO	Represents the ratio of risk-based selected DECO declarations out of all selected DECO declarations
R3	Risk-based inspection share AGS	Represents the ratio of risk-based selected AGS/DMS declarations out of all selected AGS/DMS declarations
R4	Irregularities selected share	Represents the ratio of selected declarations containing irregularities out of all declarations containing irregularities
R5	Irregularities selected share DECO	Represents the ratio of selected DECO declarations containing irregularities out of all DECO declarations containing irregularities
R6	Irregularities selected share AGS	Represents the ratio of selected AGS/DMS declarations containing irregularities out of all AGS/DMS declarations containing irregularities
R7	Inspection Share	Represents the ratio of selected declarations out of all declarations in the system
R8	Inspection Share DECO	Represents the ratio of selected DECO declarations out of all DECO declarations in the system
R9	Inspection Share AGS	Represents the ratio of selected AGS/DMS declarations out of all AGS/DMS declarations in the system
R10	Risk-based hit share	Represents the ratio of correctly risk-based selected declarations containing irregularities out of all risk-based selected declarations
R11	Risk-based hit share DECO	Represents the ratio of correctly risk-based selected DECO declarations containing irregularities out of all risk-based selected DECO declarations
R12	Risk-based hit share AGS	Represents the ratio of correctly risk-based selected AGS/DMS declarations containing irregularities out of all risk-based selected AGS/DMS declarations
R13	Inspection Finding Rate	Represents the ratio of inspections resulting in an inspection finding out of all inspections performed
R14	Found fiscal irregularities rate AGS	Represents the ratio of detected AGS/DMS shipments containing fiscal irregularities out of all AGS/DMS shipments in the inspection system
R15	Found safety irregularities rate AGS	Represents the ratio of detected AGS/DMS shipments containing fiscal irregularities out of all AGS/DMS shipments in the inspection system
R16	Found fiscal irregularities rate DECO	Represents the ratio of detected DECO shipments containing fiscal irregularities out of all DECO shipments in the inspection system
R17	Found safety irregularities rate DECO	Represents the ratio of detected DECO shipments containing fiscal irregularities out of all DECO shipments in the inspection system
R18	Average daily occupancy rate AB DECO	Represents the workload of AB DECO employees
R19	Average daily occupancy rate AB AGS	Represents the workload of AB AGS/DMS employees
R20	Weighted average daily occupancy rate FT morning	Represents the workload of FT employees in the morning shift weighted over all five custom regions
R21	Weighted average daily occupancy rate FT afternoon	Represents the workload of FT employees in the afternoon shift weighted over all five custom regions
R22	Weighted AGS-on-Time Rate	Represents the ratio of AGS/DMS shipments being inspected within the agreed customs reaction time out of all AGS/DMS shipments weighted
R23	Weighted AGS Maximum Delay time	Represents the maximum delay time of AGS/DMS shipments due to being subjected to a physical inspection
R24	Weighted AGS average Delay time	Represents the average delay time of AGS/DMS shipments due to being subjected to a physical inspection
R25	Weighted DECO Maximum Delay time	Represents the maximum delay time of DECO shipments due to being subjected to a physical inspection
R26	Weighted DECO Average Delay time	Represents the average delay time of DECO shipments due to being subjected to a physical inspection

Quantitative Modelling Results

This section describes the quantitative results based on the simulation models. The simulations were used to generate quantitative results in two scenarios: the current situation (S0) and when the UCC comes into force (S1). For both scenarios, the five actions, selected in Chapter 6, are evaluated. These actions are displayed in Table 8.1.

Table 8.1: Overview evaluated Supervisory Actions

Actions	
A1	<i>Confidential</i>
A2.A	<i>Confidential</i>
A2.B	Adopt preventive supervision measures on submitting parties
A3	<i>Confidential</i>
A4	Automate customs processes
A5	Stimulate curiosity of customs officers

For the interpretation and evaluation of the supervisory actions, this study employs a total of 26 KPIs (see Table 8.2). Table 7.6 provides an full overview and description of the KPIs in this research. Before the KPIs are interpreted and discussed a modelling output analysis is performed. The aim of the modelling output analysis is to determine the precision of the output values as well as the statistical significance of the actions on the KPIs. The design and result of the modelling output analysis can be found in Appendix G.

Table 8.2: Overview KPIs in Simulation Models

↑: KPI should be as high as possible

↓: KPI should be as low as possible

↑¹: KPI should be as high as possible without exceeding 1

Selection Model			Inspection Model		
R1	Risk-based Inspection Share	↑	R13	Inspection Finding Rate	↑
R2	Risk-based Inspection Share DECO	↑	R14	AGS Found Fiscal Irregularity Rate	↑
R3	Risk-based Inspection Share AGS	↑	R15	AGS Found Safety Irregularity Rate	↑
R4	Irregularities Selected Share	↑	R.16	DECO Found Fiscal Irregularity Rate	↑
R5	Irregularities Selected Share DECO	↑	R17	DECO Found Safety Irregularity Rate	↑
R6	Irregularities Selected Share AGS	↑	R18	Average Daily Occupancy Rate AB AGS	↑ ¹
R7	Inspections Share	↑	R19	Average Daily Occupancy Rate AB DECO	↑ ¹
R8	Inspections Share DECO	↑	R20	Weighted Average Daily Occupancy Rate FT morning	↑ ¹
R9	Inspections Share AGS	↑	R21	Weighted Average Daily Occupancy Rate FT afternoon	↑ ¹
R10	Risk-based Hit Share	↑	R22	Weighted AGS-on-Time Rate	↑
R11	Risk-based Hit Share DECO	↑	R23	Weighted AGS Maximum Delay Time	↓
R12	Risk-based Hit Share AGS	↑	R24	Weighted AGS Average Delay Time	↓
			R25	Weighted DECO Maximum Delay Time	↓
			R26	Weighted DECO Average Delay Time	↓

8.1. Current Situation

The purpose of this scenario is to provide a baseline against which to assess the actions and changes expected in the future scenario when the UCC comes into force. In addition, this scenario provides insights into supervisory actions that can be used to strengthen e-commerce import supervision before the new legislation comes into force. The results of the selection model are first presented and interpreted. The results of the inspection model are then discussed.

The results of the Selection Model are shown in Table 8.3. In this experiment, only A1 leads to a statistically significant difference compared to the KPI output values when doing nothing (A0). Furthermore, only a small percentage of shipments (2.169 e-3 %) are selected for further inspection, resulting in an even smaller percentage of selected shipments with safety or fiscal irregularities. When A1 is implemented, the number of selected DECO declarations with a fiscal or safety irregularity increases significantly. This indicates that more non-compliant shipments are selected for further inspection. Looking at the effects of adopting preventive measures, it can be noted that these do not make a statistically significant difference compared to the KPI outputs of A0 in this model. However, the selected irregularities share (R4) when adopting preventive measures to submitting parties (A2.B) shows a slight increase compared to A0. It can also be noted that the risk-based hit share (R10) decreases when adopting preventive measures. This can be explained as the preventive measures result in fewer incorrect declarations, whilst the inspection share only slightly reduces when adopting preventive measures. This indicates that the same share of declarations is selected for further research while the share of incorrect declarations has been reduced. The other three actions do not affect the processes in this model, so as expected, there are no statistical differences in the results.

Table 8.4 shows the simulation results of the Inspection Model. For this model, eight KPIs are tested for statistical significance (see MOA column). In the current situation without applying any supervisory actions (A0), only 13.6 % of the inspections resulted in an inspection finding (R13). This indicates that there is room for improvement in terms of effectiveness. Furthermore, the daily occupancy rates of customs officers (R18 - R21) indicate that the number of inspections can be increased without causing excessive workload. However, applying A1 leads to a maximum workload of AB DECO and FT employees. The occupancy rate values exceed 1 as this indicates that the customs officers are finishing their current tasks while their shift has ended. In addition to the increased workload, A1 results in a huge increase (2514 %) in the weighted DECO average delay time (R26). This suggests that the inspection system is full with this supervisory action. R23 and R24 contain NaN values for this action (A1), resulting from the absence of completed AGS shipment inspections. Furthermore, this action shows a significant decrease in the DECO and AGS Found Fiscal Irregularity Rate compared to A0. A1 does significantly increase the inspection finding rate, indicating that the effectiveness of the inspections increases compared to A0. On the contrary, adopting preventive measures reduces the effectiveness of the inspections. However, preventive measures on submitting parties increase the AGS-on-time ratio (R22) and reduce the delay time of DECO declarations (R25 and R26), whilst still providing room for an increase in inspections as the occupancy rates (R18 - R21) only slightly differ from A0. In addition, A3 leaves even more room for increasing the number of inspections, as can be seen from the daily occupancy rate of FT offers. Furthermore, this action results in a high AGS on-time rate (R22), which means that the Dutch Customs Administration is better able to comply with the agreements made. The results of A4 show that automation has a major impact on the workload of AB employees, as a significant part of their work can be automated. Stimulating the curiosity of the customs officers (A5) slightly improves the inspection rate compared to A0. However, this action does not affect other KPIs.

8.2. Future with a reformed UCC

The purpose of this scenario is to provide insights into a future perspective of e-commerce import supervision and the impact of supervisory actions in this situation. For this scenario, the results of the selection model are also discussed first, followed by an interpretation of the results of the inspection model. In this scenario, A1 as a stand-alone action has been dropped, as this action is already included in the UCC reform effect.

Table 8.5 shows the output of the selection model in a scenario where the reformed UCC has entered into force. The results show that this scenario statistically significantly differs from S0 as all three KPIs included in the Modelling Output Analysis of A0 in S0 and A0 in S1 are statistically significant. It can

Table 8.3: Output Values of the Selection Model in Scenario 0
MOA: Included in the Modelling Output Analysis
Bold values indicate statistical significance

	MOA	A0	A1	A2.A	A2.B	A3	A4	A5
R1	X	0.187	0.999	0.187	0.178	0.187	0.187	0.187
R2		0.000	0.999	0.000	0.000	0.000	0.000	0.000
R3		0.998	0.996	0.991	0.994	0.998	0.998	0.998
R4	X	2.169e-5	0.037	2.126e-5	2.393e-5	2.169e-5	2.169e-5	2.169e-5
R5		1.690e-5	0.037	1.698e-5	1.856e-5	1.690e-5	1.690e-5	1.690e-5
R6		0.085	0.070	0.070	0.066	0.085	0.085	0.085
R7		4.322e-5	0.011	4.29e-5	4.269e-5	4.322e-5	4.322e-5	4.322e-5
R8	X	3.527e-5	0.011	3.529e-5	3.522e-5	3.527e-5	3.527e-5	3.527e-5
R9		0.002	0.002	0.003	0.002	0.002	0.002	0.002
R10		0.153	0.877	0.133	0.128	0.153	0.153	0.153
R11		0.000	0.878	0.000	0.000	0.000	0.000	0.000
R12		0.153	0.128	0.133	0.128	0.153	0.153	0.153

Table 8.4: Output Values of the Inspection Model in Scenario 0
MOA: Included in the Modelling Output Analysis
Bold values indicate statistical significance

	MOA	A0	A1	A2.A	A2.B	A3	A4	A5
R13	X	0.136	0.692	0.093	0.089	0.129	0.133	0.154
R14		0.769	0.345	0.738	0.736	0.677	0.731	0.846
R15		0.000	0.000	0.000	0.000	0.000	0.000	0.000
R16		0.743	0.014	0.742	0.735	0.728	0.734	0.851
R17		0.000	2.593e-5	0.021	0.000	0.000	0.000	0.000
R18	X	0.742	0.183	0.618	0.694	0.751	0.663	0.742
R19	X	0.193	1.042	0.216	0.192	0.193	0.135	0.193
R20	X	0.410	1.031	0.344	0.376	0.224	0.354	0.410
R21	X	0.297	1.031	0.199	0.184	0.116	0.230	0.297
R22	X	0.771	0.729	0.756	0.766	0.914	0.733	0.771
R23		11.76	NaN	13.70	15.90	12.26	9.922	11.76
R24	X	4.794	NaN	5.004	5.071	3.756	4.606	4.794
R25		17.39	151.4	16.15	18.16	17.58	7.210	17.39
R26	X	3.812	99.65	2.975	4.185	2.878	2.789	3.812

be seen that almost all selected declarations are selected using risk profiles (R1), as this output value is close to 1. In this case, almost 10 % of the selected declarations contain irregularities (R4) using a risk selection mechanism that selects incorrect declarations 96,4 % of the time (R10). The adoption of preventive measures has a minimal effect in this scenario. According to the results, it slightly reduces the risk-based hit share (R10), indicating that more correct declarations are selected compared to a scenario when no preventive measures are in place. This scenario also holds that the other actions do not affect the KPIs of the Selection Model, similar to the current situation.

Table 8.6 shows the results of the inspection model for this scenario. Unfortunately, R23 and R24 do not contain usable values. This can be explained by the absence of completed AGS/DMS shipment inspections in some customs regions, which provide NaN values for the calculated weighted delay times. However, the results of the other KPIs evaluated suggest that the inspection system will be overloaded once the new legislation comes into force using the same conditions as used in this scenario. This can be seen from the occupancy rates of the FT employees (R20 and R21) and the DECO delay times (R25 and R26) when no supervisory actions are implemented. Nevertheless, the inspection finding rate (R13) suggests a decent effectiveness of the inspections as 77 % of the completed inspections resulted in the interception of incorrectly declared shipments. A2.A results in a slightly desired decrease in the DECO delay time. However, preventive measures do not improve the success of the supervision based on the other KPIs evaluated. Contrary to expectations, A3 does not result in an increased supervision effectiveness or efficiency of the inspections. Nevertheless, the automation of customs processes (A4) does affect the evaluated KPIs in the desired direction, as the workload of the customs officers (R19 - R22) and the average delay time of DECO declarations (R26) are slightly reduced. The results of the last supervisory action evaluated, stimulating the curiosity of customs officers (A5), indicate the focus

point of this action as it only affects the inspection finding rate (R13). Based on the results, this action has a direct positive effect, increasing the effectiveness of the supervision on one of the many identified aspects.

Table 8.5: Output Values of the Selection Model in Scenario 1
MOA: Included in the Modelling Output Analysis
Bold values indicate statistical significance

	MOA	A0	A1	A2.A	A2.B	A3	A4	A5
R1	X	0.999	X	0.999	0.999	0.999	0.999	0.999
R2		0.999	X	0.999	0.999	0.999	0.999	0.999
R3		0.968	X	0.973	0.990	0.968	0.968	0.968
R4	X	0.097	X	0.097	0.097	0.097	0.097	0.097
R5		0.097	X	0.097	0.097	0.097	0.097	0.097
R6		0.183	X	0.175	0.175	0.183	0.183	0.183
R7		0.013	X	0.013	0.013	0.013	0.013	0.013
R8		0.013	X	0.013	0.013	0.013	0.013	0.013
R9		8.564e-4	X	7.427e-04	7.723e-04	8.564e-4	8.564e-4	8.564e-4
R10	X	0.964	X	0.915	0.690	0.964	0.964	0.964
R11		0.964	X	0.916	0.690	0.964	0.964	0.964
R12		0.374	X	0.414	0.408	0.374	0.374	0.374

Table 8.6: Output Values of the Inspection Model in Scenario 1
MOA: Included in the Modelling Output Analysis
Bold values indicate statistical significance

	MOA	A0	A1	A2.A	A2.B	A3	A4	A5
R13	X	0.772	X	0.539	0.724	0.763	0.773	0.913
R14		0.000	X	0.207	0.088	0.056	0.000	0.000
R15		0.000	X	0.000	0.238	0.000	0.000	0.000
R16		0.011	X	0.011	0.011	0.011	0.015	0.013
R17		4.511e-5	X	1.414e-5	3.582e-5	3.508e-5	4.135e-5	4.761e-5
R18	X	0.009	X	0.063	0.045	0.016	0.014	0.011
R19	X	1.041	X	1.042	1.042	1.041	1.021	1.042
R20	X	1.035	X	1.033	1.033	1.033	1.024	1.036
R21	X	1.035	X	1.033	1.034	1.033	1.026	1.034
R22	X	1.000	X	0.976	0.765	1.000	1.000	1.000
R23		NaN	X	NaN	NaN	NaN	NaN	NaN
R24	X	NaN	X	NaN	NaN	NaN	NaN	NaN
R25		153.2	X	153.2	153.2	153.3	152.3	152.2
R26	X	100.5	X	100.3	100.5	100.7	99.81	100.5

8.3. Evaluated Effects of Supervisory Actions

In the two sections above, the supervisory actions are evaluated in two scenarios. Based on the results and the interpretation, it can be stated that the current situation provides room for improvement in the effectiveness and efficiency of the supervision. A future scenario with a reformed UCC results in the overflow of the supervisory system, similar to applying A1 in the current situation. This results in a high workload and hinders the logistical process of shipments. Furthermore, from the results, it can be noted that the adoption of preventive measures does not have a big positive effect on the KPIs measured. A3 and automating customs processes (A4) do reduce the workload of the customs officers, indicating a more efficient use of supervision resources. However, these actions do not positively affect the effectiveness of the inspection. Stimulating the curiosity of the customs officers (A5) is a promising action that specifically positively targets the inspection finding rate in both scenarios.

Model Validation

This chapter presents the validation process of the simulation models using an expert validation approach. The expert session setup is described first. Then, the results of the first session are elaborated on, followed by the model adaptations based on the results. Last, the results of the section session are elaborated on.

9.1. Session setup

The validation of the simulation models adopts an expert validation approach, which is used to gather the expertise of customs employees. For the validation, two expert sessions were held with respectively six and two experts. One expert was invited to validate the model as an external customs expert, as this expert, in contrast to the other experts, did not already participate in this research for the interview analysis. This study uses two models, which are both discussed during the expert sessions. The experts were asked to evaluate the validity of the models based on six validation aspects (see table 9.1).

9.2. Results of the first Expert Session

In the first expert session, six custom experts validated the selection and inspection model. The experts expressed some minor validity concerns, which were further addressed in the session. The sections below elaborate on the validation and the validity concerns discussed during this session.

9.2.1. Conceptual Model

The experts consider the conceptual model used to conceptualise the selection system valid, despite future uncertainties. The assumptions used to study the potential effect of a reformed UCC are plausible. However, the experts note that additional uncertainties can be addressed, which would increase the uncertainty of the future and the incorporated changes in the system. Expert 6 stated that preventive supervision is not directly related to the nature of the declaration but takes on a more service-oriented task. Additionally, expert 2 mentioned that the European Customs Authority could have a significant role in selecting e-commerce shipments. However, it is not yet possible to estimate the effect of the European Customs Authority as an additional player in supervision. Therefore, the effect of the European Customs Authority is not included in this model. The potential impact of shifted responsibility on the selection of shipments, as suggested by expert 1, should be considered. Additionally, experts noted that the terms 'automation' and 'prevention' may be interpreted differently, with some associating them with nuclear radiation detection, conveyor belt usage, and services (experts 3 and 6). This could lead to confusion regarding the nature and effects of the investigated supervisory actions. The experts validated the conceptual model of the inspection system and identified a potential effect of the UCC that is not included in the model. Specifically, the UCC proposes a more streamlined flow of information with the introduction of the ECDH, which enables document inspection for DECO declarations. Currently, this is not performed due to the lack of additional documents provided.

Table 9.1: Model Validation Aspects

Section	Aspect	Description
Conceptual model	Conformity with reality	The extent to which the conceptual model describes actual supervision processes and relationships between supervision factors, and covers all relevant process steps, factors and relationships.
	Future scenarios and supervision actions	The extent to which the conceptual model contains plausible future scenarios with all possible effects and realistic and achievable supervision actions.
	Logic and consistency	The extent to which the conceptual model is logical and consistent with known principles and theoretical knowledge and contains consistent and realistic assumptions.
Formalised model	Model parameters	The extent to which the formalised model contains realistic model variables and model parameters.
Model results	Empirical data	The extent to which the results correspond with expected consequences of future scenarios and supervision actions and discrepancies between model results and empirical data should be further investigated.
	Accuracy and precision	The extent to which sources of errors and inaccuracies that may affect the results can be identified.

9.2.2. Computational Model

The computational model was validated by the experts based on input values of variables and parameters, as well as the assumptions made. The experts deemed the model plausible, logical, and consistent. However, expert 2 noted that quantifying the plausible effect of the reformed UCC is difficult, but still considered the investigated scenario a realistic option. The impact of additional legislation, such as the DSA, can indirectly affect the rate of irregularities (expert 3). Furthermore, experts have raised concerns about the accuracy of the derivation of fiscal and safety irregularities. The experts were unable to provide a more valid assumption, with estimates ranging from 5 % to 80 % of irregularities. Therefore, acknowledging potential inaccuracies, the experts chose to use rates derived from available data due to the absence of more valid estimations. The distinction between shipments with a true value of less than 150 EUR and those with a value of more than 150 EUR is important due to the duty exemption in place (expert 2). Additionally, expert 5 questions the input value of the PLATO generation time for DECO declarations used in the inspection model, suggesting that it should be a fully automated process taking no more than 1 minute. In addition, the time required for inspecting shipments using A3 is dependent on the compliance of the shipment (expert 3).

9.2.3. Qualitative Results

The quantitative results are then validated. Experts consider the results to be realistic given the input values and modelling scope. However, it should be noted that the lack of knowledge about the quantitative information needs to be taken into account during this validation process.

9.3. Model Adaptations

Table 9.2 shows the adjustments made to the simulation models based on the feedback provided in the first session, which mitigated some validity concerns.

9.4. Results of second Expert Session

The second expert session confirmed the validity of all three aspects of the simulation model. Four validity points were raised during this session, which should be taken into account when interpreting the model results. Expert 8 noted that some of the DECO data is shared with the customs organization before the submission of the declaration in a 'pre-arrival registration'. This can impact the selection mechanism as the data quality improves with an increase in the timeliness of the data. Moreover, expert 7 questions the impact of the UCC on irregularity rates. Additionally, non-conform declarations require a longer time for cross-validation. Finally, both experts assert that irregularity rates are significantly underestimated, with estimations suggesting that at least 50 % of DECO declarations contain fiscal irregularities.

Table 9.2: Validity Mitigation Considerations

	Validity concern	Mitigation considerations
Conceptual model	No direct relation between preventive supervision and the nature of the declaration	Original preventive supervision in terms of service does not have a direct relation. However, this action has a different approach, so no adjustments are made.
	Lacking effect of European Customs Authorisation on selected declarations	The absent effect is kept outside the study's scope and therefore included in the model reductions.
Computational model	Lacking effect of other Member States on selected declarations	The absent effect is kept outside the study's scope and therefore included in the model reductions.
	Inconclusive assumptions irregularity shares	Due to the absence of more valid estimations, the rates derived from available data are still used
	Distinction of declarations based on real value	Due to the absence of data or possibilities to derive this information, it is kept outside the scope.
	Overestimation of PLATO generation time of DECO declarations	The PLATO generation time for DECO declarations is reduced to 1 minute.

10

Discussion

This chapter presents a discussion of the study. Firstly, the study findings are further interpreted and discussed. Next, the limitations of the study are addressed. Finally, the recommendations for further research and the Dutch Customs Administration are elaborated.

10.1. Study Findings

This section presents the study findings from the previous chapters, including the interpretation and comparison of successful supervision aspects, uncertainty aspects, and supervision challenges faced by customs officers. It also evaluates supervisory actions on the supervision aspects and challenges. The study findings for the definition of successful supervision are discussed first. Then the findings for the current situation are discussed first, followed by the future situation with a reformed UCC in effect.

10.1.1. Successful Supervision

Successful supervision of e-commerce imports requires a comprehensive approach that integrates multiple aspects of supervision. According to the analysis results presented in Chapter 3, the approach should facilitate accurate tax collection, prevent unsafe goods from entering the EU and promote fairness by maximising the effectiveness of supervision and minimising logistical delays. This is further broken down into 14 key factors that must be balanced to achieve successful supervision. This presents a challenging trade-off, making it extremely difficult to achieve the defined success even with the prioritisation of key factors (see table 3.1).

10.1.2. Current situation

The Dutch Customs Administration currently operates within an uncertain supervision system. The main uncertainties in the current situation, identified in Chapter 4, include the distribution of supervisory capacity, supply chain compliance, dynamic flows, technological advancements and developments in the trade market. Each of these uncertainties impacts the identified key factors of successful supervision, including the level of data quality, the (fiscal and safety) effectiveness of the supervision, the efficiency of the inspection resource allocation, the efficiency of the supervision tasks and the logistical delay of inspected shipments. Some of the identified uncertainties can also be considered as causes of the main challenges, which are identified in Chapter 5. The uncertainties in the trade market affect the volume challenge that the Dutch Customs Administration is experiencing (see Table 4.4) and put the e-commerce supervision process under pressure. To address this challenge, sufficient inspection resources should be available and efficiently allocated. However, this is difficult due to the uncertainties in national governance (see Table 4.2). The lack of control over this import flow is further amplified by challenges in the data collection and assessment as well as the dynamic characteristics of the e-commerce supply chain can be derived from uncertainties in the e-commerce supply chain and other European legislation (see Table 4.3 and Table 4.1). The simulation results indicate a limited workload, with occupancy rates ranging from 0.193 to 0.742. This confirms the challenge of efficiently allocating resources. Additionally, the study confirms the challenge of efficient data collection and assessment, as only 18.7 % of inspections result in findings. The study also highlights the need to improve effec-

tiveness to prevent a negative spiral caused by a potentially reduced curiosity of customs officers.

The study's results indicate that A1 can enhance e-commerce import supervision. However, it also floods the supervision system, resulting in significant logistical delays of approximately 100 hours on average. Furthermore, it also causes an excessive workload for customs employees. Despite this, A1 is considered an effective supervisory activity, based on the prioritization of key factors. Contrary to A1, preventive supervision measures are not considered effective, as the inspection finding rate slightly decreases. However, preventive measures do improve the logistical process of the supervision system by decreasing delay times and reducing the workload of customs employees, addressing other challenges identified by interviewees. This intervention may be of interest when uncertainties affect the situation, such as a tight labour market or a redistribution of supervisory capacity. The same holds for the A3 and automation of custom processes. However, these two supervisory actions are subject to uncertainties regarding technological advancements. This means that the automation of custom processes and A3 depend on technical developments. Nevertheless, automating custom processes can also help prepare the organization for a tight labour market as it reduces the occupancy rates of FT employees by an average of 18.10 %. Finally, simulating the curiosity of custom officers can be categorized as an effective supervisory action as it results in an inspection finding rate of 0.154. Furthermore, this action does not trigger the identified trade-offs between successful supervision aspects.

10.1.3. Future situation with a reformed UCC in effect

In a future situation with a reformed UCC, extensive data collection in a more transparent supply chain with a clear responsibility distribution over the parties involved can be performed. This provides the opportunity to enhance supervision and increase the extent to which successful supervision is achieved. As one of the most significant uncertainties identified in Chapter 4, the UCC itself is mitigated as the aspects are no longer a general proposal but legislation that has entered into force. The risk-selection mechanism's increased accuracy and improved data quality address key challenges posed by European legislation, supply chain compliance and technological advancements (see Table 4.1). The reformed UCC's implementation has a direct positive effect on two supervision aspects, namely the level of data exchange and the level of data quality. The quantitative results also indicate an improvement of the supervisory effectiveness as the risk-based inspection share and the risk-based hit share increase to respectively 0.999 and 0.964. The increased accuracy of the risk selection mechanism leads to a significant increase in the inspection finding rate to 0.772.

Preventive supervision measures are not contributing to the success of e-commerce supervision, similar to the current situation. The supervisory system has become flooded due to the reformed UCC, which has shifted the positive effect of A3 to a slightly negative effect on the logistical delay of shipments. Furthermore, automating custom processes still reduces the workload of DECO employees (resulting in an average decrease of 1.28 %) and slightly improves logistical delays. Therefore, this supervisory action contributes to the achievement of successful supervision. In addition to its positive effects, the action also addresses challenges in inspection performance. However, automating custom processes alone is not sufficient to mitigate the system flooding effect of the reformed UCC as the occupancy rate of the DECO employees still exceeds 1. In contrast to other supervisory actions, the final action has a positive effect of stimulating curiosity among custom employees in the future scenario. However, the results show that the effect has been reduced from a 65 % increase in the inspection finding rate to an 18 % increase.

10.1.4. Feasibility of Supervisory Actions

In addition to the effects of supervisory actions, their feasibility is of great importance. The factors determining feasibility were discussed in the second part of the expert sessions (refer to Appendix C). The study assigns the window of opportunity, determined by willingness and ability, as the most important factor affecting the acceptance. Furthermore, a concrete and clear explanation of the method, effects and potential changes should be logical and estimable. This makes the feasibility of A1, A3 and automation of custom processes in the organisation higher than the preventive supervision measures and stimulation of curiosity. A contrast is identified in the implementation feasibility where the policy advisors indicate the efficacy of a top-down approach, while others highlight the importance of alternative actions. Finally, the feasibility of all identified supervisory actions is mainly hindered by the lack of legislative grounds, as the UCC is not in force yet.

10.1.5. Application of DAPP approach

The study follows the first four steps of the DAPP approach (see Table 1.1). The application of the DAPP approach, or similar decision-making approaches, to identify and evaluate supervisory and potentially strengthen the strategy formulation process has not yet been done within the context of customs administrations. Therefore, this research fills the gap in the literature. Although achieving successful supervision, as currently defined, is difficult, the definition does identify important key factors of supervision and corresponding desired directions. Therefore, this study fills a gap in the existing literature on the supervision of e-commerce imports as the Strategic Multi-annual Plan (Customs Strategy Team, 2021) and external literature provided by the Dutch Government or other studies (Ministry of Justice and Security, 2005; Hu et al., 2023) provide general aspects without specifying factors and corresponding success values. Contrary to the definition of successful supervision, uncertainties, challenges, opportunities and some evaluated supervisory actions were subjected to research before. However, the interview and observation analysis complemented and specified findings from the literature, such as the identification of the supervisory action 'Automate customs processes' (A4) and 'Adopt preventive measures' (A2) (see Table 6.1). Furthermore, the quantitative effects of the supervisory actions and future scenarios were lacking in the literature. The impact assessment of the UCC reform (European Commission, 2023c) does not include quantitative results of the effects of the UCC reform on the Dutch supervisory system.

10.2. Study Limitations

There are a few study limitations to be mentioned for transparency and future recommendations. The first limitation can be found in the qualitative approaches. Successful e-commerce supervision is defined based on literature and interviews, which may exclude insights from all organizational departments. Additionally, the prioritization of key factors is determined by a single expert, which may lack consensus among customs staff. Observational analysis, based on a limited number of observations, may not fully represent all customs regions and operational days, leading to potential disparities. The simulation method used to explore supervisory actions also presents limitations. It is built using assumptions due to limited knowledge. Furthermore, a reduced representation of the e-commerce supervision system excludes certain factors, such as actor-based control approaches. Due to time constraints, a comprehensive uncertainty analysis could not be conducted, which limited the depth of insights. Another concern is generalizability. As this study focuses solely on the Dutch Customs Administration's operations, its findings may not be universally applicable to other customs administrations. Although EU Member States share similar goals and challenges, variations in national objectives and processes may affect the applicability of the findings. Customs administrations outside the EU may encounter even greater differences. Therefore, the results of the study can inspire, but caution should be exercised when applying them outside the context of Dutch Customs Administration.

10.3. Recommendations

This study formalises five recommendations. These recommendations aim to enhance the e-commerce import supervision by addressing the core challenges and leveraging opportunities for improvements, while also considering feasibility constraints and potential uncertainties. The five recommendations are stated below.

This recommendation is not available in the public version for confidentiality reasons.

Strategically approach automation of customs processes

A strategic approach to automating customs processes should be taken. Automation of customs processes mainly helps in the reduction of the workload and slightly reducing the logistical delay of the selected shipments (see Table 8.4 and Table 8.6). This approach should focus on identifying and automating high-impact processes that alleviate the workload for DECO employees while considering resource constraints. By doing so, successful supervision can be achieved and challenges in inspection performance can be addressed.

Investigate methods to stimulate curiosity among custom officers

Analyse different approaches to promote curiosity among customs officers to potentially increase the inspection finding rate (see Table 8.4 and Table 8.6). This action may not only improve successful su-

pervision but also enhance job satisfaction, as the effectiveness of the inspection increases, mitigating potential problems caused by a tight labour market. Furthermore, a study by Siripanukul et al. (2022) states that curious customs officers play a key role in the identification of unusual shipments, even if it is not selected by the risk selection mechanism or declared by trusted parties in the supply chain.

Ensure clear communication and transparency during the implementation phase

Clear communication and transparency widen the window of opportunity for the implementation of supervisory actions. This recommendation is based on the results of the feasibility study. Customs officers should be provided with concrete explanations of the methods, expected results and potential changes associated with each supervisory action to increase the feasibility of the supervisory action.

Expand research to complete the Dynamic Adaptive Policy Pathways (DAPP) analysis

Extend the study to include the remaining steps of the DAPP approach beyond the initial four steps completed in this study. By conducting a full DAPP analysis, the research can provide a comprehensive framework that facilitates the development of robust adaptive supervision strategies. Nevertheless, it should be kept in mind that implementing additional supervisory actions for a potential change in legislation by the Dutch Customs Administration is hard without any legislative ground (Interviewee 10).

11

Conclusion

This chapter contains the conclusion of the study, which gives a clear answer to the research questions formalised in Chapter 1. The purpose of the conclusion is to provide a clear understanding of the findings of the study. The four sub-questions are answered first, followed by the main research question.

11.1. Successful Supervision of E-Commerce Import

This study started with the definition of the key concept 'successful supervision of e-commerce imports', as this is one of the critical aspects of the Dutch Customs Administration's operations. This section answers the first sub-question: "What is successful e-commerce import supervision?". Based on a thorough review of literature and interviews, key aspects with corresponding factors, KPIs and success values that underpin successful supervision in the complex landscape of e-commerce imports were delineated. Successful supervision of e-commerce imports, as revealed by the results of the study, involves a comprehensive approach that integrates different dimensions. In essence, successful surveillance requires a careful balance between resource allocation, intervention strategies, cooperation with other Member States, surveillance authorities and parties in the supply chain, transparency, effectiveness of selection, integrity and efficiency of operations, while limiting logistical disruption to trade flows. It is a dynamic process that aims to ensure accurate collection of taxes and duties, prevent the entry of unsafe goods and promote fairness in trade flows. The findings of the study underscore the need for continuous adaptation and innovation of practices, guided by the principles of efficiency, fairness and effectiveness. The study shows that the definition of successful monitoring differs according to the literature and those interviewed. While both literature and interviews emphasise the importance of multi-faceted approaches, prompt intervention and effective supervisory actions, differences in emphasis emerged, particularly in relation to the role of a skilled workforce.

11.2. Uncertainties and Evolving Developments in the E-Commerce Supervision

Once the definition of successful e-commerce supervision had been established, the study delved into the uncertainties in this area to address the second research question: "What uncertainties and evolving developments can be identified in the timeframe of the UCC implementation?" The study identified six different areas of uncertainty, each of which has an impact on the achievement of successful e-commerce supervision. European governance emerges as a central area of uncertainty, as the Dutch Customs Administration operates within the framework of the EU Customs Union. The dynamics of European legislation, in particular the impending reforms included in the reform of the Union Customs Code (UCC), represent the main layer of uncertainty. Other uncertainties in EU governance are geopolitical shifts and potential expansions, which raise uncertainty about the volume and nature of e-commerce imports processed by Dutch Customs Administration. National governance is also identified as an area of uncertainty, with national legislation and the allocation of supervisory capacity as the main challenges affecting the prioritisation of enforcement areas, and thus the potential success of e-commerce import supervision. The e-commerce supply chain emerges as the third source of uncertainty, characterised by compliance challenges and the dynamic nature of supply chain flows, resulting

in security and fiscal risks and requiring complicated efforts to increase the accuracy of declarations. The dynamics of the trade market introduce further uncertainty, influenced by factors such as global trade strategies, leading to uncertainties in the volume and data quality of declarations. Technological advances offer potential solutions but also contribute to uncertainty as their implementation and effectiveness remain uncertain. Finally, the labour market emerges as the final area of uncertainty, with implications for labour availability and job satisfaction, which affect the completeness of the work cycle and the efficiency of control activities. Uncertainties in the supervision of e-commerce thus include a wide range of factors that determine the success of the supervision of e-commerce imports.

11.3. Challenges in the E-Commerce Import Supervision System

Next, this study explored the challenges faced in the supervision of e-commerce imports by answering the third sub-question: "What are the challenges in the current supervision process?". Both literature and interviews were used to classify the challenges into different categories, highlighting the complexity of e-commerce supervision. Five key categories were identified from the literature. The e-commerce supply chain poses significant hurdles due to its increasing complexity and lack of transparency, hindering effective information assessment and compliance efforts. In addition, the high volume of e-commerce imports puts a heavy burden on Dutch Customs Administration, leading to facilitation and enforcement problems. Difficulties in data collection and assessment complicate the problem. European legislation introduces uncertainties and ambiguities that affect supervisory activities and procedures. Interviews confirmed these findings and provided insight into the specific challenges faced by Dutch Customs Administration. Inspection performance is constrained by the high volume of e-commerce imports, resulting in a low perception of the impact of inspections and limited effectiveness. Data collection remains fragmented and of poor quality. Geopolitical dynamics within the EU and national legislation affect the ability to supervise. The e-commerce supply chain poses further challenges, including the lack of import responsibility in the current supply chain composition and the complexity of e-commerce as a low-value, high-volume trade. Organisational culture also plays an important role, with high workloads and staff turnover affecting supervisory resources and adaptability. The challenges in supervising e-commerce are multifaceted and intertwined, resulting from the complex landscape in which the Dutch Customs Administration operates.

11.4. Actions for Enhancing Supervision of E-commerce Imports

The final sub-question of this study is: "What e-commerce supervisory actions can be identified to enhance successful supervision of e-commerce imports?" A1 shows promising results, despite potential challenges such as logistical delays. Preventive measures can address logistical issues but have a limited impact on inspection rates. To enhance inspection performance and align with the goal of continuous improvement, stimulating curiosity among customs officers is seen as a means. These findings highlight the importance of a multifaceted approach to supervision, potentially combining supervisory actions to address challenges and uncertainties. By A3, automating custom processes and stimulating the curiosity of customs officers strategically, the Dutch Customs Administration can improve its ability to successfully supervise e-commerce imports.

11.5. Impact of the New Union Customs Code on the Realisation of Successful Supervision

The research objective was to investigate the impact of supervisory measures on the successful supervision of e-commerce after the entry into force of the new Union Customs Code, which led to the following research question: "What is the impact of the new Union Customs Code on the successful supervision of e-commerce imports by the Dutch Customs Administration, given the uncertainties in the future?" The success of e-commerce import supervision by the Dutch Customs Administration, in light of the new Union Customs Code (UCC), depends on the organization's ability to navigate uncertainties, mitigate challenges, and take effective supervisory actions. To achieve successful supervision, a multifaceted approach is necessary, with a focus on efficiency, effectiveness, and data quality. The importance of adapting to evolving legal requirements and technological developments under the UCC is highlighted by the uncertainties surrounding e-commerce supervision. The challenges in the current supervision process emphasize the necessity of proactive supervisory actions to address shortcomings and optimize supervision activities. Identified supervisory actions offer potential solutions to improve

supervision success. A1 may be considered as a temporary solution pending the entry into force of the UCC. More permanent solutions can be found by automating customs processes and simulating the curiosity of customs employees. However, success depends on alignment with the UCC framework and adaptation to emerging challenges and uncertainties. Overall, the UCC presents an opportunity to streamline supervision processes, enhance data quality, and improve compliance. This will ultimately contribute to the successful realization of e-commerce import supervision in the future.

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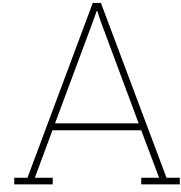
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Interview Design

This appendix contains two elements of the interview analysis. The first element is the interview protocol. This includes the interview structure and the interviewee selection. The second element is the interview analysis which elaborates on the analysis process of the interviews, so they are translated into useful insights.

A.1. Interview Protocol

The interviews aim to obtain two types of qualitative data. Initially, they explore the key factors of e-commerce supervision. These factors include the definition of successful supervision of e-commerce imports from the interviewees' perspective, possible future developments in the e-commerce and supervision world and the identification of supervision opportunities, vulnerabilities and possible courses of action. The second objective is to examine customs processes in more detail, such as declaration processing and physical supervision.

A.1.1. Interview Structure

The interviews will adopt a semi-structured approach. This implies that the interviews will follow a main list of questions, with potential supplementary questions based on the responses to help address the research questions that may be asked (Magaldi & Berler, 2020). The comfort level of the interviewee and the duration of the interview can be categorized into five phases: apprehension, exploration, co-operation, participation, and concluding, and is determined by the choice and method of presentation of the additional question.

The seven main questions are formulated in the interview guide:

1. What is the definition of successful supervision of e-commerce import?
2. What uncertainties arise in the supervision of importing e-commerce?
3. What are the challenges facing e-commerce import supervision?
4. Which potential opportunities could be identified to achieve successful supervision imports in the future?
5. What potential vulnerabilities could impede the successful supervision of e-commerce imports in the future?
6. What actions, based on the identified opportunities and vulnerabilities, can lead to successful future e-commerce import supervision?

A.1.2. Interviewee Selection

The selection of the interviewees is guided by their role in the Dutch Customs Administration or field of expertise. The Dutch Customs Administration submits proposals for interviewees, who are ultimately selected with their agreement. With the interviewee's consent, the audio recordings and transcriptions are created. To maintain confidentiality, all interviewees remain anonymous. The report does not include audio recordings or transcriptions due to privacy concerns. Table A.1 presents the interview register and an overview of all the interviewees who participated in this study.

Table A.1: Interview Register

	Organisation	Function	Interview Date
1	Dutch Customs Administration	Enforcement Director	2023/11/10
2	Dutch Customs Administration	Case officer E-commerce	2023/11/13
3	Dutch Customs Administration	Enforcement director	2023/11/14
4	Dutch Customs Administration	Policy Advisor	2023/11/14
5	Dutch Customs Administration	Policy Advisor	2023/11/15
6	Dutch Customs Administration	Policy Advisor	2023/11/16
7	Dutch Customs Administration	Policy Advisor	2023/11/16
8	Ministry of Finance	Policy Advisor	2023/11/21
9	Dutch Customs Administration	Team Manager Declaration processing	2023/12/05
10	Dutch Customs Administration	Policy Advisor	2023/12/05
11	Ministry of Foreign Affairs	Customs Counsellor	2023/12/08
12	European Commission	Legal and Policy Officer	2023/12/08
13	Dutch Customs Administration	Case officer E-commerce	2023/12/13
14	Dutch Customs Administration	Team Manager Physical inspections	2023/12/13
15	Dutch Customs Administration	Project Manager	2023/12/15
16	Delft University of Technology	Researcher	2023/12/19
17	Auburn University	Associate professor	2024/01/11

A.2. Interview Analysis

Table A.1 shows that 17 semi-structured interviews have taken place. These interviews consumed between 45 minutes and 1.5 hours. Analysis of the interviews is required to answer the study's first three sub-questions regarding the definition of successful e-commerce import supervision, uncertainties in the world of e-commerce supervision and challenges experienced in the current supervision design. Analysis of the interviews is also needed to design and provide input on the simulation model used to answer the study's fourth research question. In this study, the six-step focused and systematic analysis of Rädiker and Kuckartz (2020) is used. Table A.2 provides an overview of the interview analysis process.

Table A.2: Interview Analysis Process Steps

Step	Application
1 Data preparation, organisation and exploration	The interviews are transcribed and approved by an interviewee-based organisation. Finally, the first exploration is done by identifying commonly used terms, summarizing statements, and highlighting contradictory statements between interviewees
2 Category Development	Categorizing the statements using fact, thematic and analytical categories: e-commerce supervision aspects, values of success, uncertainty areas, uncertainty trends, uncertainty levels, areas of challenges, source of challenges, effect of challenges, opportunity areas, opportunity effects, window of opportunities, area of weaknesses, weaknesses effects, action areas, action implementation, action effects, AB-process steps, FT-process steps. Additional categories are other and quotable text passages
3 Basic Coding of Interviews	Basic coding uses two coding rules, namely the coded statement contains at least one whole sentence which should be understandable on its own, and repeated statements are coded multiple times as this may indicate the severity of the category or indicates the focus point of the organisation.
4 Fine Coding of Interviews	Fine coding by compiling all interview segments coded with the same category, adding the category 'uncertainty causes', subcategorizing the statements by aspect and/or area as well as consequence-based subcategorizing the statements about the effects.
5 Further Analysis	Analysis of the fine-coded statements by a more in-depth analysis of the category contents, frequency analysis, identification of extreme cases, creating process maps of AB and FT inspection processes and analyse (causal) relationships between statements.
6 Document analysis results	Document de interview results. Insights on successful supervision of e-commerce imports in Chapter 3, insights on uncertainties in supervision in Chapter 4, insights on challenges of supervision in Chapter 5, insights on opportunities, weaknesses and actions in Chapter 6 and insights on inspection processes in Chapter 7.

B

Observation Design

This appendix contains two elements of the observation design. First, the observation protocol is described. This includes the observation focus and observation overview. The second part of this appendix is the observation analysis which elaborates on the observation analysis process.

B.1. Observation Protocol

The observations aim to obtain qualitative data about the inspection process by FT employees. Thereby, the observation analysis enhances the interview analysis and document analysis by providing specific information about the inspection activities and routines of the Dutch Customs officers. Table B.1 provides an overview of the observations in this study. All interviews are direct observations: observations where the observer observes events happening in real-time (Ciesielska et al., 2017). This study focuses on the fifth observation aspect proposed in a study by Ciesielska et al. (2017), namely Routines, Rituals and Episodes as it focuses on inspection activities and routines of FT officers. As can be seen, the role of the observer in the first observation is nonparticipation. This is caused because this observation is a guided visit which provides the first observations about the FT employee routines and helps determine the scope of the observation. During the other observations, the observer's role is Observer as Participant (Barker, 2006), where most time is spent observing, but the observer may conduct short interviews.

Table B.1: Observation Overview

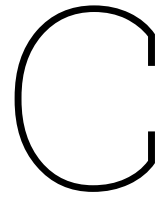
	Observation Team	Observation Date	Observation Type	Observation Time
1	FT Douane Amsterdam	2023/09/20	Nonparticipation	2 hours
2	FT Douane Schiphol	2023/10/26	Partially Participating	8 hours
3	FT Douane Breda	2023/11/08	Partially Participating	8 hours

B.2. Observation Analysis

During the observations, notes and voice memos are made to collect information for further analysis. After the observation days, these notes and voice memos are further analysed to serve as input for the inspection model. For the analysis of the observation results, a similar approach to the interview analysis is used, in which the data is analysed in four steps (see Table B.2).

Table B.2: Observation Analysis Process Steps

Step		Application
1	Category Development	Categorizing the data based on the inspection activities in categories: travelling, preparation, waiting, inspection, administration and finalizing.
2	Coding of the Observations	Coding of the observation data under the categories formalised in step 1.
3	Further Analysis	Analysis of the coded data by a more in-dept analysis of the category contents and identifying similarities and differences between the data, creating process maps of the inspection process.
4	Document analysis results	Document de observation results in Chapter 7 when describing the system.



Expert Session Design

This appendix describes the expert session design. First, the protocol of the expert session is elaborated on, imposing the session objectives, contents and participants. Secondly, an analysis of the expert session result is explained.

C.1. Expert Session Protocol

The expert session serves two objectives. Initially, the experts are asked to validate the simulation model used to answer the fourth question of this study. Validation of the model indicates the extent to which the simulation model represents the real supervision systems in place. The second part of the expert session is used to perform a feasibility study. The feasibility study provides insights about components and factors that are important to take into account for potential further implementation of the supervision activities.

C.1.1. Expert Session Structure

The expert session will adopt a two-part approach based on the two objectives of the session. This implies that the expert session starts with the validation of the model. This study uses two models, the selection model and the inspection model, which means both models are discussed in the session. The experts are asked to provide their comments about the six validation aspects on a feedback form. The setup of the validation expert sessions can be seen in Chapter 9.

Table C.1: Feasibility Aspects

	Feasibility Aspect	Description
1	Acceptation	Assessing the alignment of supervisory actions with the organisations' perceptions and organisational capabilities within the customs organization.
2	Demand	Evaluating the demand for supervisory actions and their economic viability within the organization
3	Implementation	Examining the practicality of executing supervisory actions within the organisation, including technical requirements
4	Adaptability	Assessing the adaptability of supervisory actions to different contexts within customs operations while ensuring long-term sustainability
5	Integration	Evaluating the level of organisational change required to integrate supervisory actions effectively within existing processes and procedures
6	Extensibility	Exploring the potential success of scaling supervisory actions across different departments or regions
7	Practicality	Assessing the practicality of implementing supervisory actions within resource, time and commitment constraints

The second part of the session focuses on the feasibility study. The feasibility study contains seven aspects which all indicate various parts of the feasibility (Bowen et al., 2009; McLeod, 2021), presented in Table C.1 The feasibility identifies the most important factors relevant for further implementation of the supervision actions and answers the question to which extent the supervision actions are feasible

within the organisation. The results of this part of the session are collected similarly to the first part, namely with general annotations and feedback forms completed by the participating experts.

C.1.2. Expert Selection

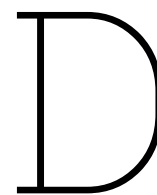
The selection of the experts invited to the expert session is guided by their role within the study or their field of expertise. Initially, 15 custom employees were invited to participate in the session, which covered a broad range of departments, teams and knowledge. Due to the limited availability of the experts, two expert sessions with respectively 6 and 2 experts were held. To maintain confidentiality, all experts remain anonymous. Table C.2 presents the overview of experts who participated in this study.

Table C.2: Expert Register

	Function	Expert session date
1	Policy Advisor	2024/02/21
2	Policy Advisor	2024/02/21
3	Enforcement Director	2024/02/21
4	Policy Advisor	2024/02/21
5	Team Manager	2024/02/21
6	Policy Advisor	2024/02/21
7	Case officer E-commerce	2024/03/04
8	Case officer E-commerce	2024/03/04

C.2. Expert Session Analysis

In this study, two expert sessions have taken place. The expert sessions consumed approximately 2 hours per session. The results of the expert session are analysed for further insight creation. The first part of the session is used to validate the simulation models used in this study. The results can be seen in Chapter 9. The second part of the expert session was intended to provide insights into the feasibility of the supervision actions analysed. Unfortunately, the feasibility study led to inconclusive results. The inconclusiveness resulted from limited feedback provided by the experts, as only two of the experts from the first session completed three out of seven aspects of the feasibility feedback form. The other experts from this session provided less feedback. Due to time constraints, the feasibility part of the feedback provided in the second session was collected in a general manner which did provide information about six out of seven feasibility aspects.



Successful Supervision Aspect Description

This appendix contains an elaborate description of the aspects of successful supervision. The first section describes the aspects identified in the literature in further detail. Followed by a details description of the aspects identified by the interviewees in the second section.

D.1. Aspects in Literature

The literature study identified 12 different aspects to consider when defining successful supervision of e-commerce imports. The aspects are explained in the text below.

Selective supervision involves a thoughtful approach by the supervisor to regulate while considering the capacity and responsibility of citizens, companies and institutions to enforce rules. It requires the strategic allocation of resources, and prioritizing supervision based on risks, costs and benefits. The supervisor makes informed decisions, aligning with other forms of accountability. This approach fosters justified trust, leading to less direct control. For the Dutch Customs Administration, selective supervision means making efficient use of customs officers, and inspection resources and using risk analysis to prioritise the supervision tasks.

Decisive supervision requires a balanced yet firm approach that prioritizes to taking prompt and effective action based on verified information. It involves a measured enforcement strategy, with interventions tailored to the timing and severity of the violations. Appropriate interventions are used for compliance supervision, ensuring prompt responses to non-compliance while maintaining fairness and professionalism in the enforcement. For the Dutch Customs Administration, decisive supervision means a human dimension-oriented approach and fast service.

Collaborative supervision involves enhanced cooperation between supervisors to minimise the supervisory burden on civilians and organisations. Compliance supervisors identify cross-departmental themes on which they should cooperate on a structural basis. In addition, supervisors make use of a government-wide basic register to share the information they collect, thereby reducing the information burden on organisations. Collaborative supervision from the perspective of the Dutch Customs Administration is the use of national and/or European data systems and cooperation with other supervisors such as the Nationale Voedsel en Waren Autoriteit (NVWA), the supervisor for safe food, and the Belastingdienst, the Dutch Tax Administration.

Independent supervision ensures impartial judgement and allows supervisors to freely disclose misconduct and take necessary action. Supervisors have the autonomy to gather information, record findings and make informed decisions about interventions. This promotes public confidence and accountability. Independent supervision maintains the integrity of the supervision process and promotes fairness and effectiveness in regulatory enforcement. The independent supervision of the Dutch Customs Administration is the complete separation from the Belastingdienst and the publication of the inspection results

in an annual report.

Transparent supervision includes open communication and accountability, where supervisors publicly disclose their compliance plan and reasons for supervision. The objectives and benefits of the supervisory efforts are explained, providing clarity for the parties involved. Transparent supervision should build trust, promote understanding and enhance the effectiveness of supervision. The Dutch Customs Administration are transparent in its supervision when it communicates openly with the companies involved and publishes their inspection decisions.

Professional supervision embodies flexibility, integrity and continuous development to adapt to changing needs and advances. Individual supervisors, like Customs Officials, demonstrate integrity. A professional organisation adds value to society through its expertise and ethical standards. It evolves with the times, embracing alternative methods of supervision, European influences and modern IT abilities. Customs supervision is professional when ethical standards are taken into account in the use of risk analysis and maintaining an integer workforce.

Streamlined supervision emphasizes efficiency through simplified import- and export procedures, faster clearance times and lower compliance costs. It includes continuous improvement of the business environment. Supervision is strengthened using logistics data and proactive planning for the development of a single window, facilitating deeper alignment with international trade, supply chains and finance.

Fiscal-oriented supervision involves focusing on national macroeconomic policies and developments by strengthening tax investigations, contributing to economic development and optimizing the business environment. It plays a significant role in ensuring fiscal integrity and facilitating effective tax administration.

Qualified supervision embodies improving the skills and quality of customs officials to meet the evolving requirements, including active capacity-building initiatives and anti-corruption efforts. Through qualified supervision, the customs administrations prioritise the strengthening of the officers' skills and the development of future talent. Customs academies and research institutions play a significant role in effective staff training and technological reform, thereby improving the productivity and efficiency of the supervision tasks.

Unified supervision ensures the professionalism, incorruptibility and predictability of the organisation, by promoting uniformity and integrity. Flexibility is achieved through robustness, resilience, responsiveness, and adaptation. A balanced workforce reflects the diversity and inclusiveness of society. Despite staff turnover, knowledge and professionalism remain intact, moving towards a knowledge-driven and data-centric organisation. Digitalisation facilitates ease of transaction and compliance for customers and promotes the accuracy of first-time declaration submissions.

Strategic supervision transforms customs operations through the intelligent use of people and resources to monitor a greater volume of declarations and goods. Enforcement moves towards data-driven risk management, using automated detection to increase efficiency and minimise delays. Customs effectively differentiates between different flows and applies tailored enforcement strategies.

Data-driven supervision involves reliance on comprehensive, accurate and timely information to make decisions. Consistent information and data collection provide actionable insights and access to reliable information for effective supervision. Robust systems ensure the continuous provision of information and scalable IT supports transaction processing, data exchange and analysis. The customs administrations maintain a strategic information position on goods and operators and share information with other supervisors and the business community.

D.2. Aspects in the Interview

Interviewees identified 11 different aspects to consider when defining successful supervision of e-commerce imports. The aspects are explained in the text below.

Fiscally-complete supervision means that the correct amount of taxes and duties are collected in the e-commerce import stream. This aspect is a translation of the main objective of 'Remittance'. Interviewee 7 mentions that the focus for this aspect should be on the correctness of the declaration rather than the completeness of the declaration. However, interviewee 10 notes that in the current system, there

is an import regime where the duties levied are zero. This is the exemption for all goods imported with a value of less than EUR 150. (Interviewee 6, 7, 9, 10, 11 and 16)

Interceptive supervision involves stopping goods that are not allowed to enter the EU. This aspect is also known as the 'Protection' objective of the Dutch Customs Administration. This includes unsafe and undesirable goods. For the DECO flow, this also means the restricted goods that may not be imported via this specific declaration system. In this way, the EU is protected at its customs borders and thus protects its civilian population from potentially dangerous goods (interviewee 7). According to interviewee 8, the focus of import supervision in e-commerce should be on the non-fiscal and thus safety-related tasks to guarantee safety, as the release into free circulation of unsafe products cannot be repaired afterwards. (Interviewees 6, 7, 8, 9, 11 and 16).

Equal supervision is achieved when a fair level playing field is realized, which touches on the last objective of the Dutch Customs Administration 'Level-playing field'. However, interviewee 7 takes the same perspective on the main objective, which is to increase the competitive position of the Netherlands and the EU, equal supervision should also minimise the differences between the B2C and B2B flows (interviewee 8). The import regulations, exemptions and ease of import should be as equal as possible between these two flows. (Interviewees 7 and 8)

The second main aspect is the pursuit of a compliant market. This aspect can be broken down into five sub-aspects, two of which overlap with the first aspect. These are fiscally-complete supervision and interceptive supervision. The other sub-aspects are actor-oriented supervision, declaration-accurate supervision and suppressive supervision.

Actor-oriented supervision Actor-oriented supervision implies the implementation of different approaches for compliant and non-compliant companies. This aspect corresponds to the 'decisive' aspect of successful supervision identified in the literature. Companies that are considered compliant are less supervised by the Dutch Customs Administration companies that are not considered compliant. According to interviewee 9, the focus of supervision should be on those declarants who are negligent in their declaration behaviour. Interviewee 12 states that the Dutch Customs Administration should reward compliant companies because non-compliant declarations are costly to deal with. (Interviewees 9 and 12)

Declaration-accurate supervision involves increasing the reliability of the main data source, the declaration. Successful e-commerce import can be achieved by enhancing the accuracy of declarations to overcome misuse of information (Interviewees 2 and 6). As mentioned in the description of actor-oriented supervision, non-compliant declarations, i.e. unreliable declarations, are costly, so the efficiency of the inspection can also be increased with declaration-accurate supervision. (Interviewees 2, 6 and 12).

Abuse-suppressing supervision is the discouragement of those who wish to import prohibited and restricted goods. Interviewee 1 describes suppressive supervision as creating a high perceived risk of being caught so they abandon their plan. Suppressive supervision includes visible inspections and open communication about the inspection results, as well as clear communication about the import rules and the consequences of breaching them. Abuse-suppressing supervision also includes reducing abuse of the C07 and C08 exemptions (Interviewee 9). (Interviewees 1, 3, 9 and 16)

The last main aspect is the optimisation of the supervisory process. This aspect also already includes three aspects described above, namely actor-oriented supervision, declaration-accurate supervision and suppressive supervision. New aspects of successful supervision are delay-suppressing supervision, outcome-maximising supervision, policy-driven supervision, risk-based supervision and reactive supervision.

Delay-suppressing supervision focuses on minimising delays in the company's logistical processes. For this aspect, it is important to carry out effective inspections, so that the interruptions in the logistical processes lead to an inspection finding. According to interviewee 5, both the Dutch Customs Administration and the companies benefit from delay-suppressing supervision. This aspect touches on the first factor of equal supervision because the ability to operate smoothly leads to the maintenance or even increase of trade from the Netherlands. (Interviewees 3 and 5)

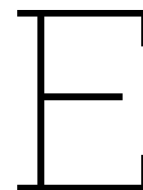
Outcome-maximising supervision refers to the output and outcome of the supervision carried out by the Dutch Customs Administration. The output, the inspections and other enforcement activities performed

should be maximised and at the same time be effective. This means that the supervision strategy should both be efficient and effective to be considered successful (interviewee 4).

Policy-driven supervision includes having an organization-wide, clear and well-communicated enforcement plan. Communicating the enforcement plan helps to increase the organization's adaption speed and enables departments to be fully prepared for changes in enforcement plans and legislation, thereby increasing the effectiveness of the supervision. (Interviewee 9)

Risk-based supervision involves considering all possible risks when formulating the enforcement plan or setting up interventions. Risk-based supervision should lead to the formulation of an inspection that will lead to an inspection finding and thus lead to an effective inspection. (Interviewee 3 and 5)

Reactive supervision implies a prompt and complete learning cycle. The learning cycle, which runs through multiple departments in the organisation, results in an alert response to a risk signal (Interviewee 10). Risk signals have sources such as findings from a physical inspection or irregularities found by DLTC (Interviewees 13 and 14). All risk signals should be considered when identifying risks and should be weighted towards the highest risks. (Interviewees 10 and 13)



UCC Reform Description

This section contains a detailed discussion of the UCC reform. A summarised version is included in the main text of Chapter 4. The UCC reform proposal consists of three pillars. Each pillar is described below.

The first pillar is the new partnership with business. The EU Customs Data Hub (ECDH) is a single centralised IT environment for customs formalities and aims to strengthen European and national customs control by ensuring data integrity, traceability and non-repudiation of the data (Baert, 2024). The focus on declaration-based information will be replaced by event-based information. This means that the information will be transmitted to the hub when an event occurs (interviewee 10), which should increase the timeliness of the data. However, the proposal does not specify what these events are (interviewee 11). The ECDH aims to increase the efficiency of information exchange between business and customs agencies (Antov, 2023a). Ultimately, the ECDH will lead to an increase in data accessibility (interviewee 10), data quality and the exchange (interviewee 6). The first pillar also introduces the Trust and Check Traders. This will increase data transparency as this new partnership will allow customs to access traders' electronic systems to check compliance and track the movement of goods over time. In return, traders will be granted the 'green lanes', allowing them to release their goods without active customs intervention.

The creation of the EU Customs Authority is the only provision of the second pillar, the smarter approach to customs checks, and it will have oversight of the ECDH, leading to centralised management at the EU level rather than at the national level. This will help prioritise identified safety risks (Antov, 2023a) and could potentially lead to more effective supervision. Another aspect of supervision affected by the creation of the EU Customs Authority is the number of inspections carried out. As stated in the European Parliament (EP) briefing (Baert, 2024), risk management could potentially lead to the issuance of recommendations to member states. This is already happening, but a more effective risk mechanism could increase or decrease this number (interviewees 8 and 11).

The modern approach to e-commerce encompasses five provisions, with the first involving the abolition of customs duty exemption (C07/08). Consequently, e-commerce goods will now be subject to customs duties. This alteration might affect data quality, potentially necessitating a shift from the simplified dataset (H7) to the more detailed dataset (H1), as data granularity increases (interviewee 10). Furthermore, the accuracy of data could improve, as the structural abuse of duty exemption for undervaluation and split shipments risks is mitigated (Antov, 2023a). However, this change may impact the efficiency of supervision tasks, as inspectors must now verify real values instead of merely assessing if thresholds are exceeded. Moreover, the provision diminishes the distinction between B2B and B2C declarations, fostering a more level playing field. To streamline customs duty calculation complexities, a bucket system is proposed, reducing numerous categories to four or five main ones (Antov, 2023a; Baert, 2024). However, according to interviewee 11, this adjustment exacerbates the unfairness of the playing field division. Additionally, e-commerce platforms will now be considered 'deemed importers,' responsible for customs duties and taxes. This classification enhances their involvement in customs af-

fairs, potentially increasing intervention opportunities (Antov, 2023a). Although this provision simplifies customs duty collection through the extension of the Import One-Stop Shop (IOSS), with the customs department located in the Member State of identification, interviewee 12 suggests that platforms are unlikely to change their identification to Member State as a result. Approximately 6 % of DECO declarations imported in the Netherlands are associated with a Dutch IOSS number, indicating a potential revenue loss for the Dutch Customs Administration. Finally, platforms can now make monthly duty payments, streamlining the importation process and lowering the importation threshold (Interviewee 11).

F

System Analysis

This appendix is not available in the public version for confidentiality reasons.



Modelling Output Analysis

This section presents the analysis of the output variables, providing information about the study's experiments. Both experiments investigate the effect of five supervision actions on measured KPIs. The output analysis incorporates 11 KPIs (refer to Table G.1). The statistical analysis consists of two parts. Firstly, the confidence intervals of the observed values of the KPIs per action are interpreted to determine the precision of the output values. The second part of this section calculates and interprets the statistical significance of the supervisory actions.

Table G.1: Overview Actions and KPIs

Action	KPI
1 <i>Confidential</i>	1 Risk-based inspection Share
2a <i>Confidential</i>	2 Risk-based hit share
2b Preventive supervision on Submitting parties	3 Irregularities selected share
3 <i>Confidential</i>	4 Inspection finding rate
4 Automation of custom processes	5 Average Occupancy rate AB AGS
5 Stimulation of curiosity	6 Average Occupancy rate AB DECO
	7 Weighted occupancy rate FT officers morning shift
	8 Weighted occupancy rate FT officers afternoon shift
	9 Weighted AGS-on-Time share
	10 Weighted average AGS delay time
	11 Weighted average DECO delay time

The table presents weighted key performance indicators (KPIs 7-11) due to the significant variation in shipments inspected across customs regions. The KPIs are weighted according to the number of shipments inspected.

G.1. Precision of Output Values

The CI width is analysed to assess the precision of the output variables. A small CI width indicates a high precision of the simulation outputs for that output variable.

The CIs and their widths are calculated using the programming language Python with a confidence level of over 95 %. Figure G.1 displays the code used in this analysis.

Figure G.1: Python Code for CI (width) calculation

```

1 def calculate_confidence_interval(data, confidence_level=0.95):
2
3     # Calculate sample mean and sample standard deviation
4     sample_mean = np.mean(data)
5     sample_stdev = np.std(data, ddof=1)
6
7     # Calculate standard error
8     std_error = sample_stdev / np.sqrt(len(data))
9
10    # Calculate t-critical value
11    dof = len(data) - 1
12    t_value = t.ppf((1 + confidence_level) / 2, dof)
13
14    # Calculate margin of error
15    margin_of_error = t_value * std_error
16
17    # Calculate confidence interval
18    lower_bound = sample_mean - margin_of_error
19    upper_bound = sample_mean + margin_of_error
20
21    # Calculate width of confidence interval
22    ci_width = 2 * margin_of_error
23
24    print("Confidence Interval (95%):", (lower_bound, upper_bound))
25    print("Width of Confidence Interval:", ci_width)
26
27    return lower_bound, upper_bound

```

The confidence interval (CI) widths of Experiment 1, displayed in Table G.2, indicate high precision for nearly all actions and key performance indicators (KPIs) investigated, as the CI width is narrow. However, A0 and A5 exhibit wider confidence intervals across multiple KPIs, suggesting lower precision of the final output value. Additionally, A2.A shows a slightly larger CI width in KPI 7, indicating lower precision than the other actions provide. It is worth noting that the confidence interval widths of KPI 10 and KPI 11 are slightly larger compared to the other KPIs. This is because KPIs 10 and 11 represent hours, while the other KPIs represent shares.

Table G.2: KPI Confidence Interval Widths of Scenario 0

	KPI1	KPI2	KPI3	KPI4	KPI5	KPI6	KPI7	KPI8	KPI9	KPI10	KPI11
A0	0.026	0.056	4.297e-06	0.006	0.040	0.002	0.029	0.025	0.107	0.452	0.609
A1	1.062e-7	1.334e-4	3.134e-4	0.010	0.015	3.349e-16	0.008	0.004	0.136	NaN	0.168
A2A	0.031	0.033	3.310e-6	0.009	0.015	0.003	0.201	0.020	0.073	0.488	0.376
A2B	0.031	0.048	4.258e-6	0.012	0.022	0.001	0.018	0.016	0.038	0.312	0.361
A3	-	-	-	0.006	0.046	0.002	0.016	0.012	0.035	0.284	0.209
A4	-	-	-	0.012	0.024	0.001	0.017	0.021	0.066	0.262	0.178
A5	-	-	-	0.008	0.030	0.002	0.029	0.025	0.107	0.452	0.609

Table G.3 presents the CI widths of the output values generated in the second experiment. However, the CI widths for KPI 10 are missing due to a modelling error that occurred during the calculation of this KPI. Additionally, the CI width of A2A for KPI 9 is noteworthy as it indicates lower precision for this KPI with a CI width of 0.465. This can be explained by looking at the input data, as few AGS consignments are included and checked. may have caused the high CI interval. Furthermore, KPI 6 includes a confidence interval of 0.000 for all actions except for A4, indicating that the output variables

were distinct for each run. This is an unusual observation given that the simulation model incorporates stochastic variables.

Table G.3: KPI Confidence Interval Widths of Scenario 1

	KPI1	KPI2	KPI3	KPI4	KPI5	KPI6	KPI7	KPI8	KPI9	KPI10	KPI11
A0	2.763e-4	7.507e-04	0.001	0.012	0.102	0.000	0.006	0.005	0.000	NaN	0.205
A1	-	-	-	-	-	-	-	-	-	-	-
A2A	1.348e-4	0.001	0.001	0.021	0.009	0.000	0.009	0.006	0.465	NaN	0.103
A2B	2.633e-4	0.002	0.001	0.010	9.704e-17	0.000	0.004	0.004	0.117	NaN	0.158
A3	-	-	-	0.057	0.026	0.000	0.041	0.005	0.000	NaN	0.167
A4	-	-	-	0.011	0.017	4.436e-16	0.004	0.003	0.000	NaN	0.137
A5	-	-	-	0.007	0.019	0.000	0.007	0.007	0.000	NaN	0.167

G.2. Statistical Significance of Supervisory Actions

The second statistical analysis performed on the output variables determines the statistical significance of the actions in both scenarios. An independent sample t-test is conducted for the output values for which normality can be assumed. For the output values for which normality cannot be assumed, the confidence intervals are compared.

To assess the normality of the output values, a Shapiro-Wilk Test is conducted. This test determines whether the observed data significantly deviates from a normal distribution. An alpha value of 0.05 is used in this study. Figure G.2 shows the Python code used for the normality tests. The following hypotheses are employed in this statistical test:

- Null Hypothesis (H0): The observed output values are normally distributed, and
- Alternative Hypothesis (H1): The observed output values are not normally distributed.

Figure G.2: Python Code for Shapiro-Wilk Test

```

1 def normality_test(data):
2     statistic, p_value = shapiro(data)
3     print("Shapiro-Wilk Test Statistic:", statistic)
4     print("p-value:", p_value)
5     if p_value <= 0.05:
6         print("The data does not appear to be normally distributed (H0 is
          rejected)")
7     else:
8         print("The data appears to be normally distributed (H0 is
          accepted)")
9     return statistic, p_value

```

G.2.1. Independent Sample T-Test Setup

The independent sample t-test compares the means of the output values of A0 and one supervisory action to determine if they significantly differ from each other. This statistical test is also executed using Python (see Figure G.3). The hypotheses of this test are:

- Null hypothesis (H0): There is no significant difference between the means of the observed output values of A0 and a supervisory action, and
- Alternative Hypothesis (H1): There is a significant difference between the means of the observed output values of A0 and a supervisory action.

Figure G.3: Python Code for Independent Sample T-Test

```

1 def calculate_standard_deviation(data):
2     n = len(data)
3     mean = sum(data) / n
4     variance = sum((x - mean) ** 2 for x in data) / (n - 1)
5     return math.sqrt(variance)
6
7 def calculate_t_value(sample_mean1, sample_mean2, sample_std1,
8     sample_std2, n1, n2):
9     pooled_std = math.sqrt((sample_std1 ** 2 / n1) + (sample_std2 ** 2 /
10         n2))
11     t_value = (sample_mean1 - sample_mean2) / pooled_std
12     return t_value
13
14 def t_test(data1, data2, alpha=0.05):
15     # Check normality of data1
16     stat1, p_value1 = normality_test(data1)
17     if p_value1 > alpha:
18         print("Data1 is normally distributed.")
19     else:
20         print("Data1 is not normally distributed. T-test cannot be
21             performed.")
22         return
23
24     # Check normality of data2
25     stat2, p_value2 = normality_test(data2)
26     if p_value2 > alpha:
27         print("Data2 is normally distributed.")
28     else:
29         print("Data2 is not normally distributed. T-test cannot be
30             performed.")
31         return
32
33     n1 = len(data1)
34     n2 = len(data2)
35     mean1 = sum(data1) / n1
36     mean2 = sum(data2) / n2
37     std1 = calculate_standard_deviation(data1)
38     std2 = calculate_standard_deviation(data2)
39     t_value = calculate_t_value(mean1, mean2, std1, std2, n1, n2)
40     DoF = n1 + n2 - 2
41     critical_t = t.ppf(1 - alpha/2, DoF)
42     p_value = t.sf(abs(t_value), DoF) * 2
43     print('p-value: ', p_value)
44     print('t-value: ', t_value)
45     if p_value < 0.05:
46         print('H0 rejected: statistically significant difference')
47     else:
48         print('H0 accepted: no statistically significant difference')

```

G.2.2. Statistical Significance Analysis Results

The statistical significance analysis determines whether the action has a statistically significant impact on the KPIs compared to a situation where no actions are taken (A0). The results are presented per scenario in Table G.4 and Table G.5. Furthermore, the statistical significance of the two scenarios is

