Master Thesis

Measuring and improving effectiveness of targeting choices for supervision on the RoHS Directive, with statistical means

What role do used risk indicators and repeated inspections play in the effectiveness of law enforcement on the RoHS Directive?

Executive Master
Customs & Supply Chain Compliance

Rotterdam School of Management
Erasmus University

Note:
to protect interests of the problem-owning organization, confidentiality of information, activities, results, etc. linked to (communication about) the research activities and regarding the content of this thesis report are a very strict requirement from the problem-owning organization Dutch Customs

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Preface

Before you lies the result of my graduation assignment with regard to the program Executive Master Customs & Supply Chain Management of the Erasmus University Rotterdam. The following thesis report is the final assessment of this study, which I started in February 2020. For me, following this three-year course has been an enormous enrichment in terms of knowledge, skills and insights in the field of customs legislation, transport & logistics and IT & Auditing. This applies to each discipline separately, as well as to their mutual coherence in relation to compliance management, as daily performed by Dutch Customs.

My employment at Dutch Customs started in 2007, based on my intrinsic motivation to contribute to the protection of the European and global market against goods and actors that do not comply with the rules, and trying to facilitate cargo flows and actors that do comply with the legal requirements. Nowadays, this incentive still matches with my consistent interest in risk management. My graduation assignment is directly linked to the former mentioned tension field in enforcement activities, as well as to my interest.

This thesis report is the result of a research project, for which the integration of enforcement of customs legislation, aspects of transport & logistics and current IT possibilities together form the basis for a statistical analysis. The intention of this research project is to improve compliance management by evaluation and improvement of current targeting choices for risk-based profiling. In this quantitative research I combine the three main pillars of the executive program and appliance of statistic means, with the aim to contribute to further improvement of compliance management with regard to risk-based declaration-oriented supervision by Dutch Customs.

In general, my thanks go to family, friends, colleagues, teachers and supervisors who made it possible for me to start, do and successfully complete this executive course. I would like to specifically express my gratitude to my former manager who offered me the opportunity to apply for this master program and my current manager for the support for my study activities in general, and for the graduation assignment and support for my research project activities in particular. I am also very grateful to my internal colleagues and external client, who encouraged, supported and facilitated me. I would also like to thank the teachers of the master program for their passion, knowledge and skills with which they have provided the teaching material, and my thesis supervisor and co-reader for the constructive discussions, and their valuable guidance and feedback on the design and execution of my research.

With regard to my private life, I would like to thank my friends for their unlimited understanding that I had little time for them during my education and for their patience and awareness of the temporary nature of this. I would like to thank my parents, parents-in-law, brother, sister, brother-in-law and sister-in-law for their support and all their personal efforts to make it possible for me to achieve my graduation.

And, most important to me, I would like to express my unlimited appreciation and endless admiration to my wife and children, who each contributed in their own lovingly way and within their own possibilities to the fact that I was able to start, do and finish this executive master program. I hope my graduation will inspire my children and that it will be supportive for their future choices with regard to education.

For me personally, combining study, working hours and private life has been very difficult. I had to call on the best and worst character traits I have, and I needed and achieved fast mental growth to continuously meet the test requirements in this master program. I also needed and achieved necessary improvements of my working methods to facilitate this. Mentally, I have given everything I had in me to achieve my graduation goal. Finally, after 20 years of living with 'unfinished business…', I can now say: 'job done!'.

Christiaan van Holland, 26 March 2023

Executive summary

Dutch Customs is responsible for supervision on applicable laws and regulations. The Union Customs Code expects Dutch Customs to protect the Union market against non-compliant products and actors. At the same time, Dutch Customs is supposed to facilitate legitimate trade. For non-fiscal laws and regulations, in the Netherlands supervision is a cooperation between the national designated market authority, acting as principal, and Dutch Customs in the role of executive organization with regard to good flows that cross the Union boarder. Both are legally obliged to apply risk management for executing their supervision tasks. For supervision purposes they have to apply risk management to maximise the effect they can achieve with their limited control capacity. To apply risk management effectively, supervising agencies need to gather and use information about (non-) compliance for their compliance management. Risk-based declaration-oriented shipment selections for inspections are part of their supervision strategy.

Dutch Customs aims for smarter law enforcement, based on advanced data analysis and auto detection. Therefore, Dutch Customs is transforming into a more data-driven organization. Using the available data of customs declarations and inspection results for statistically founded targeting choices is not very well developed yet. However, it can be a step forward in becoming data-driven and improve the effectiveness of allocation of scarce resources in an ever-growing global market.

Current evaluation of effectiveness of the targeting process of Dutch Customs for any law enforcement domain focusses on the quantitative goal of achieving the number of inspections as agreed on with the national market authority and the yield of performed inspections regarding detected non-compliance. For targeting choices, the contribution of individual risk indicators on the effectiveness of the targeting process performance is not clear. Currently, evaluating effectiveness of targeting choices is done manually, without using statistics to justify continuing or adjusting them. Furthermore, current monitoring of effectiveness of targeting process performance does not include a dimension that quantifies positive impact of inspection activities for the internal market. These problems are of generic nature for many law enforcement domains covered by Dutch Customs. For this research, statistic evaluation of targeting choices for the law enforcement domain Restriction on use of Hazardous Substances (RoHS) is used to determine how and to which extent statistical analysis of targeting choices is able to contribute to targeting process performance.

This research is about statistical testing of currently used conceptual models for targeting the declaration-oriented shipment selections for supervision on the RoHS Directive. The research is divided into different parts, based on separate models. The main question for this research is: *What is the effectiveness of current choices in risk-based targeting for inspections related to supervision on the RoHS Directive and how can adjusting them lead to improvement of the effectiveness?* To answer this research question, the sub questions focus on how the effectiveness can be evaluated, what the actual effectiveness of current targeting choices is and how targeting process performance could be improved.

It is a quantitative research, of which the outcomes have been discussed with law enforcement domain experts to gather qualitative input for correct interpretation of the research results and for formulating useful recommendations. The scope for this research is data of relevant import declarations, lodged between 1 January 2017 and 30 June 2022.

The literature review performed for this research provides the elements needed to determine the statistical analysis design and to interpret the results. This design is based on statistical testing of the effect of four targeting choices on two dimensions of targeting process performance. The evaluated targeting choices are related to (non-) AEO status of consignees of selected shipments, declared country of origin of inspected goods, customs value/net weight ratio of declared goods and choices with regard to

repeatedly inspecting shipments of consignees. For the statistical analysis, these factors are the independent variables. The defined depended variables for the statistical analysis are related to the output of the targeting process and based on literature review with regard to lean six sigma approach of evaluating process performance and literature on mitigating risks by applying risk management. The first independent (output) variable is the chance for non-compliant judgement for an inspected product and the second output variable is the extent to which the inspected products exceeded the applicable norms.

For the statistical evaluation of the effectiveness of the targeting choices the statistical techniques ANOVA and Correlation and Regression are used. To determine the effect of targeting choices on the targeting process performance, the independent variables are separated into two or more different groups. The ANOVA test is used to provide insights on whether there is a significant difference between means among two or more compared groups. A statistically significant difference in means of two groups implies that, based on variances of individual measurement values, the difference between means of two compared groups are not the result of chance but can instead be attributed to the tested cause. Variance is a measure of dispersion that takes into account the spread of all individual data points in a data set. With the ANOVA test used to determine statistically significant differences between groups of cases for which a tested factor is present or absent, this test provides a powerful indicator for non-compliance risk, The Correlation & Regression technique is used to test the extent to which presumed related metric variables contain a connection, suggesting a possible 'predicting' dependency.

The data used for performing the data analysis for the results presented in this thesis report is a combination of information from the internal registry of the laboratory of Dutch Customs and the information provided in the customs declaration of the inspected products. The registry provides the data needed for the dependent (process output) variables, whereas the information of the customs declaration for the inspected goods provides the independent (process input) variables for the first part of the research. For the second part of the research the values for the output variables are clustered per inspection experience number to execute the statistical analysis design. Based on this dataset, the current targeting process performance is being determined and used as starting point for evaluation of current targeting choices and defining and calculating scenarios for possible improvement.

With regard to the researched law enforcement domain, the results of part 1 of this research show, that, from a targeting process performance point of view, there is no reason to adjust the current targeting choice with regard to (non-) AEO-status of consignees. Since for this risk indicator, the statistical analysis did not lead to a justified argument for a lower selection percentage for shipments of AEO certified consignees compared to shipment selection percentages for non-AEO consignees. In addition, the research results can be seen as encouragement for further research on compliance of AEO certified companies with regard to non-fiscal legislations. With respect to risk indicator country of origin, the statistical analysis led to doubts about whether the particular country of origin perceived to be of highest risk, actually is of highest risk, compared to other countries. Drawing hard conclusions for these two risk indicators is not possible, due to the fact that the statistical power of the test results for both risk indicators is very limited for extreme differences in size of compared groups, combined with the fact that for both tested risk indicators for one of the two compared groups the number of cases was only very limited: less than 40 cases. But for the third tested risk indicator, relative low customs value / net weight ratios of declared goods, the analysis shows statistically significant higher levels of non-compliance and norm exceedance for lower customs value / net weight ratios of declared goods than average for the HS-code used.

Part 2 of this research provides first insights on possible effectiveness of repeatedly inspecting shipments of consignees. The research results show that first inspection experiences being compliant do not guarantee compliant results of later inspection experiences at all. And with respect to first inspection experiences being non-compliant, later inspection experiences of repeatedly inspected consignees show

better results for non-compliance and norm exceedance, but only on average, not consistently for each individual consignee. For both groups drawing hard statistically significant conclusions is not possible, due to limited group sizes for testing. Nevertheless, the gained insights do contribute to reconsideration of current law enforcement strategy with regard to repeatedly inspecting shipments of consignees, based on contribution of later inspection experiences for both groups to the targeting process performance.

Based on the research results, adjusting current targeting choices with respect to customs value / net weight ratios and repeatedly selecting shipments of consignees are expected to contribute to increase of targeting process performance. The outcomes of this part of the research are captured in different scenarios to support considerations with regard to adjusting current targeting choices. In short, the recommendation is to focus more on lowest levels of customs value / net weight ratios and limit the number of repeated selections per individual consignee.

The design of the statistical analysis in this research provides relevant insights for Dutch Customs to make an important step forward in more objectively justifying targeting choices and with that avoid or at least reduce (the possible appearance of) arbitrariness in risk-profiling. It can also contribute to smarter law enforcement in combination with smooth logistics, based on advanced data analysis and auto detection, by transforming into a more data-driven organization, as aimed for by Dutch Customs. Domain experts for supervision on RoHS confirmed that the insights of the applied statistical analysis design for this research are valuable for evaluating effectiveness of targeting choices. Therefore, it is recommended to further analyse the more structural usage of data analysis for improving effectiveness of targeting, by using the applied approach of evaluating targeting process performance.

1. Introduction

Dutch Customs is responsible for the supervision of the fiscal integrity and safety and security of the EU external border crossing freight traffic, and for the domestic supervision on the integrity and remittance of excise duties. Dutch Customs is also expected to contribute to the competitiveness of the Netherlands and the European Union, for example with less as possible disruption for logistics. With its supervision activities, Dutch Customs is covering a large number of fiscal and non-fiscal laws and regulations. In the Netherlands non-fiscal law enforcement domains contain cooperative supervision activities of Dutch Customs and national market authorities to perform the so-called 'stop-function'. With this supervision mechanism unwanted goods entering the Union market can be prevented, by 'stopping' them in time.

For the protection of the European society and internal market, it is important to ensure that economic actors and their good flows are compliant to the applicable (non-) fiscal laws and regulations. But inspection of goods is costly and time consuming for supervising agencies and traders, and supervising agencies such as Dutch Customs have only limited control capacity and a limited budget to verify compliance of actors and their good flows. The non-fiscal legislation on Restriction on Hazardous Substances (RoHS) aims to prevent access of goods to the Union market that contain more hazardous substances than the norms in the Directive allows. For verifying compliance of goods subject to non-fiscal laws and regulations, real time shipment selections followed by in principle physical checks are needed.

Minimizing 'false negatives' (wrongly assumed compliant shipments) in the selection process for inspections is crucial for protection of the Union market. While minimizing 'false positives' (wrongly assumed non-compliant shipments) is important for contribution to competitiveness of legitimate trade. In addition, both are important for efficient and effective use of the limited resources of the supervising agencies. To achieve this, risk management is applied by Dutch Customs and national inspection agencies.

Applying risk management consists of a continuous process of identification, quantification and mitigation of risks, in order to be able to judge upon the necessity of mitigating perceived risks with suitable counter measures. For balancing between providing safety and security with inspections and facilitating legitimate trade by exemption from, or reducing chances for, inspections via targeting choices, supervising agencies like Dutch Customs need to efficiently and effectively gather and use information about (non-) compliance for effective risk-based profiling for shipment selections for efficient and effective use of scarce resources.

Dutch Customs wants to be equipped for the future. In the strategic long-term plan (SMP) 2020-2025 of Dutch Customs, its management formulated goals for 5 years to achieve its ambitions. This makes the SMP leading for the content of the regular annual plans. Amongst other things, the SMP contains objectives aimed at smarter law enforcement in combination with smooth logistics, based on advanced data analysis and auto detection by transforming into a more data-driven organization.

Using the available data of customs declarations and inspection results for statistically founded targeting choices is not very well developed yet, although it can be a step forward in effective risk-based profiling, and with that contribute to the goals stated in the SMP. The statistical analysis of effectiveness of targeting choices for risk-based declaration-oriented inspections regarding a specific law enforcement domain, as presented in this thesis report, aims to provide an example that can methodologically contribute to improvement of compliance management, within the framework of the SMP.

Chapter 2 of this report contains the research framework. In Chapter 3 the relevant insights from literature review are summarized. Chapter 4 starts with the methodology for executing the research: the statistical analysis design. In Chapter 5 preparation and content of the used dataset is being described. Chapter 6 contains the starting point and importance for evaluation of effectiveness of targeting choices. In chapter 7 and 8 the research results are presented, including possible scenarios for improving targeting process performance. Chapter 9 contains the vision of domain experts on the presented research results. Chapter 10 states the contribution of this research for both research and practice. And finally, the conclusions and recommendations based on this research can be found in chapter 11 of this report.

2. Research framework

Problem description

Currently, for non-fiscal law enforcement domains, national market authorities provide Dutch Customs risk indicators for supervision. These are the basis for risk-based declaration-oriented profiling, needed for risk-based shipment selection for inspection activities. The supervision on the RoHS Directive requires laboratory analysis of samples of shipments, making every false positive, besides an unwanted logistic delay for traders, also a costly matter for both Dutch customs and the economic actors involved.

Current evaluation of effectiveness of the targeting process of Dutch Customs for any law enforcement domain focusses on the quantitative goal of achieving the number of inspections as agreed on with the national market authority and the yield of performed inspections regarding detected non-compliance. In the current situation, for targeting choices for supervision on the RoHS Directive, the contribution of individual risk indicators on the effectiveness of the targeting process is not clear. Any periodic evaluating of the effectiveness of risk profiling, leading to shipment selections for inspection, is done manually, without statistics for objectively justifying continuing or adjusting targeting choices, and only with limited information. Furthermore, current monitoring of effectiveness of the targeting process for supervision on the RoHS Directive does not include a dimension for impact, in terms of quantifying positive effects of law enforcement activities. These problems are of generic nature for many law enforcement domains covered by Dutch Customs.

Evaluation of contribution of targeting choices to (non-) compliant inspection results and their positive impact for the law enforcement on the RoHS-Directive, is likely to benefit from a statistical evaluation, to support or question the effectiveness of current targeting choices and detect possible improvements. This can justify or improve targeting by reducing false positives and improve detection of true positives.

Research aim

For balancing between protection of the Union market and facilitation of bona fide trade, (continuously improvement of) objective evaluation of risk indicators is important for the effectiveness of targeting. This research has the aim to objectify, and if possible, improve justification for risk-based shipment selection within the researched law enforcement domain RoHS, based on (non-) compliance of actors and their good flows that were subject of inspection activities. The intention derived from this is, to use the findings to generate input for improving the internal process of periodically evaluation of risk profiles generally.

Research questions

In this report, the results of a confirmatory research are presented. The research concerns statistical testing of currently used conceptual models for targeting for declaration-oriented shipment selections for supervision on the RoHS Directive. The research is divided into different parts, based on separate models. The main research question regarding the former mentioned problem can be stated as follows:

What is the effectiveness of current targeting choices in risk-based targeting for inspections related to supervision on the RoHS Directive and how can adjusting them lead to improvement of the effectiveness.

Answering the main research question, will provide the necessary insights for the earlier mentioned evaluation. For answering this research question, the following sub-questions need to be answered:

[1] How can the effectiveness of targeting choices be evaluated, using available knowledge on measuring process performance and effectiveness of supervision activities by statistical testing?
[2] To what extent are current targeting choices for risk profiling for law enforcement on the RoHS Directive effective?
[3] How can adjusting the current targeting choices lead to improvement of the effectiveness of the targeting process?

Research methodology

To answer question [1] for this research literature study on measuring effectiveness of processes and law enforcement activities is combined and applied with available data, which has been edited by the researcher to fulfil the needs for the aimed analysis. Furthermore, two interviews took place to complete the necessary research domain related knowledge the researcher already had. Question [2] and [3] are answered with applying statistical methods. The answers to question [2] and [3] together lead to scenarios for improving the effectiveness of targeting choices, based on the evaluation of current targeting choices.

This research makes use of quantitative analysis, combined with parts of qualitative research approach. This single case study is about a specific law enforcement domain RoHS, for which quantitative analysis, using the statistical method ANOVA, will be used to evaluate the statistical value of currently used targeting choices for risk profiling, from targeting process performance point of view. Also, correlation and regression analysis will be used. Necessary knowledge is gathered via literature study and interviews with domain experts. The results of the quantitative analysis have been qualitatively evaluated by these experts to determine plausibility and usability of the research results for (adjusting) targeting choices.

Research relevance

For risk profiling, in the Netherlands the market authority provides Dutch Customs with law enforcement domain related risk indicators, assumed to be contributing to (non-) compliance of good flows and/or actors to applicable legislation. The used risk indicators directly influence the level of effectiveness of inspection activities for law enforcement on RoHS and need to be evaluated properly to be able to:

[1] Facilitate legitimate trade, by minimizing 'false positives' in risk-based shipment selections;
[2] Protect the Union market, while trying to minimize 'false negatives' in shipment selections.

For future targeting for supervision on the RoHS Directive, it is important to test the effectiveness of choices for current risk profiling, in order to statistically support or question targeting choices made. This research is expected to show (im-) possibilities and the extent of added value of implementing the used statistical analysis design and methods for targeting (adjustments) in any law enforcement domain.

Research approach

In this research, for the evaluation of effectiveness of targeting choices for risk based profiling, the effect of each targeting choices on the non-compliance for RoHS is being statistically evaluated, using separate conceptual models for targeting choices related to risk indicators and with regard to repeated inspections. The statistical evaluation of these choices will provide insights on the presence or absence of positive or negative relations of (jointly) used risk indicators on the effectiveness of the targeting process and possibilities for improving the effectiveness of the targeting process.

Data sources (need to be linked)

For being able to perform the former described research through statistical analysis of possible factors of meaning for the effectiveness of the targeting process, data about the selected shipments, containing the used risk indicators, economic actors involved with inspections, and outcomes of inspections is combined into one dataset. Furthermore, several additions have been made to complete the dataset with extra data elements, derived from existing data particulars, that are necessary for the aimed statistical analysis.

Scope of the research domain

For the quantitative analysis this research provides, the research domain includes the following data:

Import declarations filed in Dutch Customs declaration system AGS Invoer, being lodged within the period 1 January 2017 and 30 June 2022, for shipments with a net weight above 250 kilograms, of which samples relevant for supervision on the RoHS Directive have been inspected for exceeding norms for usage of lead, after selection of shipments via risk-based profiling, using risk indicators provided by the designated market authority for law enforcement on RoHS in the Netherlands.

3. Literature review

3.1 Cohesion of performed literature review

This quantitative research focuses on using statistical means for the evaluation of the effectiveness of targeting for enforcement on the RoHS Directive in the Netherlands, by answering the questions what role used risk indicators and repeated inspections play. To answer these questions, statistical calculations are used for a judgement upon justification for and/or reasonable questioning of current targeting choices related to facilitating legitimate trade and protection of the Union market.

For supervising agencies, it is important to apply proper risk-based targeting, enabling to inspect the right goods at the right time and in the right way to detect non-compliance. And this with a minimum of hampering bona fide trade, since applying the stop-function for goods causes logistic delay and extra costs. Declaration data is the starting point to analyse the risks involved in the (possible) impairment of protective controls, as this data is the primary information source at the moment products subject to prohibitions and restrictions of the RoHS Directive are intended to be brought on the Union market.

The RoHS Directive provides the obligation to supervise on compliance of products at the moment goods are about to become available on the Union market. Therefore, understanding of relevant legal principles and possibilities for (customs) supervision on compliance of products and actors to the RoHS Directive is considered to be necessary context for performing this research and understanding the outcomes. This also holds for understanding how the assigned supervising agencies act towards traders, based on their law enforcement policies for RoHS, and their influence on compliance costs of economic operators.

The effectiveness of current choices in targeting, as part of risk management for supervision on the RoHS Directive, is the actual subject of this research. Basic understanding of principles of risk management is considered to be necessary to understand the statistical analysis design and the importance of the outcomes of this research as well. This also holds for the assumed influence of applying risk management within companies on their compliance: private actors being in control over their internal processes and general compliance related behavioural aspects as considered and relied on for supervision on compliance (risks) related to laws and regulations by inspection agencies.

Since the targeting for supervision on the RoHS Directive is based on, amongst other indicators, a mixture of assumptions and considerations regarding certain HS-codes, countries of origin, average customs value per kilogram net weight and considerations regarding possible favourable treatment of AEO-certified companies, understanding these components of current targeting choices is considered to be important as well. And as this research is of quantitative nature, literature research about collecting, examining, editing and using data for analysis and on measuring targeting process performance and appliance of suitable statistical methods for analysis of effectiveness of this process is being performed as well.

Because of the former reasoning the first part of the literature review focusses on the context of this research, by providing a short overview of: relevant laws and regulations for supervision, applied law enforcement approaches of supervising agencies, compliance and compliance costs, and relevant customs related terminology. This part of the literature review provides the information to understand the context of targeting, and the considerations lying underneath choices made within the current targeting.
The second part of the literature review contains basics about in this research applied theory, consisting of the main elements of appliance of risk management by supervising agencies and the principles for measurement and evaluation of process performance in general and of effectiveness of law enforcement activities in particular. The former mentioned separate subjects have to be seen as building blocks which provide the foundation of this research. In addition, a part of the literature review was focused on the in this research applied methods for statistical testing, in order to provide the necessary formats and understanding of the research results, evaluating the effectiveness of current targeting for supervision on compliance to RoHS. But this part of the literature research has directly been integrated into the statistical analysis design and will not be discussed in this chapter.

3.2 Context of this research

3.2.1 Legal framework for supervision on the RoHS Directive

Customs supervision

Regulation 952/2013, providing the Union Customs Code (UCC), sets out general rules and procedures applicable to goods brought into or taken out of the customs territory of the European Union, adapted to modern trade models and communication tools. The Netherlands is part of the customs Territory of the Union, as defined in the UCC. Therefore, Dutch Customs is bounded to the provisions of the UCC to perform its customs supervision, which is mainly based on risk management regarding (verification of) customs declarations and take actions in case of (assumed) non-compliance. The following brief overview, relevant for this research, is based on UCC articles 134, 145(1), 149, 150, 162, 163, 170, 182, 188, 194, 198

This UCC provides that goods brought into the customs Territory of the Union shall, from the time of their entry, be subject to customs supervision and may be subject to customs controls, as long as they maintain their status of non-Union goods. Goods brought into the Territory can be subject to prohibitions and restrictions, for example because of protection of the environment. Customs authorities are allowed and obliged to take any necessary measures, such as confiscation or destruction, or dispose of goods if obligations in customs legislation are not fulfilled or goods cannot be released for other reasons.

After entry of non-Union goods into the Customs Territory of the Union, their presence shall be covered by a temporary storage declaration. Non-Union goods in temporary storage shall be placed under a customs procedure or re-exported within 90 days. Except where otherwise provided, the declarant is free to choose one of the customs procedures under which to place the goods, under the conditions for that procedure: release for free circulation, special procedures or (re-)export, on the condition that a customs declaration has been lodged.

The UCC provides that customs declarations shall contain all the particulars necessary for application of the provisions governing the customs procedure for which the goods are declared. The supporting documents required for the application of the provisions governing the customs procedure for which the goods are declared shall be in the declarant's possession and at the disposal of the customs authorities at the time when the customs declaration is lodged. Supporting documents shall be provided to the customs authorities where Union legislation so requires or where necessary for customs controls. The customs authorities may, upon application, authorize a person to lodge a customs declaration, including a simplified declaration, in the form of an entry in the declarant's records.

Where the conditions for placing the goods under the procedure concerned are fulfilled and provided that any restriction has been applied and the goods are not subject to any prohibition, the customs authorities shall release the goods as soon as the particulars in the customs declaration have been verified or are accepted without verification. Customs authorities shall take any necessary measures, including confiscation and sale, or destruction, to dispose of goods in the following cases:

- where one of the obligations laid down in the customs legislation concerning the introduction of non-Union goods into the customs territory of the Union has not been fulfilled, or the goods have been withheld from customs supervision;
- where the goods cannot be released because:
    - it has not been possible, for reasons attributable to the declarant, to undertake or continue examination of the goods within the period prescribed by the customs;
    - the documents which must be provided before the goods can be placed under, or released for, the customs procedure requested have not been provided;
    - the goods are subject to prohibitions or restrictions;
    - where after release, goods are found not to have fulfilled the conditions for release.

Supervision on imported products, that have to be compliant to the RoHS directive

Regulation (EU) 2019/1020 lays down rules and procedures for economic operators, establishes a system for their cooperation with supervisory authorities and it establishes controls on products imported into the Union. In Annex 1, under number 39 Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the Restriction of the use of certain Hazardous Substances (RoHS) in electrical and electronic equipment (EEE) is mentioned, making regulation (EU) 2019/1020 applicable to products and economic actors mentioned in the RoHS Directive. This Directive regulates the use of hazardous substances in electrical and electronic equipment (EEE), to protect human health and the environment, in particular by enabling environmentally sound recovery and waste treatment of EEE.

Actors that import goods into the Union have to comply with rules and procedures as laid down in laws and regulations applicable to the products or substances it concerns. Regulation 2019/1020 on market surveillance and compliance of products lays down general rules for controls on products imported into the Union. In this regulation, responsibilities and powers for law enforcement are assigned to national authorities and the supervision on (relevant laws for specific) goods covered by this regulation starts at the moment of lodging an import declaration, implying intention to bring products on the Union market.

Annex I to the RoHS Directive sets out the categories of EEE that are covered by the legislation. Annex II of this Directive places an obligation on manufacturers and importers to ensure EEE that they place on the Union market have been designed and produced in line with the stated norms for the allowed levels of used heavy metals. According to the RoHS Directive importers must check that equipment to be imported is approved to be placed on the Union market, by meeting the required standards for the use of heavy metals. Distributors must also ensure these norms are met.

Cooperation and roles of Dutch Customs and ILT for law enforcement on the RoHS Directive

Whereas Dutch Customs is solely responsible for assessing compliance of private actors regarding customs legislation, within the Netherlands in principal the nationally designated market authority is responsible for compliance regarding placing products on the internal market of the Customs Territory of the Union by private actors being situated in The Netherlands. Therefore, in the Netherlands the former mentioned laws and regulations lead to a covenant in which the Dutch parties Ministry of Infrastructure and Water management (Ministry of I&W), Inspectorate for Living environment and Transport (ILT) and Dutch Customs arranged their cooperation regarding supervision on compliance to the RoHS Directive.

For their supervision, national market authorities can ask Dutch customs for system- and/or declaration-oriented inspections. The first category is based on audited reliability of internal processes of economic actors, providing reasonable assurance about (customs) compliance. The latter category covers selecting and inspecting real time customs declarations. Only the latter is asked for supervision on RoHS Directive.

Integration of aspects of legal framework into the statistical analysis design for this research

The applicable laws to be supervised provide the responsibilities, tasks and authorizations for law enforcement agencies to act in order to achieve the goals of the legislation for which the supervision is assigned to them, as well as the obligations of, and norms for, private actors that need supervision. This framework is the starting point for possibilities and limitations for enforcing compliance goals.

3.2.2 Law enforcement approach of supervising parties

Programmatic law enforcement

In the Netherlands ministries and inspectorates are obliged to make explicit what the minimum desired level of compliance is for making decisions regarding law enforcement activities (Court of Audit, 2005). These decisions require information and relevant insights about risks that have to be mitigated and motives for (non-) compliance. The methodology 'Programmatic law enforcement' provides the required professional judgement for this.

In their 'internal' guidelines for programmatic law enforcement within Dutch governmental organizations Van Mourik *et al* (2007) describe four sequential steps for initiating/evaluating law enforcement activities. First a risk analysis should be done, to motivate and define general priorities for law enforcement

activities in a structured way. The focus of this step lies on determining target groups having the most negative effect on the aimed compliance level. With the outcomes of this risk analysis as starting point, the second step is to define an intervention strategy to achieve better compliance to law and regulation. Within this step, law enforcement priorities are defined, regarding target groups and their behaviour. The guidelines provide a tool to determine the compliance and violation motives of these groups. The chosen intervention strategy is meant to connect to these motives for the prioritized groups, to correct unwanted behaviour and stimulate wanted behaviour effectively. The next step of the methodology of Mourik et al is executing the intervention strategy, by allocating the tasks needed for law enforcement to the right parties involved. Finally the effectiveness of the law enforcement strategy should be measured to test the assumptions that were the basis for the defined and executed interventions to reduce the compliance risk that had to be covered by law enforcement parties.

The guidelines for Programmatic law enforcement distinguishes five target groups: [1] unknowingly compliant actors, [2] unknowingly offenders, [3] spontaneous compliant actors, [4] enforcement deterred compliant actors and [5] knowingly offenders. Group [1], [3] and [4] consist of compliant actors, for different reasons. The non-compliant actors can be found in group [2] and [5], based on different reasons.

In their governmental-wide accepted philosophy of programmatic law enforcement, Van Mourik *et al* (2007) state that (non-) compliance is influenced by the combination of 11 factors: [1] knowing the rules, [2] costs and benefits of (non-) compliance, [3] extent of acceptance of the rules, [4] willingness to comply to norms, and the perceived [5] social control from society, [6] chance to be reported by non-governmental parties, [7] chance to be subject of governmental inspection, [8] chance that non-compliance gets detected during inspection, [9] increase of chance to get inspected after proven non-compliance, [10] chance to get sanctioned and [11] severity of sanctions for non-compliance. In this philosophy, any (non-) compliance inspection result for RoHS is supposed to contribute in more or less extent to each of these factors, in order to maintain an acceptable compliance level in case of compliance and stimulate the necessary changes in behaviour to achieve an acceptable compliance level if inspection results showed non-compliance of products to the norms for RoHS.

With its approach, the methodology of programmatic law enforcement takes incentives and behaviour of (groups of) people, including companies, as starting point for choices in law enforcement. It is a planned, integral, transparent and cyclical way of weighing costs and desired effects of law enforcement, by performing the sequential steps in order, ought to be applied by inspection agencies in the Netherlands.

Responsive regulation

Responsive regulation, as described by Ayres and Braithwaite (1992) is an important principle of the law enforcement policy context within the Netherlands. It is called responsive for being responsive to the environment in which the regulation occurs, including being responsive to the community in which responsive regulation is embedded. But most important it is called this way for being responsive towards actors being regulated. The way actors respond to what the regulator wants them to do, determines the way the law enforcing agency is acting. This is expressed in their so called law enforcement pyramid.
In general, for the group of compliant actors at the base of the pyramid, not much intervention or supervising pressure is needed to get and keep them compliant to laws and regulations. Moving upwards in the pyramid, less (willing to be) compliant actors face a tougher law enforcement regime. The pyramid provides law enforcers tools to effectively enforce regulations, by responding to behaviour of actors with principles of equivalent retaliation. The seriousness of the offence determines the severity of sanctions. Having and using a responsive regulation pyramid, with different sanction possibilities, supports voluntary regulation of compliance and is essential to achieve good compliance results with supervision activities.

Enforcement vision Dutch Customs

For efficient and effective fulfilling its dual protective and facilitating role, Dutch Customs (2014) established their enforcement vision 'Pushing Boundaries', with risk-based inspections as one of the key elements. The core of this vision is the model of so-called layered enforcement: fewer and less drastic interventions in logistics for (trade lanes of) proven reliable actors, and more checks for 'unknown' and non-compliant actors, with less attention for the logistic interests in favour of mitigating risks at border crossing of goods.

Integration of aspects of law enforcement approaches into the statistical analysis design for this research
Recently, the Dutch Inspectorate of living environment and Transport (ILT), acting as principal of Dutch Customs for law enforcement on environmental law enforcement domains such as RoHS, stated its goal for 2023 as follows: *"100% compliance with prohibitions and restrictions regarding each individual environmental regulation, and the proper functioning of risk profiles for selecting shipments for inspection, for which it can be necessary for enforcement partners to work together".* This goal contains a very ambitious minimum desired level of compliance for making decisions regarding law enforcement activities. To achieve this goal, or at least reduce the current compliance gap that prevents this goal to be achieved, ILT implicitly states that it is determined to increase the effectiveness of current risk profiling.

According to the methodology of programmatic law enforcement of Van Mourik *et al* (2007), the first step for possible improvement of risk profiles is to evaluate the effectiveness of the current targeting choices. The evaluation performed in this research is meant to provide objective information about this effectiveness and ideally provides insights on target groups and their behaviour, to facilitate step 2 of the programmatic law enforcement process for either continuing or adjusting the current law enforcement strategy regarding risk profiles. For defining and executing (changes in) law enforcement activities, the principles of responsive regulation are relevant and the principles of the enforcement vision of Dutch Customs are ought to be applied in risk profiling. Both are meant to facilitate legitimate trade, by minimizing hampering compliant actors, while executing the law enforcement strategy to improve compliance of other actors.

3.2.3 Influence on, and costs of, compliance to the RoHS Directive

Compliance
As stated in article 4 of the RoHS Directive, for supervision, compliance is to be seen as complying to norms, laid down in legal provisions, regarding import of the described products. According to articles 162, 170(1) and 171 of the UCC, in order to be compliant with regard to the customs legislation, for import of products it is necessary that the declarations for the release for free circulation of goods are made in a timely, correct and complete manner. 'Timely' means at the moment the goods in question can be presented to customs. 'Correct' means that all the particulars provided in the customs declaration have to be according the 'physical truth' of the shipment: commodity code, goods description, weight, country of origin, value etc. must reflect the truth about the actual physical shipment. 'Complete' refers to the fact that the customs declaration has to cover all goods that should be declared and that all the necessary documentation for legally valid release for free circulation of goods is in possession of the relevant parties involved, or if the law provides it, that the relevant documents for acquiring for legally valid release for free circulation of the goods have been provided to customs, at the moment the customs declaration is lodged or customs asks for it for inspection. In addition, for importing products subject to the RoHS Directive, there are prohibitions and restrictions in place. The prohibitions concern use of certain types of heavy metals in specified groups of products, for which legally provided norms are not allowed to be exceeded. These norms provide restrictions for the use of certain metals.

Supervision on compliance to RoHS
Since prohibitions and restrictions are part of the task of customs authorities as well, and Dutch Customs responsibility covers all releases for requested customs procedures, in daily practice both national market authority ILT and Dutch Customs share the responsibility for achieving a high compliance level at the moment of release for free circulation of products that enter the Union market and are subject to the RoHS Directive. The way these inspection agencies work together is laid down in a national covenant on cooperation between the Dutch Ministry of Infrastructure & Water management I&W) and the Dutch Ministry of Finance, about the execution of legal duties regarding the policy area of the ministry of infrastructure & Water management by Dutch Customs. Basically, the national designated market authority for supervision on RoHS (ILT) acts as principal of Dutch Customs with regard to providing risk indicators for generating inspections and handling non-compliance. If irregularities are deemed to be possible, the selected goods cannot follow the requested customs procedure, for example 'release for free circulation', until the moment the market authority approves it. If an irregularity is established, the goods may definitively not be released for the requested customs procedure. The national market authority decides about whether or not and under which conditions goods may (not) follow the requested

procedure. Dutch Customs facilitates the execution of decisions of the national market authority, within the legal framework of customs laws and regulations.

Types and size of compliance costs

Like trade and customs compliance costs at seaports, as discussed by Grainger (2014), similar types of costs are related to the legal act of 'bring products on the Union market' by lodging a customs declaration for release for free circulation. As for compliance costs in seaports, the costs for bringing products on the Union market can be divided into three categories: [1] initial set-up and approval (authorisation) costs; [2] transactional costs and [3] inspection costs. According to Grainger (2014), Trade-related transactional costs could alone equate to anything between 2 and 15 percent of the value of imported goods. Although these figures are based on different scopes and they lack context, they give an indication for costs to become and stay compliant.

Authorisation costs are related to receiving, storing and/or shipping cargo, within legal procedures and limitations and includes keeping (inventory) records for (customs) supervision purposes and approval of locations used for customs related business activities. Transactional costs can be defined as costs related to providing regulatory-relevant information that is normally not required for physical handling and commercial operations alone. Examples are costs for creating necessary documents and providing customs declaration systems with the required data for the requested customs procedure. And Customs procedures are subject to some form of verification. The frequency of physical inspections depends on the inspection model. Inspections are quota based if a certain volume of a specific commodity has to be inspected. The other model is risk-based: if economic actors involved with a shipment and/or certain cargo are perceived as high risk, inspection will follow. Either way, economic operators have to provide labour and location to make inspection possible and inspection, especially physical ones, results in some form of delay in the logistics of the goods involved.

(Influencing) compliance behaviour

In every entity, (groups of) people perform actions for executing internal processes that lead to some kind of value for the organization, contributing to the continuity and profitability of the organization. Choices in daily operations while executing these processes, leading to legal consequences, can be seen as organizational compliance behaviour. Since daily choices while executing processes are made by humans, human behaviour aspects are considered to be relevant for (influencing) organizational compliance levels.

Alblas and Wijsman (1998) summarized very concisely several of widely known and often tested human behavioural theories. Based on the so called 'interaction approach', behaviour is the result of both situational aspects as personal aspects. Within this particular behaviour model, the personal (organizational) aspects can be divided into characteristics, values/beliefs and attitudes and the situational aspects are stimuli and opportunities. Together these factors determine intended behaviour, which is supposed to be re-considered before acting. Valuation of stimuli and opportunities is personal.

According to Alblas and Wijsman (1998) cognitive behavioural theories focus on the interaction process. Behavioural subjects are not passively governed by situational factors or by inner forces, but can think, observe, weigh and consider the consequences of decisions. Expectations and goals play a more prominent role in these theories. According to the 'value expectation theory' people (organizations) are motivated to perform certain behaviour when they expect to get attractive returns from doing so. The value of these returns is subjective, as is the judgement upon the efforts needed to achieve these attractive returns. The 'attribution theory' focuses on how people (organizations) interpret, understand and explain their behaviour and that of others. To what extent is internal and external motivation present? Internal motivation comes from the inside: the unconstrained will to do something. The external motivation is based on influencing behaviour with external stimuli: triggers for behaviour.

Any organization, actually being a group of individuals, is capable of learning. Alblas & Wijsman (1998) state that this learning can take the form of 'classical conditioning' of behaviour: a stimulus provokes a response, which is repeated if successful. Active learning is also possible: experimental behaviour is either rewarded or not. If rewarded, repetition of the behaviour is very likely to happen.

Integration of aspects of improving compliance into the statistical analysis design for this research
The focus of this research is on the compliance of examined products to the norms provided by the RoHS Directive. For the supervision on RoHS, the legal norms about usage of heavy metals require physical inspections to sample selected shipments and laboratory analysis for judging upon compliance behaviour regarding legally provided norms. Executing powers by supervising agencies by initiating inspections and acting on non-compliance can be seen as external forces that are able to influence (intended) behaviour of organizations, via generating stimuli and opportunities for (attitudes towards) compliance performance of supervised private actors. (Employees of) these entities are able to think and weigh options and decide, taking corporate and personal risk appetite into account, while trying to achieve goals. The compliance performance is likely to be influenced by inspections as external stimuli. Estimating the effect of executed inspections as external stimuli for (adjusting) behaviour is an important aspect in part 2 of this research. Current compliance costs are estimated to argue necessity of periodical evaluation of targeting choices.

3.2.4 Relevant customs related terminology

Relevance of customs related terminology for this research
The scope of this research is related to inspected goods, for which the customs declaration provides the commodity code, country of origin, customs value and information about (AEO-certified) parties involved. For determining the HS-code, the Country of Origin and the customs value certain rules are applicable and have to be followed by private actors, in order to provide the right information in customs declarations for release for free circulation. Dutch Customs relies on this information for its risk assessment and declaration-oriented risk-based profiling for its supervision. Because this research evaluates targeting choices based on customs declarations, these components are briefly explained, as well as legal principles of Authorised Economic Operator (AEO), for their relevance for evaluation effectiveness of the targeting.

Classification of goods according to the nomenclature
Goods must be described in the customs declaration in such a way that classification of goods into the correct customs tariff HS code (commodity code) is possible, and the declared HS-codes needs to be correct, to provide customs the possibility for supervision on, and risk-based inspections for determining the extent of compliance to applicable tariff and non-tariff measures for goods concerned. Weerth (2008) states that, goods can be classified by material (condition) and by function or usage. The customs classification of goods into the tariff scheme of the Harmonized System (HS) nomenclature is complex.

Weerth (2008) describes the rules for classifications of goods. Placing a certain product into the nomenclature is based on only six General Rules (GRs), applied worldwide. The HS and all nomenclatures based thereon consist of 21 sections and 96 chapters, mainly based on the 'production principle': raw materials placed in the beginning, fully produced goods at the end of the nomenclature. As stated by Weerth (2008), basically goods can be classified by (combination of) material condition and by function or usage.

Country of Origin
In general, to determine the country of origin of goods it is essential whether products comply to rules of specific Free Trade Agreements (FTA's) or the non-preferential rules of origin (NPRO's) of the UCC are applicable. In case preferential rules of origin (PRO's) of an FTA are applicable, the Generalized System of Preferences (GSP) of the Union is applicable to the product it concerns.

Melin and Arnold (2019) and Rogiest *et al* (2020) describe that under NPRO's, goods wholly obtained in a certain country are supposed to originate from that country. For goods for which this is not the case, for customs matters, the country of origin is the country in which the last substantial transformation in the production process took place. The UCC provides rules to determine whether a transformation took place and whether this transformation is to be called substantial. A transformation is to be seen as a step in the production process in which a product gets its own typical properties and composition, which it did not possess before. A transformation is called substantial if it leads to a real and objective distinction between the materials or components used for the product and the possessed product itself. To claim a country of origin under NPRO's, proof is needed, by providing a form A or invoice declaration or the actor can use its Registered Exporter (REX) certification.

Besides the NPRO's of the UCC, also Preferential Rules of Origin (PRO's) exist, based on FTA's. Rogiest *et al* (2020) describe that every FTA establishes a different set of rules of origin. PROs are often designed in a very restrictive way and to prove preferential origin usually a complicated administrative procedure needs to be followed. These procedures can differ from one FTA to another. The Union has FTAs with different countries. Whether (no) measures for facilitating trade, supporting protectionism or encouragement or discouragement of trade and cargo flows are applicable, depends on type of goods, classified via an HS-code, and their Country of Origin (CoO). Applicable tariff measure requires correct valuation of goods.

Customs value of goods

De Wit (2017) describes that the customs value of goods has to be determined at the time of acceptance of the customs declaration. Primary basis for the customs value is the sales price of the goods, which can be agreed on and declared in any currency. With this declared value, the customs value is calculated in euro's, taken into account several rules about components that need to be added to and subtracted from the declared sales price. The customs value of imported goods is the basis for calculating the customs debt that becomes due at the moment non-Union goods liable to import duty are placed under the customs procedure release for free circulation or temporary admission with partial relief from import duty. The customs value of goods together with the origin and nature of the goods and the applicable tariff determines the import duty due.

The basis for customs value of goods is the transaction value. This is the price actually paid or payable for the goods, when sold for export to the customs territory of the Union. The customs value has to be determined at the time of acceptance of the customs declaration. Basis for the valuation is the sale that actually occurred immediately before the goods were brought into the Union. But if the goods are sold for export to the customs territory of the Union not before they were brought into the Union, while the goods were in temporary storage or placed under another special procedure than internal transit, end-use or outward processing, the customs value will be based on that sale.

There are different ways to determine the customs value of goods. The order of applying them is stated by law. For using the transaction value method, it is required that the parties of a transaction of goods can be regarded as buyer and seller, acting independent from each other. The invoice which relates to the declared transaction is required as a supporting document. If the sale criteria of buyer and seller is not applicable to an EU border crossing shipment, valuation rules for so called 'intercompany traffic' apply. When the customs value of goods cannot be determined with the transaction value method, it has to be determined with one of the other methods provided by law. It is obliged to use the first method, by law presented order, that enables customs valuation. Besides value of the goods themselves, for the customs value of goods several elements need to be supplemented and should not be included in the calculation.

Authorised Economic Operator

The Authorised Economic Operator (AEO) concept is based on the Customs-to-Business partnership introduced by the World Customs Organisation (WCO). According to the Authorised Economic Guidelines of Taxud (2016), which are based on the provisions on the AEO-concept in the UCC, the AEO status can be granted to any economic operator that has a good record of compliance to customs and tax regulations, a high level of control of its operations and of the flow of goods and a proven solvency. For AEO-C also practical standards of competence or professional qualifications directly related to the business activities is required. For AEO-S appropriate security and safety standards are a requirement. The focus of AEO-C status is on correctness of fulfilling custom formalities, where the focus of AEO-S status is mainly on assurance of safety and security of cargo flows.

Customs expects an Authorised Economic Operator (AEO) to apply enterprise risk management with appropriate internal control measures, to ensure that risks related to customs activities of the actor are identified and minimised. Generated trust in compliance of the actor's risk management gives access to the AEO-status and its benefits. The AEO concept is meant to provide customs authorities the possibility of a risk-based shift from transaction-based supervision at borders to (partly) system-based supervision on good flows. According to the guidelines, based on the UCC, an AEO-C is entitled to benefit from:

- specific types of simplifications, if certain requirements are fulfilled;
- more favourable treatment than non-AEO operators in respect of customs controls, including fewer physical and document-based controls, with exception of safety and security measures;
- prior notification, treatment, and choice of location in case of selection for customs control.

3.3 Subject knowledge: evaluating effectiveness of the targeting process

3.3.1 Risk management

Legal obligations for appliance of risk management by supervising agencies

Risk management includes the systematic identification of risks and the implementation of measures needed to prevent and reduce the exposure to risks. Risk management consists of identification, quantification, and mitigation of risks. Firstly, to make proper risk management possible, risks must be noticed. After noticing a risk, the chance that the risk can/will occur and the possible impact of the risk must be estimated, in order to be able to judge upon the necessity of mitigating the risks with suitable counter measures. If measures are needed, come up with suitable measures, implementing and monitoring the effectiveness of them are also part of a continuous process of risk management.

UCC article 4 requires customs authorities to protect the financial, safety & security, health, economic and environmental interests of the Union and facilitating trade at the same time, with a proper balance between customs controls and facilitating of legitimate trade. To effectuate the former pursuit, UCC article 46 provides customs authorities the possibility to carry out any customs controls they deem necessary, with the obligation that, random checks excluded, all checks need to be based on risk analysis, using electronic data-processing techniques. Its purpose is, to identify and evaluate the risks and developing the necessary countermeasures, on the basis of criteria developed at national., Union and international level.
According to articles 13, 16, 18 and 19 of the market surveillance regulation, national designated authorities shall ensure that products presenting a serious risk are withdrawn or recalled, where there is no other effective means available to eliminate the serious risk, or that their being made available on the market is prohibited. A decision whether or not a product presents a serious risk is provided to be based on appropriate risk assessment that takes account of the nature of the hazard and the likelihood of its occurrence. In this context “risk” means the likelihood and the impact of bringing goods into – and the presence of goods in - the territory of the Customs Union, which could violate correct application of applicable measures, comprise financial interests of (Member States of) the Union, or pose a threat to security and safety of the Union and its residents, including human, animal and plant health and environment.

Applying risk management by law enforcement agencies & economic actors

A Committee of Sponsoring Organizations of the Treadway Commission (COSO) together with PWC started to develop an internal control framework that could be used by managements to evaluate and improve their organizations’ enterprise risk management. As a result, COSO (1994) introduced the ‘Internal Control – Integrated Framework’ to help entities assess and enhance their internal control systems. This framework has been incorporated into policy, and regulation, and is used by thousands of companies to better control their activities with which they try to achieve their objectives. Among the most critical challenges for managements is determining how much risk the entity is prepared to accept, since business activity brings uncertainty, which holds both risk and opportunity, with potential loss of increase of value. Enterprise risk management enables management to effectively deal with them to enhance the capacity to increase value. Whereas the programmatic law enforcement philosophy focusses on defining target groups for achieving/improving compliance and determining which factors are likely leading to (non-) compliance, the COSO framework focusses on prioritizing mitigating risks based on chance of occurrence and impact of possible events.

COSO (1994) states that Enterprise risk management consists of several components. First there is the aligning of risk appetite and strategy via evaluating directional decisions and alternatives to create value and mitigate related risks. Enhancing risk response decisions, providing the ability to identify and select

response to risks, is the second part. The third component is reducing the number of and/or impact of negative impacts on daily operations to avoid costs or losses. Identifying and managing complex interrelated risks should also get enough attention, for effective integrated responses to multiple risks with complex interdependencies. The fifth part is called 'seizing opportunities': management should decide upon acting on a range of potential positive and negative events to enhance the chance of succeeding in achieving objectives. Finally, gathering proper risk information allows management to effectively decide upon needs and allocation of resources, with which management can facilitate the performance of the company.

COSO (1994) defines that enterprise risk management is about managing the risks and opportunities affecting value creation or preservation. It is an ongoing process, effected by people at every level of an organization. It is applied in, and affected by, strategic setting and across the company, at every level and unit. It is designed to identify potential risks that, if they occur, will affect the organization and management needs to decide upon the risk appetite to deal with these risks. It is meant to support the achievement of objectives, which can be defined on strategic level with high-level goals, on operational level with operational efficiency and effectiveness, on reporting level (reliability of reporting) and/or on compliance (to laws) level.

The Enterprise Risk Management framework of COSO (1994) integrates several focus points to achieve compliance. First there is the 'internal environment', encompassing tone, views, and culture of the organization, including risk appetite. Secondly this framework provides a process for 'objective setting', needed for management to identify potential events affecting achievement of goals. 'Event identification' provides the channelling of identified, distinguished risks and opportunities towards management strategy and objective-setting processes. In the part 'risk assessment' of COSO, the impact and likelihood of events form the bases of how these risks should be managed. 'Risk response' is the way and extent to which management actually tolerates and responds to the identified risks, with 'control activities': policies and procedures to facilitate proper mitigation of risks that require response. Furthermore, relevant information needs to be identified, captured, and communicated to enable employees to carry out their tasks well and in time. Finally, every enterprise risk management system needs monitoring to identify necessary modifications to improve the quality of the embedded framework.

According to COSO (1994) Identified risks need to be mapped based on likelihood and impact. At least the risks with large impact and highly estimated likelihood should be mitigated. The mitigation of risks with other combinations highly depends on the risk appetite of the entity. Risks can be avoided, reduced, transferred or accepted. For avoidance, either the likelihood or impact needs to be taken away. Reducing requires reducing impact and/or likelihood. Transferring requires an assurance to cover liability or the transfer for the liability itself.

Integration of aspects of risk management into the statistical analysis design for this research

With limited control capacity and inspections being costly and time consuming for all parties involved, law enforcement agencies are facing the challenge to be effective in mitigating the compliance risks for the law enforcement domains assigned to them. To achieve this, risk management is applied by supervising agencies to find a proper balance between facilitating trade and their control activities. In accordance with the principles of (enterprise) risk management, this research focusses on evaluating and improving the targeting process performance, by adopting the COSO framework risk assessment likelihood and impact of events. For the evaluation of targeting choices within this research, the influence of these choices is measured along the dimensions of likelihood of detecting non-compliance and the impact of detected non-compliance. In line with the COSO framework, for the statistical analysis design for this research, targeting choices are considered to be more effective for higher classifications for both dimensions for individual cases and on average for the whole targeting process. Reducing risks is key.

Regarding the researched effect of repeated sampling, the aim of this research is to provide insights on the risk response of consignees on inspections activities: does the available outcome of statistical analysis make consistent high levels of compliance and/or taking counter measures after non-compliance of consignees – and therefore a proper appliance of risk management by consignees – somehow plausible?

3.3.2 Measuring effectiveness of targeting

Programmatic law enforcement philosophy

In their guidelines for programmatic law enforcement Van Mourik *et al* (2007) state that for measurement of effectiveness in the context of enforcement of laws and regulations, a distinction can be made between the actor who carries out interventions (supervisor), the supervised group (target group) who are subject of the interventions and the society in which the realization of policy objectives must be noticeable. According to their guidelines, measuring effectiveness starts with choosing suitable indicators. And subsequently, a research method must be chosen, relevant data must be collected and analysed. Based on the results of this analysis, in theory statements can be made about effectiveness of a law enforcement process and choices made for, and within, it. This requires setting up the measurement of effectiveness in such a way that an estimate can be made of the effect of choices on the outcomes of a process: to what extent can the occurring effects be attributed to the choices made?

Lean Six Sigma philosophy

In his book Lean Six Sigma – Green Belt, Theisens (2018) writes that performance indicators of business processes can relate to input, throughput, output, and resources of a process. Input indicators relate to what is brought into/is being 'consumed' by the process of creating a product. Output indicators concern the outcomes, or results, of the executed process. Throughput indicators relate to measuring the efforts in the process itself. When measuring effectiveness, it is important to identify indicators with which processes in organizations can be managed and evaluated, in line with organizational objectives.

According to Theisens (2018), for analysis and improvement of the performance of any process the starting point is the main goal of the process itself: what is executing the process ought to achieve? For this it is important to define the desired output of a business process, with clear specifications. According to the Lean Six Sigma philosophy, the desired outcomes of any business process, should be related to the goals at corporate level. One of the instruments to achieve the necessary alignment, is a CTQ flow down. With this schematic approach the aspects that are Critical To Quality (CTQ) are defined and leading for the desired output that single business processes need to deliver to support the organization with achieving its goals. The Lean Six Sigma philosophy states that measuring corresponding process indicators will provide insights about average process performance and the existence and extent of variances present in the output of the measured process. For Lean Six Sigma both can be relevant for process improvement.

In the Lean Six Sigma philosophy the main question for improving any process is the question why the process does not 'deliver' what it is supposed to and find solutions for the root causes that are the basis for the problems that lead to partially unfulfilled needs regarding expected outcomes of the process. Therefore, process performance should be measured before starting any interventions to improve the process performance, in order to be able to attribute any change in process performance to the interventions made, based on the analysis of the root causes and defining and implementing solutions for the problems that caused the process to fall short. For defining these measures, it is important to keep focus on the goals of the process. Any measures to improve process performance, are related to one of the following aspects, causing loss of process performance: overproduction, waiting time, transport, overprocessing, unnecessary inventory, unnecessary movements, failures and/or unused knowledge. Failures for example, can lead to products that do not correspond to the desired specifications and cause loss of resources. Overproduction is a problem if the output is not needed/desired by the stakeholders.

If the objectives of the process are not fully achieved, there is room for process improvement. According to Theisens (2018), process improvement can be achieved by using a sequential approach, with the phases Define, Measure, Analyse, Improve and Control (DMAIC). This methodology is commonly used in lean practice. In the first phase, the problem (a performance gap) of the process is defined, as well as target for improving the process performance. In the measure phase it is defined what can and has to be measured to create valuable insights with regard to current process performance. In the analyse phase, the process performance is being analysed and root causes for the experienced performance gap are defined, based on this analysis. Afterwards, in the improve stage of the improvement process, measures to enhance process performance are defined and implemented. The control stage is about securing the achieved improvements and maintain new process performance level via proper (continuous) monitoring.

In the Lean Six Sigma philosophy statistically significant difference between measurable output of processes before and after interventions for improvement is used to determine their effectiveness.

Integration of aspects of Lean Six Sigma and programmatic law enforcement into the statistical analysis design for this research

In line with the Programmatic law enforcement guidelines of Van Mourik *et al* (2007), this research focusses on the effectiveness of targeting choices of the actor who carries out interventions as supervisor: Dutch Customs. Both parts of this research contain a measurement element for realization of the relevant environmental policy objective (impact) for the chosen law enforcement domain, as well as measuring effectiveness of enforcement activities along a dimension related to likelihood of desired output of targeting. The second part of this research is focussed on supervised groups of consignees and analysing their compliance behaviour over several inspection experiences. For both parts of this research, in line with Programmatic law enforcement philosophy, the key elements are: to what extent can the occurring process output be attributed to the targeting choices made and can possible improvements be defined?

According to the Lean Six Sigma philosophy, the goals of the targeting process should be in line with the corporate strategy. The legal context provides the basis for the corporate strategy of supervising parties. Together with the national market authority ILT as its principal, Dutch Customs is responsible for the risk-based supervision of the fiscal integrity and safety and security of the EU external border crossing freight traffic, and for the domestic supervision on the integrity and remittance of excise duties. With this supervision mechanism unwanted goods entering the Union market can be prevented, by 'stopping' them in time. Besides this, ILT and Dutch Customs are also expected to contribute to the competitiveness of the Netherlands and the European Union, for example with less as possible disruption for logistics.

For evaluating effectiveness of the targeting process for supervision on RoHS, applying a 'CTQ flow down' resulted in defining three goals of the targeting process performance. First, for capacity reasons, the actually executed number of inspections during a certain time period should be close to the planned/ agreed number of inspections. Within this quantitative process output target, which evaluation is outside of scope for this research, scarce resources need to be used to achieve effective supervision. The other two defined goals of the targeting process output are of qualitative nature and in scope for this research.

The second and third goals of the targeting process, the basis for this research, are connected to the task of customs and market authorities to supervise safety and security of products (to be) brought on and/or leaving the Union market, with only limited resources available for supervision. These products must apply to the norms provided in applicable laws and legislation and actors involved must apply to the obligations these laws and legislations provide. For targeting, minimizing 'false negatives' (wrongly assumed compliant shipments) in the selection process for inspections is crucial for protection of the Union market. While minimizing 'false positives' (wrongly assumed non-compliant shipments) is important for contribution to competitiveness of legitimate trade. And both are important for efficient and effective use of limited control capacity of the supervising agencies. Furthermore, in this research law enforcement activities preventing larger negative impacts are considered more effective than activities that prevent smaller negative impacts, related to the limited resources available. For translating the former reasoning into measurable variables to evaluate targeting process performance, two Key Process Indicators (KPI's) have been defined: one for likelihood of non-compliance and one for norm exceedance. For this research, these KPI's are used to evaluate the effectiveness of targeting choices, by performing ANOVA tests to compare means of groups, which are distinguished by one targeting choice at the time.

With the output variables of the targeting process defined to measure its performance, a starting point is created to evaluate the targeting choices that function as input for the targeting process. In this research the contribution of each targeting choice to the current average targeting process performance is analysed and indications for possible improvement have been followed up, resulting in scenarios that are likely to be able to push up the targeting process performance. The expected process performance applying the different presented scenarios are mathematically compared with the current targeting process performance, to quantify possible process improvement of adjustments to targeting choices.

3.3.3 Measuring effectiveness of law enforcement interventions

Based on the findings of the Court of Audit of The Netherlands (2005, 2008), concluding that inspectorates work reasonably professionally, but lacking insight into the relationship between enforcement, compliance, and risk reduction, in 2008 the Dutch Inspection Council expressed its ambition to learn more about the effectiveness of supervision in a multi-year program 'Evaluation of the effects of supervision'. The aim of this program was to improve supervisory practice with insights from research into its effectiveness. In this context, Winter and De Ridder (2010) performed a literature study to connect (scientific) knowledge about the relationship between enforcement, supervision, behaviour, and effects. For this research 70 designs and best practices based on collected domestic and foreign effectiveness studies were collected. Special attention was paid to the way selected investigations were carried out, which designs were used, their results and how inspection agencies can carry out such investigations.

Winter and De Ridder (2010) state that, in a general, 'effectiveness of supervision' can be described as the extent to which the exercise of supervision leads to the achievement of the objectives of that supervision. In this light, goals can be seen as continuing good behaviour and changing undesirable behaviour towards good behaviour. Much of the evaluated research aims to determine effectiveness of a supervisory action at a given time in terms of a given behaviour change. Effectiveness of supervision in relation to maintaining certain patterns of behaviour under the supervised actors has been studied less often. According to Winter and De Ridder (2010) inspectorates often focus their activities on compliance with rules and standards and the (often plausible) assumption is that with this they will also achieve social objectives. Action by inspectorates can lead to compliance effects. Research among environmental enforcers showed that they are mainly focused on preventing or reducing environmental damage. They then use the legal rules that are violated by undesired behaviour as a tool in the form of compliance effects.

Based on their research, Winter and De Ridder (2010) found that incidentally, the action of an inspectorate can also have (un-) desired side effects and that determining the effects of supervision, however specified, requires in any case to establish a connection between supervised conduct and the actions of the supervisor. Of these possible consequences, the intended effects will usually receive the most attention. Research aimed at whether the intended consequences are achieved is called effectiveness research.

Most strictly, effectiveness research combines four types of observations: observations before and after the intervention and observations related to those under supervision on the one hand and a control group on the other hand. If not possible, the alternative is: observations in time series after intervention. Change in behaviour is then related to the actions of the supervisor. No design with measurements at different points in time, guarantees observed changes in behaviour to be attributable to interventions.

Winter and De Ridder (2010) reported on an aggregated level about the extent to which the researchers succeeded in providing insights into effectiveness of supervision and which problems they encountered in doing so. Most of this reviewed research thus focus on compliance effects. They state that researchers can try to operationalize vaguely formulated objectives into measurable goals in order to be able to make statements about the effectiveness of supervision. Next, they have to deal with a question of causality: whether behavioural change is being brought about by the supervisory interventions or by other factors or both. Are the behavioural effects attributable to the activities of the inspection agency?

What is striking for Winter and De Ridder (2010) is that the supervisory action in many of the studies examined has a strong communicative aspect and often involves a combination of interventions is applied, of which communication is a part. Their analysis shows that it is difficult, but not impossible, to make effects of supervisory interventions measurable. Based on their analysis, Winter and De Ridder (2010) formulated advices for Dutch supervisors when setting up research into the effectiveness of supervisory interventions: keep it simple, formulate expectations, embedding in the supervisory strategy, perform qualitative research as well, work with time series measurements, and be aware of any side effects.

Integration of aspects of effectiveness research into the statistical analysis design for this research

In line with observations of Winter and De Ridder (2010), this research is about effectiveness of supervision, measured along two dimensions to generate insights on the extent to which the appliance of risk-based profiling leads to the achievement of the objectives of the targeting process, as basis for supervision activities. In the ideal situation, the targeting should contribute to continuing and improving good compliance behaviour. This research makes use of the observation of Winter and De Ridder (2010) that a possible starting point of effectiveness research can be applying legal rules that are violated by behaviour.

For the chosen law enforcement domain for this research it is not possible to collect compliance behaviour information without inspections. Therefore, the most ideal form of effectiveness research via four types of observations (before and after an intervention and behaviour related to parties under supervision and a control group) is not possible. For this reason, part 2 of this research is built on the second best approach: analysing outcomes of inspection activities over time, after a compliance intervention. And since social effects are difficult to measure and effectiveness research is not well developed yet within Dutch Customs, for this research another recommendation of Winter and De Ridder (2010) has been followed. They recommend starting with a research design that is simple and possible, since effectiveness research experience should be build step by step. Furthermore, the intention is to use the outcomes of this research in the supervisory strategy and the quantitative outcomes of this research are being discussed in an expert session to gain qualitative input for right interpretation of the quantitative results. Finally, in accordance with the recommendations of Winter and De Ridder (2010), possible side effects have been taken into account while concluding on the quantitative outcomes of the different analysis.

For this research the objectives of law enforcement activities are not clearly stated by the relevant inspection agency. As advised by Winter and De Ridder (2010), general objectives of market authority ILT have been translated into measurable variables to make statements about effectiveness of targeting choices.

4. Statistical analysis design

4.1 Theory testing using statistical means

4.1.1 Applied methodology for quantitative analysis

For the theory testing within this research, the relevant steps of the methodology of Forza (2002) have been used. Although this methodology is primarily meant for survey research, it contains a structured approach for collecting and handling data for theory testing with use of statistical analysis. In short, the used parts relate to methodological approach for theory testing via hypothesis, considerations and choices with regard to sampling and data handling and appliance of statistical methods for theory testing.

This research is a confirmatory research, based on conceptual models and underlying propositions. In accordance with Forza's method, before collecting data conceptual models were formulated. For this, construct names and nominal definitions have been identified and explained, as well as the variables that will be tested. With help of the propositions, the expected role of constructs and expected linkages have been estimated, explained and visualized in models. Boundary conditions have been defined, under which conditions the suggested relationships are expected to hold. Finally, data is being collected and tested to determine the adequacy of the presented conceptual models.

After constructing the theoretical models and defining the boundary conditions, the propositions that pinpoint the expected relationship between constructs, have been translated into hypothesis. For this, the unit of analysis and operational definitions for the constructs are defined, to translate the theoretical concepts into measurable elements. The used operational definitions specify both the observable elements of the presented constructs, how they are to be observed and they are tested for content validity. After these steps, hypotheses have been formulated, stating logically expected relationships between the defined variables, expressed in the form of testable statements, with the null hypothesis stated as no (significant) relationship between two (or more) tested groups. Rejecting the null hypotheses leads to acceptance of the alternative hypothesis. For testing the hypotheses, specific statistical tests have been selected.

For this research, in accordance with the working method of Forza, the design phase for testing the hypotheses has been followed by a testing phase, before executing the actual theory testing. To study the expected phenomena, a sampling process is 'simulated' by using the already performed inspections and their results have been used. Based on the used data, it can be stated that this research has been performed with a probabilistic sample design. The collected data contains both non-metric (qualitative) and metric (quantitative) data. The non-metric data included attributes, characteristics or categorical properties that can be used to identify or describe a (group of) subjects. A part of the non-metric data has been translated into metric data and vice versa. As advised by Forza (2002), special attention has been given to gain knowledge about possible errors within the dataset and minimizing sampling error, measurement error, statistical conclusion error and internally validation errors. For this, the researcher identified the information needs and before conducting the statistical analyses the reliability of measurement results has been investigated. The measurement procedure of the laboratory, leading to the in this research evaluated results, is of an 'alternative form method': different measurement methods have been used.

4.1.2 Applied methodology for data collection and data handling

In accordance with the working method of Rozinat and Van der Aalst (2018) every inspection in the data, to be seen as an 'event', can be identified with one or more unique reference numbers on case level: a case ID. Every case is about a laboratory analysis, and therefore can be seen as an 'activity' for which the data provides the attributes that describe characteristics of the logged case. The data contains cases that have been started within the defined timeframe, for which the 'activity' laboratory analysis has been completed and the result is available within the dataset. Multiple datasets have been merged into one, by using an internal reference number on case ID level.

Before collecting data, the requirements regarding the needed content of the dataset to be used for analysis have been defined. Scoping the analysis, agreement of stakeholders on that, assessing the availability of data and internal support for both the analysis and handling the results has been given attention. Questions about the process have been formulated, which the analysis should be able to answer. These questions provided the focus for analysis as well as input for the data requirements, as instructed by Rozinat & Van der Aalst (2018). This combination of process and questions determined the data.

Rozinat & Van der Aalst (2018) warn for the fact that the results of the statistical analysis are questioned or even not being accepted by stakeholders. To avoid this potential problem, before performing the research conversations on data validation took place with the process and domain experts. To minimize the risk of interpreting the quantitative results of this study wrongly or not in an optimal way, the quantitative results were presented in an expert session. This session provided qualitative feedback for interpreting the quantitative research results, which has been integrated into the final conclusions of this research.

4.1.3 Applied statistical methods

Performing statistical tests

According to the working method of Forza (2002), for preliminary data analysis a few basic descriptive statistics are used to acquire knowledge about the characteristics and properties of the collected data. This gave preliminary indications of how well the coding and entering of data has been done, how useful defined categories and scales were, and where content validity and systemic bias appeared to play a role. In this phase, checks have been done for central tendencies, dispersions, frequency distributions, and calculations regarding differences in means and variances between sub-groups. Testing of hypotheses has been done with parametric tests, using ratio measurements.

The categories used to define subgroups, are mainly of non-parametric nature. For testing the hypotheses within this research, the ANOVA test and Correlation & Regression test have been selected and used to generate the desired insights for evaluation of effectiveness of targeting choices. The ANOVA test is used to provide insights on whether there is a significant difference between means among two or more compared groups. The Correlation & Regression technique is used to test the extent to which presumed related metric variables contain a connection: a possible ‘predicting’ dependency.

Since this research is built around statistical testing of hypothesis, this research report provides in a concise manner, the information readers and reviewers need to understand about what has been done, to be able to critically evaluate what the value and contribution of the research is/can be and to reproduce the work and providing the ability to compare the results with other studies. The chosen approach is meant to present a purposive, rigor, testable, replicable, precise and confident research, including objectivity, generalizability and parsimony of both approach and results.

ANOVA

With the statistical procedure Analysis Of Variances (ANOVA) the variability in data of defined sub-groups is analysed. As Kim (2016) explains, purpose of using ANOVA is to test for significant differences between means of populations, which is done by analysis of variances. Variances are the differences between individual values and the means of the population. According to Kim (2016), ANOVA is a widely known and used method for interpreting experimental outcomes and determine influence of variables on the outcome of experiments. For the usage of ANOVA in this research the data is divided into groups by using one factor of meaning to differ the groups, to perform a so called ‘one-way ANOVA’. This type of test is suitable for testing hypothesis about expected (in-) equality of the means of the defined populations, without necessity of equal size of groups. As any ANOVA variant, the idea of this one is to compare and analyse variation between groups and variation within groups. The ANOVA test is done for each defined independent variable, for both defined dependent variables.

Kim (2016) explains that the ANOVA test uses the test statistic F-value to provide the ratio of the calculated values for the Mean Sum of squares for treatment (MSC) and Mean sum of squares for error

(MSE) via the equation F = MSC / MSE. With this equation the ANOVA test procedure actually compares the variation in observations between samples (sum of squares for groups SSC) to the variation within samples (sum of squares for error, SSE). The standard ANOVA table also provides the p-value, which provides information about the probability of rejecting the null hypothesis in case the null hypothesis holds. With α chosen as the significance level for the test, null hypothesis can be rejected with a probability greater than (1- α) x100%. This actually means that the ANOVA F-test rejects the null hypothesis that the mean responses are equal in all groups if SSC is large relative to SSE. Within this report, the results of the calculations that are the basis for the value of the F-statistic are presented in summarized ANOVA tables. According to Kim (2016) the ANOVA test provides the most reliable results if the data shows a normal distribution pattern of individual values. But even if the distribution of values differs from this ideal pattern, a one-way ANOVA can still provide good results, if the test is done with sample seizes that are large enough to compensate that shortcoming. With small sample seizes, that do not fit the profile of a normal distribution, one-way ANOVA can however be unreliable.

In light of the statistical analysis design as applied in this research, a statistically significant difference in means of two groups implies that, based on variances of individual measurement values, the difference in means for two compared groups are not the result of chance but can instead be attributed to the tested cause. Variance is a measure of dispersion that takes into account the spread of all individual data points in a data set.

In this research, for determining statistically significance, the null hypothesis is being rejected if the p-value of the ANOVA test is smaller than α=0,05, which leads to the acceptance of the alternative hypothesis H1. For evaluating effectiveness of currently used risk indicators and the effect of repeated inspections, the null hypothesis (H0) is stated as 'absence of desired statistical difference between groups' and the alternative hypothesis is stated as 'presence of the desired difference between groups'. With this approach, rejecting the null hypothesis supports the reasoning for the effectiveness of targeting based on the evaluated independent variable.

Correlation and Regression analysis

Theisens (2018) explains that the correlation analysis examines the degree of correlation between two continuous variables. According to Theisens (2018) the Pearson correlation coefficient is used to quantify the strength of the linear relationship between two variables. The correlation coefficient can have any value between -1 and +1. The value -1 indicates complete negative dependence between two variables, which is also called an inverse dependence. The value +1 represents a positive dependency, also known as a direct dependency. The value 0 indicates complete independency of two variables.

Theisens (2018) states that correlation means that two variables show a certain relationship in an orderly manner, but correlation does not imply causation between variables. Therefore, a strong correlation between variables does not necessarily mean that there is a cause and effect relationship. The correlation coefficient (R) is considered to indicate a strong dependence between two variables if it exceeds the value of 0.8, whereas a correlation coefficient smaller than 0.5 is associated with a weak dependence between the variables. If the value for R lies between 0.5 and 0.8, the relationship is considered to be of an average dependence.

Regression analysis is a method for estimating the relationships between variables, as well as modeling and analyzing these relationships. In regression analysis, the outcome is often referred to as the predicted variable or response variable. This is often referred to as Y. This response variable changes as a result of one or more independent variables Xi, also called the predictive variable factor. These predictors can be either continuous or discrete values. The singular linear regression results in an equation describing the linear (statistical) relationship between a continuous response variable and a predictor. This equation is represented graphically by a simple linear line, which describes the calculated regression relationship in a set of measurements results, usually presented in a diagram together with the cloud of dots the regression line is derived of. This diagram is called the fitted line plot.

4.2 Research part 1: evaluating effectiveness of used risk-indicators for profiling

4.2.1 Unit of analysis, conceptual models and their constructs

Unit of analyses

For part 1 of the research, the unit of analysis is the inspected sample product of a declared shipment, identifiable in the data with its own unique ID/reference number, provided by the administration of the laboratory of Dutch Customs. Each analysed sample is taken via a shipment selection, based on targeting choices. Every analysed sample is ought to fit the used criteria for selection. Every sample is a product that is the result of a production process, using materials and components to give it its characteristics and properties. Since even within single production lines different components, components from different production lots and different (compositions of) materials can be used, every sampled product is analysed separately by the laboratory of Dutch customs. And with that, the outcome of the analysis of every single sample provides information about the chance of (non-) compliance and impact of non-compliance, attributable to the targeting choices that lead to selection of the shipment the sample was taken from.

Conceptual models & constructs

Part 1 of the research focusses on determining the statistical influence of the used risk indicators on the effectiveness of the targeting. The model is tested to determine the extent to which the used risk indicators contribute to the inspection results, to give guidance on maintaining or adjusting current risk profiling. The model is based on the risk indicators used for targeting and their (expected) influence on the outcome of the targeting process, expressed as the result of the inspection activities. These results are expressed as outcomes as (non-) compliance of inspected products to the norms of the RoHS Directive [Y1], and exceedance of norms for RoHS compliance [Y2]. [Y1] and [Y2] provide interrelated dimensions for evaluating the effectiveness of targeting. Process output variable [Y1] concerns the chance of violation of RoHS norms whereas output variable [Y2] concerns the environmental impact of norm exceedance.

For the following conceptual models, the inputs for the legal obligations and priorities for the targeting process are treated as given facts and only the used risk indicators for risk profiling are evaluated, via the inspections generated on the basis of priorities of the national market authority. These priorities actually resulted in temporarily alternately selection of certain products. Based on the former, the conceptual models for evaluating the effectiveness of the risk indicators used for targeting for supervision on RoHS can be depicted as follows:

FIGURE 1
Model 1A: Expected influence of currently used risk indicators [X1, X2 and X3] on non-compliance [Y1]

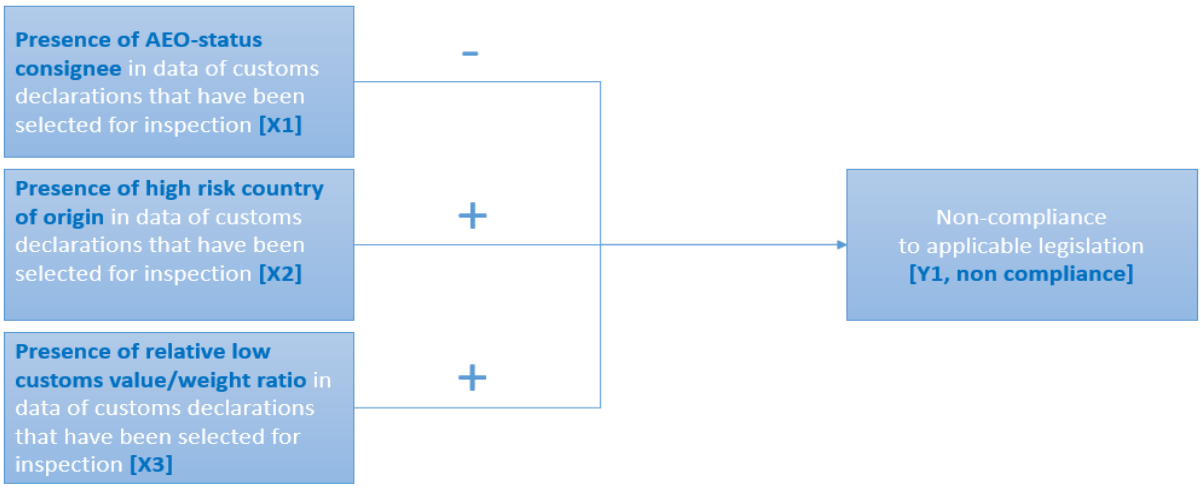
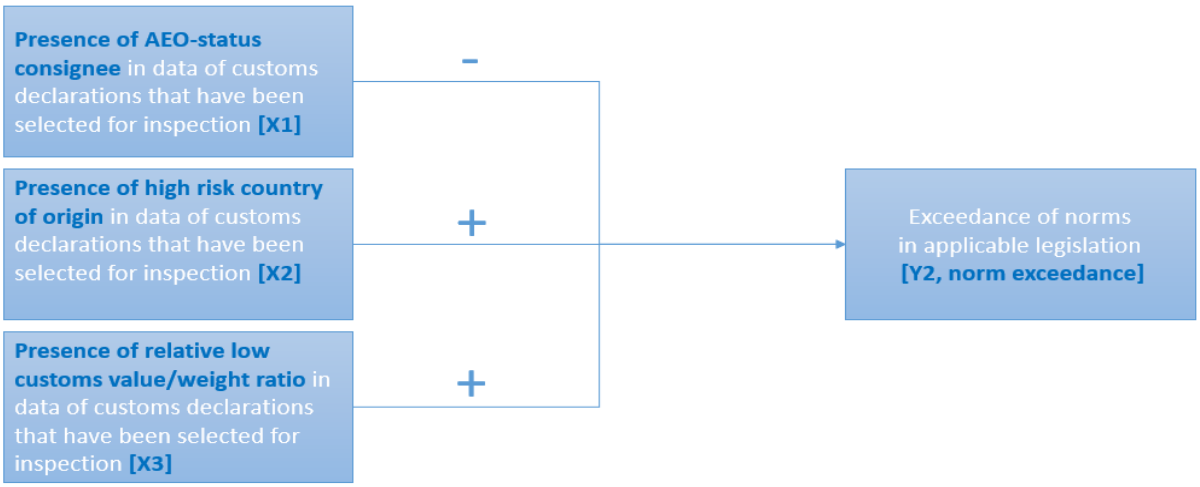


FIGURE 2
Model 1A: Expected influence of currently used risk indicators [X1, X2 and X3] on norm exceedance [Y2]



In this model, both [Y1] and [Y2] are presented as depended variables, both influenced by independent variables [X1], [X2] and [X3], since the X-variables cause shipment selections, which generate the Y-values.

Non-compliance to applicable legislation [Y1] is related to outcomes of the inspection, based on the laboratory test it requires, divided into either compliant or non-compliant. For evaluating the effectiveness of targeting along this dimension, the judgement 'compliant' is stated as 0% (targeting did not lead to desired non-compliant inspection result) and judgment 'non-compliant' is stated as 100% (targeting lead to desired non-compliant inspection result). Exceedance of norms in applicable legislation [Y2] is the exceedance of used heavy metals, based on the laboratory test, stated as volume percentage of used heavy metals above the norm volume percentage. With a value for each individual case, for [Y1] the average non-compliance percentage (avNC%) and for [Y2] the average norm exceedance % (avNE%) of tested sub-groups can be determined to test for presence or absence of a statistically significant difference between them.

In this model risk indicator [X1] is about managing the compliance risk of consignees of goods, based on their (non) AEO status. Presence of [X1] on individual case level in the data means the consignee of the goods is AEO certified at the time the import declaration is lodged. Absence of [X1] on individual case level in the data means the consignee is not AEO certified at that moment. Risk indicator [X2] is about managing the compliance risk related to imported goods, based on their country of origin. Presence of [X2] on individual case level in the data means the declared country of origin of the goods is the country perceived to generate the highest compliance risk. Absence of [X2] on individual case level in the data means the declared country of origin of the goods is another country, and with that the goods are assumed to be of lower risk for compliance. Risk indicator [X3] is about managing the compliance risk related to imported goods, based on their relatively low customs value per kilogram net weight. Presence of [X3] on individual case level in the data means the declared goods have a relatively low customs value per kilogram net weight, compared to the recent average customs value per kilogram net weight for the declared commodity code. The absence of [X3] on individual case level in the data means the average customs value per kilogram net weight for the declared goods is not considered as relatively low.

The values of the Y-variables are all based on the laboratory results. For analysis purposes, which requires certain calculations, the original judgement related to [Y1] has been converted from non-metric data with categorical characteristics into metric data on ratio scale. For the earlier mentioned calculations, the original values of [Y2] are kept as metric values on a ratio scale. The values for the X-variables are all based on information provided in the import declarations for inspected goods. For analysis purposes, the original values for the X-variables are converted into non-metric data, providing categorical properties to identify and distinguish groups of subjects to be used for the statisti0063al analysis.

4.2.2 Assumptions, explanations, propositions and testing the conceptual models

Influence of AEO-status [X1] on level of non-compliance [Y1] and norm exceedance [Y2]
A customs declaration for release for free circulation of goods to be brought on the Union market can be made by or on behalf of the consignee, as importer of the goods. The customs legislation provides the opportunity for actors, such as consignees, that fulfil certain requirements to act as an Authorised Economic Operator (AEO). A positive outcome of an audit procedure, executed by local customs authorities, is the basis for granting an AEO certificate. Focus of this audit procedure is to judge upon the quality of the enterprise risk management system regarding customs compliance. For this, the audit is focused on identification of customs compliance risks of internal business processes, and the existing and daily appliance of standard procedures and effectiveness of internal control measures to mitigate these risks. Which customs compliance risks are present? And how are they mitigated using avoidance, minimizing and acceptance?

An AEO is assumed to be familiar with the customs procedures and to have internal incentives and proven track record regarding executing its processes in such a way that it leads to sufficient compliance to laws and regulations. Otherwise stated: because of their audited internal processes, procedures and control measures, AEO certified consignees are ought to be of less risk for (customs) compliance than other parties. Therefore, using the AEO status as an indicator for customs compliance, is ought to be an important ingredient for applying risk management by Dutch Customs, as communicated in their Enforcement Vision of Dutch Customs. Within the philosophy of programmatic enforcement, AEO-status is a factor to distinguish between groups for law enforcement purposes, based on expectations and perception of differences in non-compliance risks, which have to be mitigated with inspection efforts. AEO certified consignees are ought to be found at the basis of the law enforcement pyramid of responsive regulation: the assumption is that these economic actors do not need much supervision to achieve and maintain compliance.

Based on the former reasoning, for applying risk management within the philosophy of programmatic enforcement, 'AEO-status of consignees of declared goods' is determined as a potential factor to distinguish between groups for law enforcement purposes, based on expectations and perception of difference in (seize of) risks regarding (non) compliance, which have to be mitigated with inspection efforts. Based on the former reasoning, for testing the influence of risk indicator [X1] 'AEO-status of consignee' on non-compliance and norm exceedance of inspected products the following hypotheses are formulated, to be tested for the statistical significance of their relationship:

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level for non-compliance to RoHS
H1	There is a statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level for non-compliance to RoHS

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level of exceedance of RoHS-norms
H1	There is a statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level of exceedance of RoHS-norms

Influence of country of origin [X2] on non-compliance [Y1] and norm exceedance [Y2]
Via the RoHS Directive norms apply to certain equipment that is intended to be brought on the Union market with a customs declaration for release for free circulation. These norms apply to the listed heavy metals used in the listed type of products. The compliance to these norms is a result of choices in production processes of listed products and internal control measures based on enterprise risk management of companies to guard the compliance of products to these norms. The geographical location for production of the listed types of goods is assumed to affect the compliance level of goods intended to be brought on the Union market. Here 'production' refers to the place where the last substantial transformation in the production took place, providing the product its own typical properties

and composition, which it did not possess before. Completion of this production stage is the basis for the classification of goods and legally provides the country of origin, as mentioned in the import declaration.

At the time the RoHS Directive came into force, the theoretical point of view was, that certain countries in the world are producing relatively a large part of the targeted products that have been placed on the Union market. As stated by the interviewed senior inspector of ILT for RoHS, at the start, and afterwards continuously, this starting point has been supported by data analysis and exchange of yield of inspection results in European expert groups called ADCOs. These groups consist of experts on law enforcement on national level of Member States. Furthermore, at that time a particular country was known for the fact that production processes were not very well managed by quality control or internal inspections to provide certainty that products complied to relevant norms and/or that this got not much attention. During the years, the latter has continuously been supported by experiences of (contact persons in the countries of interest of) members of the relevant ADCO groups.

Based on the former reasoning, for applying risk management within the philosophy of programmatic enforcement, country of origin of declared goods is determined as a factor to distinguish between groups for law enforcement purposes, based on expectations and perception of difference in (seize of) risks regarding (non) compliance, which have to be mitigated with inspection efforts. Therefore, for testing the influence of risk indicator [X2] 'Country of Origin' on non-compliance and norm exceedance of inspected products the following hypotheses are formulated, to be tested for the statistical significance of their relationship:

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of non-compliance to RoHS
H1	There is a statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of non-compliance to RoHS

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of exceedance of RoHS-norms
H1	There is a statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of exceedance of RoHS-norms

Influence of customs value/weight ratio [X3] on non-compliance [Y1] and norm exceedance [Y2]

At the time the RoHS Directive came into force, complying to the norms asked for adjustments in production processes since the regulated metals require other handling during production processes than their legally allowed substitutes. Besides the requirement of (investing in) modernising production processes, back then complying to the RoHS Directive also asked for investments in internal quality control. Furthermore, at that time, the legally allowed substitutes for the heavy metals regulated via the RoHS Directive were more expensive to buy. And as of 2013, proper documentation about products and production processes is an obligation to be compliant to the RoHS legislation. Aligning the production process with the norms of the RoHS Directive to guarantee compliance to RoHS with internal quality control measures and keeping an proper administration are all cost factors.

At the start of the law enforcement on RoHS the assumption was made that these cost factors would be passed on in the price of products, to keep margins unchanged, leading to the assumption that relatively cheap offered products would be of higher risk for compliance than similar and comparable but more expensive products, assuming the price difference to be caused by level of attention for, and costs of, compliance. Besides this theoretical approach, the ILT also repeatedly received information from the industry itself that pricing for imported products has been affected by compliance requirements for RoHS. As stated by the interviewed senior inspector of ILT for RoHS, this image was continuously confirmed in ADCO meetings.

Based on the former reasoning, for applying risk management within the philosophy of programmatic enforcement, customs value/net weight ratio of declared goods is determined as a factor to distinguish between groups for law enforcement purposes, based on expectations and perception of difference in (seize of) risks regarding (non) compliance, which have to be mitigated with inspection efforts. Therefore, for testing the influence of risk indicator 'Relative low customs value / net weight ratio' on non-compliance and norm exceedance of inspected products the following hypotheses are formulated, to be tested for the statistical significance of their relationship:

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of non-compliance to RoHS
H1	There is a statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of non-compliance to RoHS

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of exceedance of RoHS-norms
H1	There is a statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of exceedance of RoHS-norms

4.2.3 Importance of testing the theoretical models

For the former reasons, within the philosophy of programmatic enforcement, the AEO status of consignees should be, and country of origin and customs value/weight ratio are actually, used as a factor of meaning to distinguish between groups for law enforcement purposes. The reason is, that expectations and perception with regard to differences in (seize of) risks regarding non-compliance between groups ask for differentiation in mitigating risks with (chance of shipments to be selected for) inspection efforts.

At the start of supervision on the RoHS Directive AEO certification was a relatively new phenomenon and facilitating AEO certified companies with less inspections is mainly based on fiscal aspects, whereas the RoHS Directive is non-fiscal legislation with focus on mitigating environmental risks. At that time, there was no general information available about differences in compliance levels of AEO certified and non-AEO companies for non-fiscal law enforcement domains such as RoHS. Besides this, for enforcing product-oriented laws and regulations in the environmental domain, it is crucial to inspect physical content of shipments. Since it is impossible to inspect compliance of products with environmental-oriented norms with certainty afterwards, as the goods cannot be inspected anymore. Therefore, current declaration-oriented risk-based profiling for enforcing the RoHS Directive is currently not influenced by the (non-) AEO status of consignees of shipments. But the risk profiling has been influenced by declared country of origin and customs value / net weight ratios assumed to be of highest risk for compliance of products to the RoHS Directive, because of the consistent satisfying 'hit rate': the percentage of inspected products that lead to a non-compliant judgement.

After several years of enforcing the RoHS Directive with these choices for shipment selections for inspection, according to the cyclic principles of the programmatic law enforcement philosophy it needs to be evaluated whether and to which extent these choices influence effectiveness of current risk-profiling. If the assumed influence of AEO-status and/or (perceived to be) highest risk country of origin and/or (perceived to be) highest risk customs value / net weight ratios on compliance should be questioned or are 'supported' by data analysis, the results can be used to justify and/or improve current targeting choices and with that improving the effectiveness of targeting via the targeting process performance.

4.3 Research part 2: evaluating effectiveness of repeated inspections

4.3.1 Unit of analysis, conceptual models and their constructs

Unit of analyses

For part 2 of the research, the unit of analysis is the 'inspection experience', identifiable in the data set with its own unique ID/reference number, especially created for this part of the research. The inspection experience stands for a moment in time, on which a consignee of inspected goods is confronted with the customs supervision process of sampling its shipment and receiving the result of the laboratory analysis.

Until this particular moment in time, it is still possible that the planned and announced inspection will not take place, for example due to capacity problems of customs. This will lead to release for free circulation without determining whether the declared products apply to the norms for RoHS. After actual sampling a shipment for testing the product to the norms of the RoHS Directive, the release for free circulation is always postponed at least until the lab analysis is finished. This analysis always leads to a compliant or non-compliant judgement, which outcome is directly connected to the inspection experience of the consignee. Therefore the judgement about compliance of a product, in the data calculated as value for compliance level of an inspection experience, is considered to be a stimulus for compliance behaviour.

Since sampling one shipment can lead to more than one sample for analysis, more than one shipment can be sampled on the same day using one or more samples, and every sample is judged separately, the used mathematical values for non-compliance and norm exceedance of first inspection experiences are based on the outcomes of individual samples taken on a particular day. For later inspection experiences, the average values for compliance and exceedance of norms are based on all the inspected products of shipments declared at least 31 days after the first sample experience date. The latter is done to reduce the influence of using outcomes of inspections for the statistical analysis, while consignees did not yet receive the outcome of their first inspection experience and/or were not given reasonable time to decide upon measures to prevent future declarations for release for free circulation of non-compliant products. First inspection experiences present in the dataset are not guaranteed to be the actual first experience.

Conceptual models & constructs

The focus of part 2 of the research is on determining the effect of repeatedly inspecting shipments of consignees on the effectiveness of the targeting. The model is based on the result of the first inspection experience of a consignee of an inspected shipment within the researched period and the results of later inspection experiences. This model is tested to determine whether and to which extent a desired relation between them is present, in order to give guidance on using eventual statistical supported 'predictability' of future inspection results for choices in targeting. These choices could include (temporarily) exclusion or decrease of selection chances for (goods of) compliant actors and/or (temporarily) increasing selection chances for (goods of) non-compliant actors. The results of the inspection experiences are expressed as outcome based on non-compliance of sampled products to the norms of the RoHS Directive and the exceedance of stated norms provides the other dimension of researched effectiveness of the targeting process. Based on the former, the conceptual model for evaluating the effectiveness of repeatedly selecting and inspecting shipments of economic actors for supervision on RoHS is depicted below:

FIGURE 3
Model 2A: Expected Influence of presence of a first inspection experience on non-compliance [Y1] of future experiences

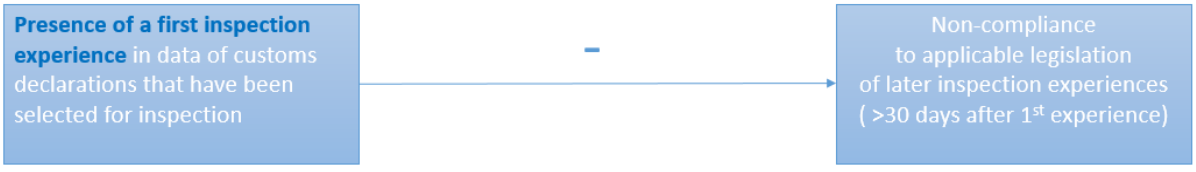
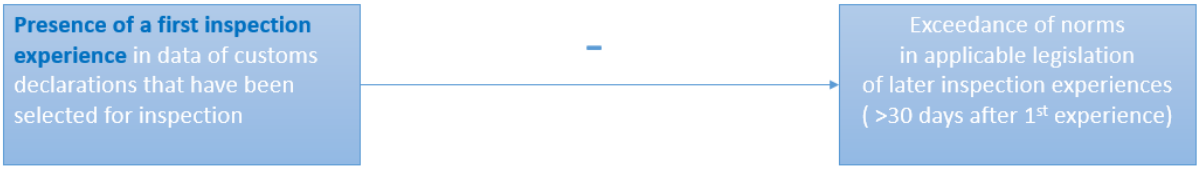


FIGURE 4
Model 2B: Expected Influence of presence of a first inspection experience on norm exceedance [Y2] of future experiences



Non-compliance to applicable legislation is related to outcomes of the inspection, based on the laboratory test it requires, divided into either compliant or non-compliant. For evaluating the effectiveness of targeting along this dimension, the judgement 'compliant' is stated as 0% (targeting did not lead to desired non-compliant inspection result) and judgment 'non-compliant' is stated as 100% (targeting lead to desired non-compliant inspection result). Exceedance of norms in applicable legislation is the exceedance of used heavy metals, based on the laboratory test, stated as volume percentage of used heavy metals above the norm volume percentage. With a value for each individual case the average non-compliance percentage (avNC%) and the average norm exceedance % (avNE%) of tested sub-groups can be determined to test for presence or absence of a statistically significant difference between them. Output variable [Y1] concerns the chance of violation of RoHS norms whereas output variable [Y2] concerns the environmental impact of norm exceedance.

For analysis purposes, which requires certain calculations, the original judgement about compliance has been converted from non-metric data with categorical characteristics into metric data on ratio scale. For calculating exceedance of the norms, the norm percentage in the RoHS Directive is subtracted from the original measurement values, keeping its metric values on a ratio scale.

4.3.2 Assumptions, explanations, propositions and testing the conceptual models

If a shipment is selected for an inspection for compliance of products to the RoHS Directive, a physical inspection takes place. During this inspection, the shipment is getting sampled, and the sample products taken are sent to the laboratory of Dutch Customs for chemical analysis. The consignee of the shipment gets notified about the inspection purpose and the shipment is put on hold by Dutch Customs until the results of the laboratory analysis are known. In case of compliance, the shipment is released for free circulation. In case RoHS norms are exceeded, the consignee gets notified by the national market authority ILT. This notification contains instruction to choose for re-export, necessary adjustment of the product or destruction, together with potential fine of five times the invoice value in case goods are brought on the market without customs clearance. The notification also contains a reference to the applicable norms.

Any (non-) compliance is based on human behaviour, via choices made in daily operations. Behaviour is a result of intentions, based on attitude, subjective norm and control over behaviour, which are interrelated with each other. Here, attitude refers to positive or negative opinions about behavioural options and preferred choices for behaviour. The subjective norm is about (the extent of) taking into account judgment of the 'business environment' about intended behaviour. And control over behaviour refers to the possibility to execute or prevent intended behaviour. The latter not only influences the intended behaviour, but also the behaviour itself. In addition, for any intended behaviour the situation in which choices occur and the personality of decision makers plays a role, including so called 'risk appetite'.

According to the government-wide accepted programmatic enforcement philosophy of Van Mourik *et al* (2007), (non-) compliance is influenced by the combination of 11 factors: [1] knowing the rules, [2] costs and benefits of (non-) compliance, [3] extent of acceptance of the rules, [4] willingness to comply to norms, and the perceived [5] social control from society, [6] chance to be reported by non-governmental parties, [7] chance to be subject of governmental inspection, [8] chance that non-compliance gets detected during inspection, [9] increase of chance to get inspected after proven non-compliance, [10] chance to get sanctioned and [11] severity of sanctions for non-compliance.

In case of inspection the consignee experiences law enforcement on the RoHS Directive, and at least several days of logistic delay. If the judgment is non-compliant, besides the former, the consignee also experiences extra logistic delay of days or weeks and extra costs because of either adjust the goods to become able to bring them on the Union market legally or get rid of them through re-export or destruction, as well as being informed about the serious consequences of not applying to the instructions of ILT. Any inspection experience should lead to adjustment of consignees of their perception of the 11 mentioned (non-) compliance factors.

In case of a compliant judgment, from programmatic law enforcement perceptive, the assumption and intention is that unknowing consignees are triggered to enforce their enterprise risk management system with extra control measures to become and/or maintain structural compliant to RoHS. And that knowing compliant consignees and enforcement deterred compliant consignees revaluate the chance and impact of risks (their risk appetite) of not being compliant to RoHS and evaluate existing measures to maintain compliant. Summarized, the assumption is that for compliant consignees a first inspection experience should work as a behavioural 'stimulus' to take action, if needed, to maintain compliant, due to a mix of (perception of) the 11 factors of programmatic enforcement, which can be different for each consignee.

For consignees that are confronted with a non-compliant judgment for their declared products, the expectation and intention of inspection experiences is, that the actor is triggered to take measures to become compliant to RoHS as soon as possible- and on a structural basis. For the knowing and unknowing non-compliant consignees, the law enforcement is meant to push their behaviour into either the group of knowing compliant consignees or the group of enforcement deterred consignees. Severity of (costs of) the experienced logistic delay and the possible penalty for neglecting instructions for re-export, adjusting or destruction of goods are ought to be the behavioural stimuli to trigger the aimed shift in behaviour.

With the reasoning that an inspection experience provides a stimulus for compliant actors to remain compliant and for non-compliant actors to become compliant on a structural basis, the average results regarding non-compliance of later inspection experiences and average norm exceedance of later inspection experiences should be better than these results of first experiences. Based on the former reasoning, for testing the influence of results of a first inspection experience on non-compliance and norm exceedance of later inspection experiences, the following hypotheses are formulated, to be tested for the statistical significance of the modelled relationship:

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between results of a first inspection experience and (average level for) non-compliance to RoHS of later inspection experiences
H1	There is a statistically significant negative relation between results of a first inspection experience and (average level for) non-compliance to RoHS of later inspection experiences

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between results of a first inspection experience and (average level for) norm exceedance for RoHS of later inspection experiences
H1	There is a statistically significant negative relation between results of a first inspection experience and (average level for) norm exceedance for RoHS of later inspection experiences

4.3.3 Importance of testing the theoretical models

Importance of testing the models

Any (non-) compliant inspection result for RoHS is supposed to contribute in more or less extent to several of the 11 (non-) compliance factors of the programmatic law enforcement philosophy, via the (changed) perception of inspected consignees. In this philosophy, the effectiveness of supervision is 'measured' via response of (non-) compliant consignees to inspection experiences regarding maintaining/ improving their compliance to RoHS. This ought to be visible in the results of later inspections. Theoretically this can provide relevant input for the effectiveness of repeatedly inspecting shipments of consignees, within the current set-up for supervision.

5. Data for analysis

5.1 Sampling data

5.1.1 Usage of sampling data

For theory testing, usually samples are taken from a certain population. For this research, the sample actually consists of all the inspected products, administered as individual sample elements in the internal registry of the laboratory of Dutch Customs. Using the complete content of this registry as sample for this research maximizes the usage of true positives and true negatives for the aimed theory testing with statistical analysis. And with regard to the ability of generalizing the outcomes of this research it is very clear that using all the sample elements of the registry is the best that can be done to perform the analysis and to maximize the usability of the results for the aimed evaluation. The same holds for maximizing the significance level and statistical power of the performed test, and the avoidance of type I errors (H0 is rejected, while it is true) and type II errors (H0 is not rejected, while H1 is true) while drawing conclusions based on the results of the statistical tests.

The population of which this sample was drawn can be stated as all import declarations in the import declaration system (AGS Invoer) of Dutch Customs, within the period 01-01-2017 and 30-06-2022, containing the same commodity code of one of the samples registered in the internal registry of the laboratory of Dutch Customs within this period. Since sample elements are the result of temporarily active risk profiles for certain commodity codes, the sample consists of a composition of products with different commodity codes, actually forming subgroups within the sample. However, for each subgroup the same selection criteria were used, and the products have the same basic technical characteristics relevant for testing on RoHS compliance by the laboratory of Dutch Customs.

Randomness of the sample is being provided by different factors. First factor is the nascence of customs about upcoming customs declarations that will meet the criteria of activated risk profiles. Secondly, the market authority ILT provides the priorities and periods of risk profiles being active. Third factor is the percentage of shipments selected for inspection, programmed in the risk-based profiling, which is applied randomly by the computerised system of Dutch Customs. However, there are also factors that limited the randomness of the composition of sampling elements. First is the fact that risk profiles were only active for short periods, providing different number of sample elements per commodity code. Secondly these temporarily active risk profiles include but also exclude shipments for selection via (mis-) matching with the profiled criteria. Thirdly, shipment selections and therefore composition of the sample, are influenced by both intentionally and unintentionally repeatedly selecting and inspecting shipments of certain consignees. Overall, it can be stated that the sample is of probalistic nature, since population elements have some known probability of being selected, which facilitates the representativeness of the sample (Forza, 2002). Based on differences between number of elements per commodity code, varying from only one, via tens and even hundreds, and the relative small sample to work with, artificially stratifying the sample is not considered to improve the quality of the aimed analysis.

For this research, mostly the sampling data is used for theory testing by dividing the sample data into two groups, based on one distinctive element, to perform the statistical test of each separate set of H0 and H1 hypothesis. The outcome of each separate test is assumed to support either continuing with the current targeting choice related to the tested element or questioning the effectiveness of this element for targeting purposes. The latter is supposed to lead to weighing options for improvement of the targeting.

5.1.2 Data collection

The preparation for the data collection started with formulating the question about how to measure the effectiveness of the targeting for supervision on RoHS, both for output (results) and input (risk indicators). These questions provided the requirements for the data needed to perform the aimed statistical analysis. Before collecting data, the presence of the required data particulars has been checked, via a view on the content of an available subset of the intended full dataset to be used for analysis. Internal stakeholders were asked for input about this content and points of interests regarding data quality, data collection and

data handling. Based on their input, scoping of the dataset was possible and the expected quantity of data could be estimated, which is important to estimate the ability to perform the aimed statistical analysis.

The evaluation of risk-based profiling for supervision on RoHS focusses on the profiling for RoHS in the Dutch declaration system for declarations for release for free circulation, called AGS Invoer. Therefore, the source that provides the independent variables for evaluating the effectiveness of targeting choices, from targeting process performance point of view, is this declaration system. As from January 2017 the laboratory of Dutch Customs is handling RoHS laboratory analysis themselves. Legal and internal restrictions related to privacy of kept data, for determining whether a company was AEO certified was only accessible as from 1 January 2017. For these reasons, the dataset for analysis only contains information from inspected customs declarations lodged after 31 December 2016 and the inspection results of all laboratory analysis for RoHS after this date, extracted from their internal registry. Since the data preparation for this research started in July 2022, customs declarations after 30-06-2022 were not involved in the performed statistical analysis.

The relevant data from the internal registry of the laboratory of Dutch Customs and the data of inspected custom declarations for release for free circulations were extracted from the computerized systems. The internal reference number of inspection assignments, the so called PLATO ID, was used to merge the data of the customs laboratory and the data of the customs declarations into one dataset, to be used for the statistical analysis for this research. However, the merged dataset did not contain all the required data, and not all data in the right format and categorizations, for the aimed statistical analysis. Therefore, after this merging, several proceedings took place to enrich the data with the needed additional data elements. This was done by categorizing already available content, using available content for calculations and adding new data, derived from tables, based on the available data within the merged dataset.

After preparing the dataset with the minimum requirements needed for the analysis, checks were performed to assure that the quality of the data is of the highest and most complete level possible. The detected small data quality problems had to be fixed. Some formatting errors had to be translated into usable formats, and a few cases showed missing data for which the cause had to be found. Afterwards, records that should not be part of the analysis were selected and motivated excepted from the dataset to be used for the statistical analysis. Furthermore, names of consignees, declaration reference numbers and several other data elements have been anonymized, in order to meet the requirements of the client organization regarding confidentiality. The described steps are described in detail in appendix 1.

Finally, to prevent problems of outcomes of this research to be questioned, or even not accepted by stakeholders, stakeholders responsible for generating and administering the inputs of the laboratory registry and stakeholders working with the outputs of this registry for reporting and profiling purposes were asked for their confirmation about quality of the used data, their approval of using this dataset for this research project, as well as for the set-up of this research: the models and the used testing methods. And in February 2022 these experts attended an expert session to comment on the research results.

5.2 Preparing the dataset for the aimed analysis

5.2.1 Merging existing datasets

The basis for the data used for performing the data analysis for the results presented in this thesis report is the combination of information from the following datasets:

[1] Internal registry of the laboratory of Dutch Customs about the outcomes of inspections for law enforcement, extracted from the software LIMS. This application is used within the laboratory for administering the lab analysis results, providing a judgment on (non) compliance of inspected products and the level of exceedance of norms of the RoHS Directive in case of non-compliance;

[2] All information provided by the submitter of customs declarations for release for free circulation in the Dutch import declaration system AGS Invoer for the sampled shipments for law enforcement on the RoHS Directive, as well as the additional information this computerized customs declaration system generates with the data of the received customs declarations.

Amongst other things, this dataset contains unique reference numbers for shipments and inspections, dates of customs declarations, dates of sampling the related shipments and judgement on (non) compliance and measurement value for norm exceedance as the outcomes of inspections. Furthermore, it contains declared HS-code, customs value, net weight and country of origin of declared goods, that got sampled for laboratory analysis, as well as information about the consignees of the goods.

5.2.2 Adding extra data elements to the merged dataset

Outcomes: non-compliance [Y1] and norm exceedance [Y2]
With the judgement about compliance and measurement value for non-compliant goods, the dataset contains the data about the outcomes of inspections, but not in the format to be used for the analysis. Since the targeting process ideally aims for only inspecting non-compliant shipments, the outcome 'non-compliant' has been 'translated' into the metric value 100% (desired outcome), and outcome compliant is translated into 0% ('waste'). The RoHS norm has been subtracted from the measurement value for non-compliant products to calculate the absolute value for norm exceedance, lying between 0% and 100%.

Presence/absence of risk indicator [X1]: 'AEO certified consignee'
The EORI number of consignees, present in the merged dataset, has been linked to a table of registered AEO companies. With this linkage it is determined whether a consignee was AEO certified at the moment of lodging the customs declaration that was sampled for laboratory analysis for a check on RoHS compliance of the declared goods. For this part of the data preparation, only AEO Customs and AEO Full certified companies were taken into consideration. Having a AEO Safety & Security certificate is not relevant here.
The result of this part of the data preparation is adding the 'label' for consignees being either AEO (C or F) or not AEO certified at the moment the declaration for release for free circulation of goods was lodged. This label is used to categorize the presence and absence of risk indicator [X1] for the statistical analysis.

Presence/absence of risk indicator [X2]: 'perceived highest risk country of origin' of goods
The merged dataset already contains the international coding for country of origin. The country of origin that is perceived to be of 'highest risk' is marked with this 'label' to distinguish this country of origin from other countries of origin present in the dataset. This label is used to categorize the presence and absence of risk indicator [X2] for the statistical analysis. The country of origin that is perceived to be of highest risk did not change over time: it is actually one particular country, relevant for analysis of the whole dataset.

Presence/absence of risk indicator [X3]: 'perceived high risk customs value/net weight ratios of goods
For each commodity code present in the merged dataset, data of the researched period has been collected with a data query of the AGS declaration system and used to calculate the average customs value per kilogram net weight per year for that particular commodity code. Next, the average customs value per kilogram net weight of declared goods that were sampled and analysed is calculated to determine the difference of this value from the average for the HS-code in the calendar year the customs declaration was lodged for the inspected shipment. The deviation from this average, calculated as percentage, has been divided into classes to facilitate the aimed statistical analysis. Since current risk profiling is aiming for shipments with net weight above 250 kilograms and destined for the Netherlands, for calculating these average values for each HS-code these parameters were used as well. The results of the above mentioned efforts are adding deviation percentage for the customs value / net weight ratio of declared goods from the average for the HS-code declared and adding the classification of these percentages to the dataset. This label is used to categorize the presence and absence of risk indicator [X3] for the statistical analysis.

Inspection experiences of consignees
Analysis of a possible connection between the outcome of a first inspection experience present in the dataset and later inspection experiences of a consignee, requires certain additions to the merged dataset. At first, the EORI number of a consignee and the calendar date of sampling its shipment are combined into a unique ID. This ID is called the 'inspection experience ID'. Every inspection experience ID stands for the samples taken from (a) selected shipment(s) of a certain consignee on a particular date. Based on the calendar date on which a sample was taken, a distinction was made between first inspection experience and later inspection experiences per consignee. For the first inspection experience averages values for

compliance judgements and norm exceedance are calculated, based on the results of single tested products belonging to that particular sample experience ID. The same is done for inspected products belonging to the later inspection experiences, with the limitation that inspection results of sampled shipments within 31 days from the first sample experience were not taken into account for calculating these averages. The labels 'first inspection experience' and 'later inspection experiences', as well as categorizing the data at the level of individual inspection experience number, are used for the statistical analysis.

Other categorizations

For exploration of the content of the dataset as well as for further analysis of the upcoming statistical tests, certain elements of the dataset are used to cluster data by categorization. For this, the following elements have been added to the dataset. The calendar date of lodging the customs declaration is used to distinguish between periods of time. From every HS-code present in the dataset, the first digits are used to form sub-groups within the data. Another categorization is based on one or more inspected products per shipment. Finally, a distinction is made, based on the 75% most frequent HS-codes and consignees present in the used dataset and the 25% other HS-codes and consignees present in the dataset.

Anonymization

The company client required that the results shown in this thesis report must be anonymized, in such a way that no linkages can be made between presented results and individual parties or their relevant custom declarations. To anonymize the sample ID used by the laboratory, this unique reference number per analysed product is transformed into a 'sample case ID'. Furthermore, for the dataset used for the statistical analysis the customs declaration ID is replaced by a new artificial 'customs declaration ID' with no obvious connection to the original one. The same is done for the EORI number of consignees.

5.2.3 Excluding data from the statistical analysis

Not all the records within the merged dataset could be used for the aimed analysis. There are a number of records that need to be excluded from the analysis, because they are for some reason outside the scope of this research project or not usable. The original dataset contained 1603 cases. One case concerned a test result of a so called control sample: a measurement of a sample to determine whether the measuring equipment is working correctly. Furthermore, the dataset contained 31 inspection results for courier shipments and 8 inspection results for inland inspection initiatives. And 23 inspection results concerned commodity codes that are outside range for this research. From the remaining cases, 2 cases could not be linked with the customs declaration system, for 2 cases measurement results were untraceable, in 6 cases the measurement results were not usable for analysis due to a format error. Based on these figures, 1,540 relevant cases remained. For 23 cases the original declared customs value and net weight could not be disclosed anymore. For these reasons, 1507 of 1540 relevant cases (97,6%) have been used for analysis. The data preparation as described in this chapter is described in more detail in appendix 1.

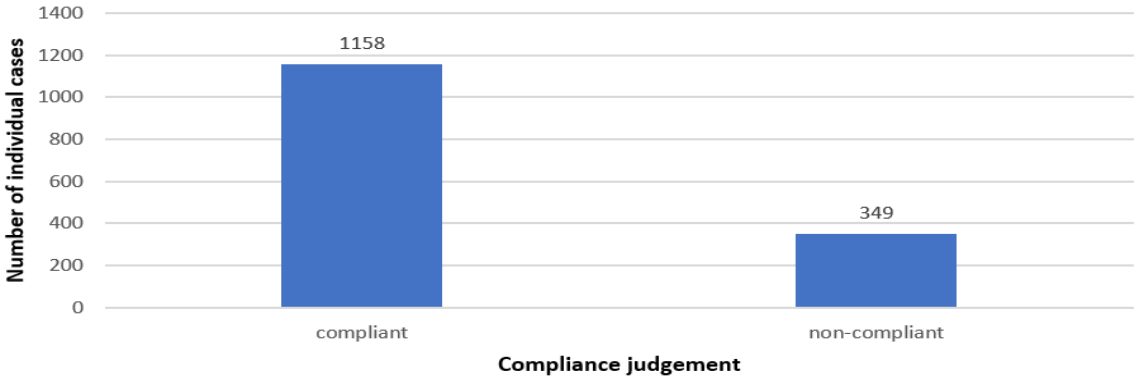
5.3 Content of the dataset used for this research

5.3.1 Basic descriptive statistics for output variables

The dataset used for analysis contains judgements on compliance on individual case level: non-compliant or compliant. From these 1507 cases, for 349 cases the judgement was non-compliant to RoHS. The graphical representation of the above mentioned categorized number of cases is presented below:

FIGURE 5

Number of individual cases of inspected products per judgement on conformity



Every non-compliant judgement comes with a norm exceedance. Every compliant judgement can be expressed as 0% norm exceedance. Logically, the 1158 compliant judgements have a norm exceedance value of 0% and for 349 cases an individual value for norm exceedance is present in the data. In order to present meaningful graphical representations, firstly the values of these individual cases are divided into classes of norm exceedance, and secondly the individual values are depicted on case level in order of size:

FIGURE 6

Number of individual cases of inspected products per class for norm exceedance percentage

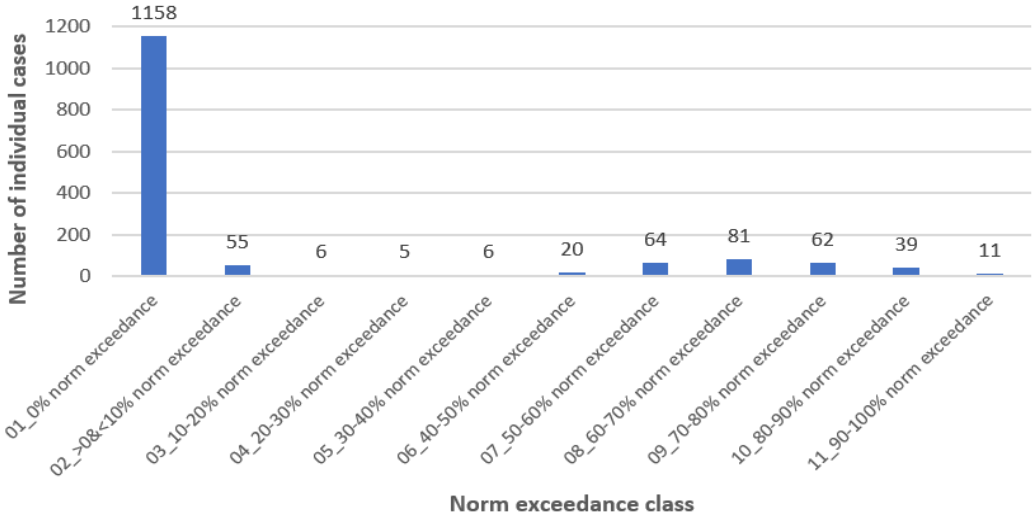
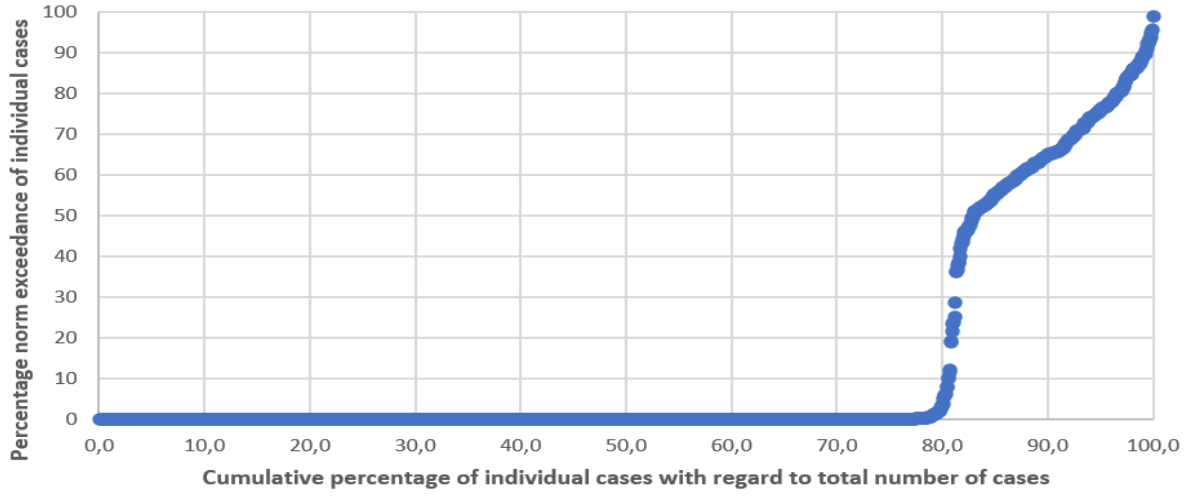


FIGURE 7

Percentage norm exceedance of individual cases, sorted ascending by norm exceedance percentage



5.3.2 Homogeneity of the dataset

To test the degree of homogeneity of the dataset, the data has been divided into two or more groups in different ways, whereby an ANOVA test is used to determine the extent to which a significant difference between the means of the various groups is present. The results of these tests are presented below, only providing the most relevant information of the performed tests.

Comparison regarding time periods

The result of the ANOVA test for comparison of group 1 '2017-2019 (3 years)' and group 2 '2020-2022 (2,5 years)' shows a 4,2% difference between both groups (group 1: 25,80, group 2: 21,56) with regard to average non-compliance percentage (avNC%). The difference regarding the average norm exceedance percentage (avNE%) between these two groups is 2,2% (group 1: 14,21, group 2: 11,98). The P-value of the ANOVA tests for both comparisons for these two groups is above the stated limit of 0,05 (for avNC%: 0,054757698 and for avNE%: 0,110391083), which indicates that there is no statistically significant difference between the means of both groups.

The result of the ANOVA test for comparison of group 1 '2017-2021 (5 years)' and group 2 '2022 (jan-jun)' shows a 1,9% difference between both groups (group 1: 23,76, group 2: 25,68) with regard to average non-compliance percentage (avNC%). The difference regarding the average norm exceedance percentage (avNE%) between these two groups is 1,6% (group 1: 13,06, group 2: 14,70). The P-value of the ANOVA tests for both comparisons for these two groups is above the stated limit of 0,05 (for avNC%: 0,567154373 and for avNE%: 0,443957039), which indicates that there is no statistically significant difference between the means of both groups.

Comparison regarding number of analysed products per shipment (one or more)

The result of the ANOVA test for comparison of group 1 'shipment of which 1 sample is analysed' and group 2 'shipment of which >1 sample is analysed' shows a 1,5% difference between both groups (group 1: 22,93, group 2: 24,39) with regard to average non-compliance percentage (avNC%). The difference regarding the average norm exceedance percentage (avNE%) between these two groups is 1,4% (group 1: 12,25, group 2: 13,65). The P-value of the ANOVA tests for both comparisons for these two groups is above the stated limit of 0,05 (for avNC%: 0,550361396 and for avNE%: 0,365566483), which indicates that there is no statistically significant difference between the means of both groups.

Comparisons regarding HS-codes

The result of the ANOVA test for comparison of group 1 'HS code starts with 84', group 2 'HS code starts with 85', group 3 'HS code starts with 91', group 4 'HS code starts with 94' and group 5 'HS code starts with 95' shows a 41,2% difference between the highest and lowest average of these groups (group 1: 20,24, group 2: 21,34, group 3: 37,50, group 4: 20,87 and group 5: 61,39) with regard to average non-compliance percentage (avNC%). The difference regarding the average norm exceedance percentage (avNE%) between the highest and lowest values of these groups is 32,8% (group 1: 9,36, group 2: 11,24, group 3: 26,51, group 4: 11,51 and group 5: 42,15). The P-value of the ANOVA tests for both comparisons for these two groups is below the stated limit of 0,05 (for avNC%: 2,25888E-18 and for avNE%: 7,3446E-29), which indicates that there is a statistically significant difference between the means of these groups.

The result of the ANOVA test for comparison of group 1 '75% most frequent present HS-codes' and group 2 'other 25% of present HS-codes' shows a 4,6% difference between both groups (group 1: 22,90, group 2: 27,47) with regard to average non-compliance percentage (avNC%). The difference regarding the average norm exceedance percentage (avNE%) between these two groups is 2,3% (group 1: 12,70, group 2: 15,03). The P-value of the ANOVA tests for both comparisons for these two groups is above the stated limit of 0,05 (for avNC%: 0,074510965 and for avNE%: 0,152080429), which indicates that there is no statistically significant difference between the means of both groups.

Comparison regarding Consignees

The result of the ANOVA test for comparison of group 1 '75% most frequent present consignees' and group 2 'other 25% of present consignees' shows a 13,2% difference between both groups (group 1: 20,90, group 2: 34,08) with regard to average non-compliance percentage (avNC%). The difference regarding the average norm exceedance percentage (avNE%) between these two groups is 8,5% (group 1:

11,26, group 2: 19,90). The P-value of the ANOVA tests for both comparisons for these two groups is below the stated limit of 0,05 (for avNC%: 2,9466E-07 and for avNE%: 1,59237E-07), which indicates that there is a statistically significant difference between the means of both groups.

Summary of results for testing homogeneity of the dataset used for the analyses

Summarized, the ANOVA test results for comparing the time periods '2017-2019 (3 years)' with '2020-2022 (2,5 years)' and '2017-2021 (5 years)' with '2022 (jan-jun)' show no statistically significant difference between the means for avNC% and avNE% of these two groups. The same holds for the comparison of the groups 'shipment of which 1 sample is analysed' with 'shipment of which >1 sample is analysed' and '75% most frequent present HS-codes' and 'other 25% of present HS-codes'. However, the ANOVA tests results for comparing the groups '75% most frequent present consignees' with 'other 25% of present consignees' and comparing the groups based on the first 2 digits of the HS codes declared do actually show statistically significant differences between the means of these compared groups.

5.3.3 Limitations of the dataset for statistical analysis

In general, the dataset does not contain the same number of records for each time period, (first digits of) each HS-code, each consignee and for presence and absence of each evaluated risk indicator. In addition, for part 2 of this research there are some more limitations that need to be mentioned here.

The dataset used for this analysis contains all inspection results of Dutch Customs for law enforcement on the RoHS Directive from 01-01-2017 until 30-06-022. However, the law enforcement on the RoHS Directive already started pilot-wise, with small inspection numbers, during 2015. After this a follow-up took place, again with small inspection numbers, in 2016. As from 2017, the regular risk-profiling for law enforcement on the RoHS Directive was implemented, leading to 300+ inspected products every calendar year. Although the law enforcement activities during 2015 and 2016 were very limited, it cannot be stated that a first inspection experience of a consignee within the analysed dataset actually is the first inspection experience of a consignee since the law enforcement on RoHS started.

Furthermore, the analysis of influence of a first inspection experience present in the dataset on the result of later inspection experiences can be influenced by the factor 'time'. This research focusses on the numerical order of inspection experiences, and not on the time measured in calendar days between every inspection experience. Time is only taken into account by excluding inspection experiences for analysis that took place within 30 days after the first inspection experience that is present within in the dataset.

6. Evaluating effectiveness of targeting choices

6.1 Targeting process and its performance

As any production process, the process of creating declaration-oriented risk-based inspections is based on inputs that are being processed with help of resources to create output. With the available resources, received relevant risk information and priorities are being translated into risk-based profiling for declaration-oriented supervision. With this risk profiling, Union-border crossing shipments are being selected for inspections and administratively and/or physically inspected, and results are being reported to the market authority and used for adjustment of risk-profiling. Market authorities use this information to report about their supervision towards their principals: national ministries. These ministries justify their law enforcement policies towards the national government. On its turn, the national government has to report to the European Union about the national inspection efforts.

Yearly, for the product 'declaration-oriented risk-based inspections' for every relevant internal supervision process a maximum number of inspections is assigned to every law enforcement domain, after negotiating and an agreement with relevant market authorities. The assigned number of inspections are translated into a monthly production planning/forecasting. Effectiveness of inspections highly depends on received risk information from market authorities and the choices within the targeting process based on this information. To 'produce' the product 'declaration-oriented risk-based inspections', Dutch Customs designed a so called 'internal enforcement management chain' (in Dutch: handhaving aansturingsketen), in which different departments, teams and functions play a role in creating the product the stakeholder asks for. The extent to which Dutch Customs succeeds, can be evaluated using for this research defined targeting process performance indicators for effectiveness: avNC% and avNE%.

Every individual inspected product receives a judgement upon (non-) compliance. The result of an inspected product can be stated as 0% compliance if the product does not apply to the norms. At the same time, this non-compliant product is 100% according to the specifications of the desired output of the risk targeting process: a non-compliant shipment, as targeted for. With every single case ID having either a compliant or non-compliant judgement, which can be stated as either 0% or 100% desired outcome of the targeting process, the average performance of the targeting process, measured on the dimension 'non-compliance', using average Non Compliance percentage (avNC%), is currently 23,2%.

In the ideal world from point of view of effective targeting, the products selected for inspection are not only non-compliant but also exceeding norms excessively. Exceedance, for this research measured in volume % of used restricted material lead, is the basis for measuring the targeting process performance on the dimension of norm exceedance, using the KPI average Norm Exceedance percentage (avNE%). The current targeting process performance on this dimension is 12,7%.

Currently, only achieving the quantitative goal of planned number of inspections and avNC% are being evaluated every calendar year. The dimension avNE% is not part of any evaluation regarding measuring, evaluating and improving the targeting process performance. The quantitative goal of number of inspections is outside of scope for this research. In this research besides avNC% also the dimension avNE% has been taken into account for evaluating the effectiveness of the targeting process performance and recommendations for improving the effectiveness of the targeting process. Based on the former figures, the starting point for statistical evaluation of effectiveness of current targeting is the current targeting process performance, which is 23,2% regarding avNC% and 12,7% regarding avNE%.

To improve effectiveness of the targeting process, by evaluating targeting choices for risk-based profiling, this research aims for new insights on achieving higher average values for NC% to improve impact (true positives in selections) and reduce collateral damage (false positives in selections) of risk profiling causing inspections. Besides this, this research also aims for insights on achieving higher values for NE%, to improve the impact of inspections from environmental protection point of view: improve investing scarce inspection capacity by selecting shipments with higher levels of norm exceedance instead of lower levels.

The performed research is meant to provide statistical input for evaluation of effectiveness of the targeting choices that function as input for the current targeting process, leading to its performance. Any continuing or adjusting of risk profiling should primarily aim for pushing the values of avNC% and/or avNE% up for better average targeting process performance regarding effectiveness of targeting choices.

6.2 Importance of evaluation of targeting choices

For the law enforcement of the RoHS Directive, from 01-01-2017 until 30-06-2022 1,541 samples were taken from goods of 690 customs declarations lodged in the Dutch customs declaration system AGS Invoer. With these inspection activities, a total net weight of 2,506,324 kilograms of goods, with a customs value of 22,978,532 euros were held up, waiting for sample analysis results. The goods of 497 declarations (72%), representing 85% of the sampled net weight and 90% of the value of held up sampled goods, were released for free circulation, because of their compliance. Related consignees of compliant shipments suffered unnecessary and costly logistic delay due to the current risk-based profiling. On average it took 9 days before the lab analysis result was available. With estimated costs of 400 euros for sampling and lab analysis together, the earlier mentioned 1,541 samples costed Dutch Customs 475,500 euros, although only 23,2% of the analysed products lead to proven violation of the RoHS Directive. Based on these figures, there is a need for evaluation the effectiveness of current targeting choices and search for ways to improve the targeting process performance, from point of view of protecting of the Union market, facilitating bona fide trade, as well as from point of view of costs involved with inspections.

Although a consignee with an AEO certificate is assumed to be familiar with customs procedures and to have an incentive and proven track record regarding sufficient compliance to laws and regulations, for current risk-based shipment selections for supervision on RoHS no distinction is made based on (non) AEO status of consignees. (Lack of) differences in compliance levels and levels of norm exceedance between AEO and non-AEO certified consignees can be of importance for justifying or adjusting current targeting. And until now, the selection of shipments often takes place with rough estimated ratios derived from the mean value for a certain type of product, identified via its commodity code in the import declaration. For risk-based shipment selections, it is currently not clear whether there is a tipping point for compliance related to customs value / net weight ratios, and where any tipping point actually occurs. This information can provide valuable input for improving the effectiveness of risk-based shipment selections, to optimize effectiveness of the supervision efforts with the limited capacity. The same holds for (lack of) compliance differences between inspection results of the country of origin perceived to be of highest risk and others.

A large number of consignees have been confronted with more than one inspection experience by sampling more than one of their shipments over time. Sometimes on the same day, or within several days or weeks, but also with larger periods between the different inspection experiences. This happened partly unintentionally, for example by selecting two or more shipments due to the fact that the consignee lodged proportionally a large number of import declarations within a certain (short) period, combined with a temporarily high selection rate of a risk profile. But repeatedly selecting shipments of consignees partly also happened intentionally. For example, for the reason that the first sample of a consignee received a non-compliant judgement, which resulted in (temporarily) higher selection rate for shipments of this consignee. The effectiveness of (un-) intentionally repeatedly inspecting shipments of consignees, measured as increase, decrease or unchanged (average) compliance level in time, is currently unknown.

Because of the jurisdiction of the Dutch market authority for RoHS, only goods meant to be brought on the Union market by Dutch companies are selected for inspection. Furthermore, because of the high costs of RoHS inspections, and (costs of) delay, shipments with relatively low net weight are not selected for inspection. Evaluating the influence of declared destination of goods and the used threshold for weight as used for shipment selections on the targeting process performance is outside of scope for this research.

Over time, several experiments, based on hunches, deviating from this combination of selection criteria, made the targeting process performance drop with regard to avNC%. Therefore, without any statistical evidence for success, the original risk indicators for selecting shipments were kept unchanged after evaluation of these experiments. Testing the effectiveness of targeting choices related to AEO status, country of origin, customs value/net weight ratio and repeated inspections for current targeting process performance is meant to provide input for continuing or adjusting current choices for risk profiling.

7. Research results: evaluation of targeting process performance

7.1 Influence of risk indicator [X1] on avNC% [Y1] & avNE% [Y2]

Hypothesis to be tested

For determining the influence of risk indicator [X1], 'AEO-status of consignee', on the targeting process performance, the following hypotheses have been tested:

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level for non-compliance to RoHS
H1	There is a statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level for non-compliance to RoHS

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level of exceedance of RoHS-norms
H1	There is a statistically significant negative relation between presence of AEO-status of a consignee [X1] and average level of exceedance of RoHS-norms

Summarized test results

The following table shows the summarized test results and interpretation thereof, as commented below.

TABLE 1
Summarized results of ANOVA test and additional calculations for influence of presence and absence of risk indicator [X1] (AEO status of consignee of declared goods) on targeting process performance indicators avNC% and avNE%

Risk factor	Cases	avNC%			avNE%		
[X1] present or [X1] absent	Cases	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
[X1] present	36	55,6	Pushing up	P-value ANOVA: 0,000 Difference between groups as % and factor: 32,2% / 2,48	33,8	Pushing up	P-value ANOVA: 0,000 Difference between groups as % and factor: 21,6% / 2,77
[X1] absent	1471	22,4	Pulling down		12,2	Pulling down	

Interpretation of results: statistically significance of differences between means of the defined groups

The P-value for testing '[X1] present' versus '[X1] absent' for avNC% is 0,00000291. For avNE% the P-value is 0,00000148. Although both P-values are lower than 0,05, both meaning a statistically significant difference between the means of the two groups '[X1] present' on case level in the data and '[X1] absent' on case level in the data, for both the statistically suggested relation between '[X1] present' and [Y1] and [Y2] are not negative, but positive, based on the difference between the means of the defined groups. However, due to the very limited number of cases (36) relevant for group '[X1] present', the outcomes of the statistical tests have only very limited power. Based on the extreme difference in size between the two groups, with only 36 cases for group '[X1] present', hypothesis H0 cannot be convincingly rejected. Therefore, no hard conclusions can be drawn for a relationship between presence of [X1] and average non-compliance and average norm exceedance. In addition, all 36 cases of '[X1] present' are related to only one actor, questioning any general relation, if present, despite any mathematical significance.

Interpretation of results: influence of presence/absence of risk indicator on targeting process performance

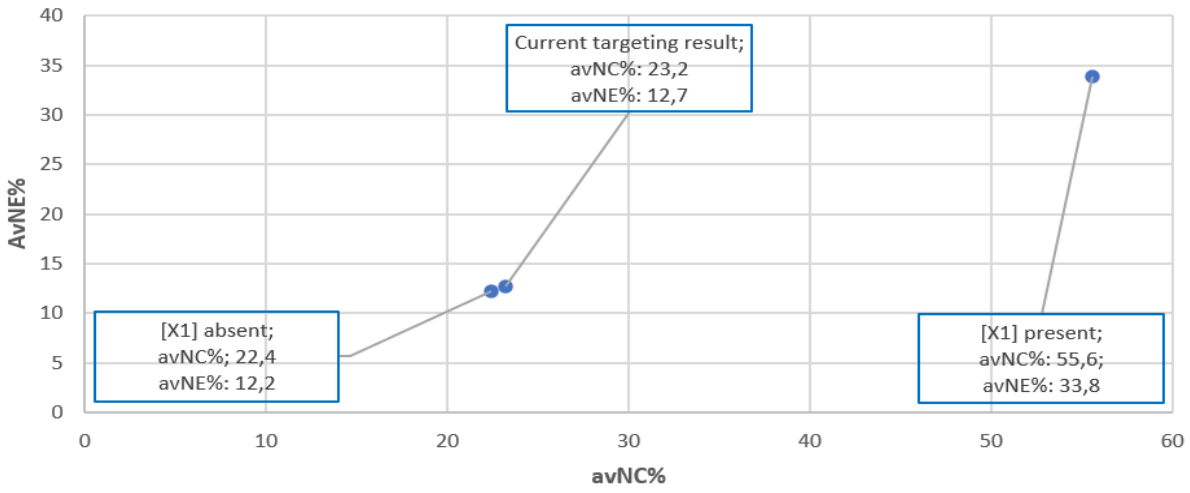
According to the content of the dataset avNC% for all inspected products is 23,2%. The avNC% for inspected products for which [X1] was present on case level within the data was 55,6% (20 out of 36), against 22,4% (329 out of 1471) of the shipments for which [X1] was absent on case level within the data. The absolute difference between both values is 32,2%, and this difference stated as ratio for risk indicator

present/absent is 2,48. Based on the former calculations, it can be stated that the risk factor [X1] being present on case level within the data is more effective for targeting for non-compliance than risk factor [X1] being absent on case level within the data. Risk indicator [X1] being present pushes the targeting process performance regarding avNC% up, compared to [X1] being absent. However, [X1] was present in 5,7% (20 out of 349) and absent in 94,3% (329 out of 349) of the non-co cases. And the last category would have been missed if presence of [X1] in risk profiling would have excluded selecting shipments for which risk indicator [X1] was absent in the customs declaration. In 44,4% of the cases (16 out of 36), risk factor [X1] being present lead to a lower avNC% than the average of current targeting choices. This effect of current targeting choices limits the process performance regarding avNC%.

According to the content of the dataset avNE% for all inspected products is 12,7%. The avNE% for inspected products for which [X1] was present was 33,8%, against 12,2% for shipments for which [X1] was absent. The absolute difference between both values is 21,6%, and the difference stated as ratio for risk indicator present/absent is 2,77. Based on these calculations, [X1] being present is more effective for targeting than risk factor [X1] being absent. Risk indicator [X1] being present pushes the targeting process performance regarding avNE% up, compared to [X1] being absent.

Down below the avNC% and avNE% of '[X1] present' and '[X1] absent' are depicted, in relation to the current targeting process performance, to illustrate the influence of the tested risk indicator with regard to the average process performance so far.

FIGURE 8
Graphic representation of targeting process performance related to the group of cases for which risk indicator [X1] is present and the group of cases for which risk indicator [X1] is absent, compared to current targeting process performance for both groups combined



However, the actual effect of [X1] present on case level within the data with regard to pushing up targeting process performance for both avNC% and avNE% is small, since only 36 of 1,507 (2,4%) of the cases contain this risk indicator. The effect of [X1] absent on case level within the data regarding pulling down targeting process performance for avNC% is small as well, since the avNC% of this group (1494 of 1,507 cases, 97,6%) is only 0,8% lower than avNC% for all cases in the dataset. The same holds for its influence on avNE% with a difference of 0,5%.

Meaning of research results for re-considering current targeting choices

From the start of supervision activities on the RoHS Directive, for risk profiling purposes no distinction was made between consignees with or without AEO-status. The research results regarding evaluation of risk indicator [X1] do not question this choice, because based on the used dataset there is no statistically significant *negative* effect of presence of AEO-status of consignees on the output variables avNC% and avNE%, compared to absence of AEO-status of consignees. This is caused by the fact that the test results show a *positive* effect and at the same time the relatively very small size of group '[X1] present' limits drawing hard conclusions based on the test results and all cases of '[X1] present' belong to one actor.

Summarized, the research results do not objectively justify adjusting the current targeting choice of not distinguishing between AEO and non-AEO consignees for shipment selection.

7.2 Influence of risk indicator [X2] on avNC% [Y1] & avNE% [Y2]

Hypothesis to be tested

For determining the influence of risk indicator [X2], 'Country of Origin, perceived to be of highest risk', on the targeting process performance, the following hypotheses have been tested:

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of non-compliance to RoHS
H1	There is a statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of non-compliance to RoHS

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of exceedance of RoHS-norms
H1	There is a statistically significant positive relation between presence of perceived highest risk country of origin of declared goods [X2] and average level of exceedance of RoHS-norms

Summarized test results

The following table shows the summarized test results and interpretation thereof, as commented below.

TABLE 2
Summarized results of ANOVA test and additional calculations for influence of presence and absence of risk indicator [X2] (Country of Origin perceived to be of highest risk) on targeting process performance indicators avNC% and avNE%

Risk factor	Cases	avNC%			avNE%		
[X2] present or [X2] absent	Cases	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
[X2] present	1472	23.2	Pushing up	P-value ANOVA: 0,966 Difference between groups as % and factor: 0,3% / 1,01	12,7	Pulling down	P-value ANOVA: 0,811 Difference between groups as % and factor: 1,1% / 0,92
[X2] absent	35	22,9	Pulling down		13,8	Pushing up	

Interpretation of results: statistical significance of differences between means of the defined groups

The P-value for testing '[X2] present' versus '[X1] absent' for avNC% is 0,966. For avNE% the P-value is 0,811. Because the P-value for testing avNC% and avNE% are both higher than 0,05, meaning lack of a statistically significant difference between the means of both groups '[X2] present' on case level within the data and '[X2] absent' on case level within the data. Herewith H0 can statistically not be rejected. The mean of group '[X2] absent' for avNC% and avNE% even suggest that there could be hardly any difference at all between the two groups, which questions a general positive relation between presence of [X2] and RoHS non-compliance. Furthermore, based on the extreme difference in size between the two groups, with only 35 cases for group '[X2] absent', hypothesis H0 could not have been convincingly rejected in case of statistically significance of the difference between means of the two tested groups. Therefore, no hard conclusions can be drawn for a relationship between presence of [X2] and average non-compliance and average norm exceedance.

Interpretation of results: influence of presence/absence of risk indicator on targeting process performance

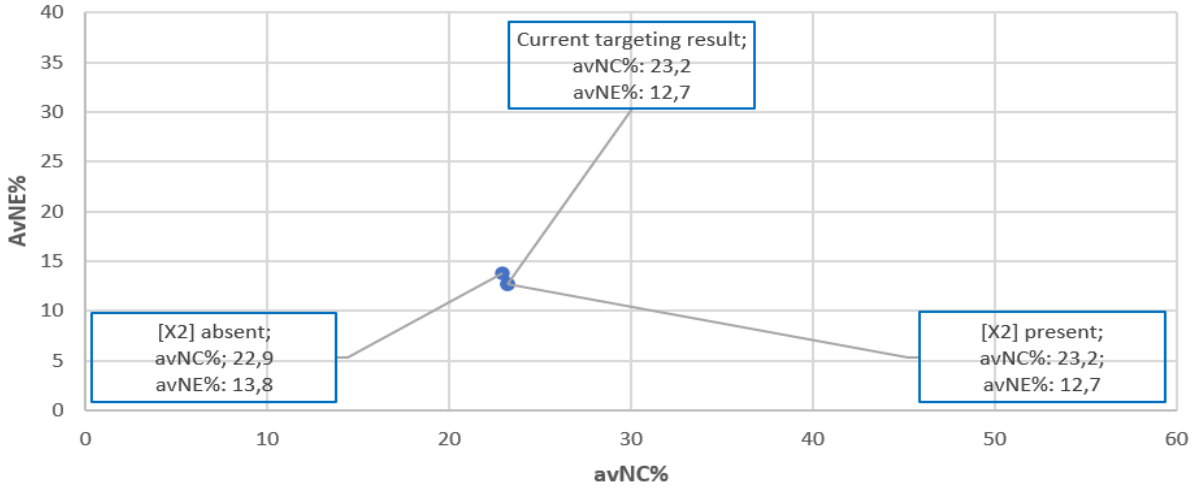
According to the content of the dataset avNC% for all inspected products is 23,2%. The avNC% for inspected products for which [X2] was present on case level in the dataset was 23,2% (341 out of 1472), against 22,9% (8 out of 35) of the shipments for which [X2] was absent on case level in the dataset. The absolute difference between both values is 0,3%, and this difference stated as ratio for risk indicator

present/absent is 1,01. Based on. the former calculations, it can be stated that the risk factor [X2] being present is minimally more effective for targeting for non-compliance than risk factor [X2] being absent. Risk indicator [X2] being present pushes the targeting process performance regarding avNC% up, compared to [X2] being absent. However, [X2] was present in 97,7% (341 out of 349) and absent in 2,3% (8 out of 349) of the non-compliant cases. And the last category would have been missed if presence of [X2] in risk profiling would have excluded selecting shipments for which risk indicator [X2] was absent in the customs declaration. In 76,8% of the cases (1131 out of 1472), risk factor [X2] being present lead to a lower NC% than the average of current targeting choices. This effect of current targeting choices slightly limits process performance regarding avNC%.

According to the content of the dataset avNE% for all inspected products is 12,7%. The avNE% for inspected products for which [X2] was present on case level in the dataset was 12,7%, against 13,8% for shipments for which [X2] was absent on case level in the dataset. The absolute difference between both values is 1,1%, and the difference stated as ratio for risk indicator present/absent is 0,92. Based on these calculations, [X2] being present is not more effective for targeting than risk factor [X2] being absent. On the contrary: risk indicator [X2] being absent pushes the targeting process performance regarding avNE% up, compared to [X2] being present.

Down below the avNC% and avNE% of '[X2] present' and '[X2] absent' are depicted, in relation to the current targeting process performance, to illustrate the influence of the tested risk indicator with regard to the average process performance so far.

FIGURE 9
Graphic representation of targeting process performance related to the group of cases for which risk indicator [X2] is present and the group of cases for which risk indicator [X2] is absent, compared to current targeting process performance for both groups combined



Meaning of research results for re-considering current targeting choices

From the start of supervision activities on the RoHS Directive, for risk profiling purposes in different ways over time a distinction was made between perceived highest risk country of origin and other countries of origin. The research results regarding evaluation of risk indicator [X2] question this choice, because based on the used dataset there is no statistic significantly negative effect of presence of the country of origin perceived to be of highest risk on the output variables avNC% and avNE%, compared to absence of this country of origin. Although based on a relatively small number of cases for the second group, it still can be questioned whether the country of origin perceived to be of highest risk actually is of more risk than others, since the mean values for avNC% and avNE% of both groups do not show a statistically significant difference, nor a statistically trustworthy but statistically insignificant difference between means of both groups, because of the very small number of cases relevant for group [X2] absent. Summarized, the research results at least question whether a former and future distinction for risk profiling purposes based on the country of origin perceived to be of highest risk can be objectively justified.

7.3 Influence of risk indicator [X3] on avNC% [Y1] & avNE% [Y2]

Hypothesis to be tested

For determining the influence of risk indicator [X3], 'customs value/net weight ratios below average for HS-code declared', on the targeting process performance, the following hypotheses have been tested:

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of non-compliance to RoHS (ratio < average)
H1	There is a statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of non-compliance to RoHS (ratio > average)

Hypothesis	Hypothesis description
H0	There is no statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of exceedance of RoHS-norms
H1	There is a statistically significant positive relation between presence of relatively low customs value/net weight ratios [X3] and average level of exceedance of RoHS-norms

Summarized test results

The following table shows the summarized test results and interpretation thereof, as commented below.

TABLE 3
Summarized results of ANOVA test and additional calculations for influence of presence and absence of risk indicator [X3] (relative low customs value/net weight ratio) on targeting process performance indicators avNC% and avNE%

Risk factor	Cases	avNC%			avNE%		
[X3] present or [X3] absent	Cases	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
[X3] present: *ratio<average*	1079	25,1	Pushing up	P-value ANOVA: 0,004 Difference between groups as % and factor: 6,9% / 1,38	14,0	Pushing up	P-value ANOVA: 0,004 Difference between groups as % and factor: 4,4% / 1,46
[X3] absent: *ratio>average*	428	18,3	Pulling down		9,6	Pulling down	

Interpretation of results: statistical significance of differences between means of the defined groups

The P-value for testing '[X3] present' versus '[X3] absent' for avNC% is 0,004. For avNE% the P-value is 0,004. For customs value/net weight ratios lower than the average for the declared HS-codes the P-values for testing avNC% and avNE% are lower than 0,05, meaning a statistically significant difference between the means of the two groups '[X3] present' on case level in the dataset and '[X3] absent' on case level in the dataset. Combined with the fact that the means of avNC% and avNE% for '[X3] present' are higher than for '[X3] absent', H0 is rejected for both dimensions non-compliance and norm exceedance: there is a statistically significant positive effect of customs value/net weight lower than average on [Y1] and [Y2].

Interpretation of results: influence of presence/absence of risk indicator on targeting process performance

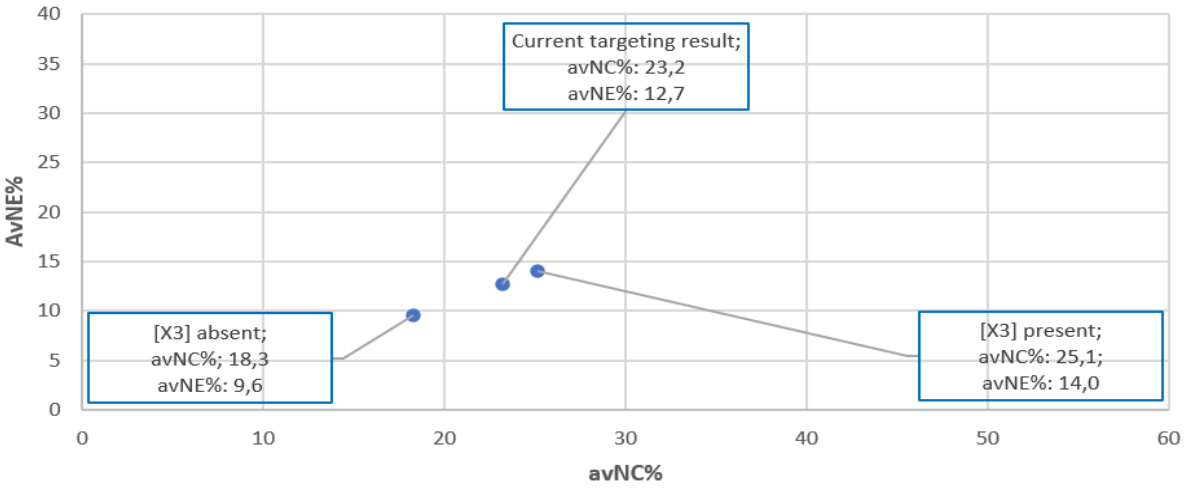
According to the content of the dataset avNC% for all inspected products is 23,2%. The avNC% for inspected products for which [X1] was present on case level within the data was 25,1% (271 out of 1079), against 18,3% (78 out of 428) of the shipments for which [X3] was absent on case level in the dataset. The absolute difference between both values is 6,8%, and this difference stated as ratio for risk indicator present/absent is 1,38. Based on the former calculations, it can be stated that the risk factor [X3] being present is more effective for targeting for non-compliance than risk factor [X3] being absent. Risk indicator [X3] being present pushes the targeting process performance regarding avNC% up, compared to [X3] being absent. However, [X3] was present in 77,7% (271 out of 349) and absent in 22,3% (78 out of 349) of the non-compliant cases. And the last category would have been missed if presence of [X3] in risk profiling would have excluded selecting shipments for which risk indicator [X3] was absent in the customs declaration. In 74,9% of the cases (808 out of 1079), risk factor [X3] being present lead to a lower NC% than the average of current targeting choices. This effect of current targeting choices limits the process

performance regarding avNC%.

According to the content of the dataset avNE% for all inspected products is 12,7%. The avNE% for inspected products for which [X3] was present on case level in the data was 14,0%, against 9,6% for shipments for which [X3] was absent on case level within the data. The absolute difference between both values is 4,4%, and the difference stated as ratio for risk indicator present/absent is 1,46. Based on these calculations, [X3] being present is more effective for targeting than risk factor [X3] being absent. Risk indicator [X3] being absent pushes the targeting process performance regarding avNE% up, compared to [X3] being present.

Down below the avNC% and avNE% of '[X3] present' and '[X3] absent' are depicted, in relation to the current targeting process performance, to illustrate the influence of the tested risk indicator with regard to the average process performance so far.

FIGURE 10
Graphic representation of targeting process performance related to the group of cases for which risk indicator [X3] is present and the group of cases for which risk indicator [X3] is absent, compared to current targeting process performance for both groups combined



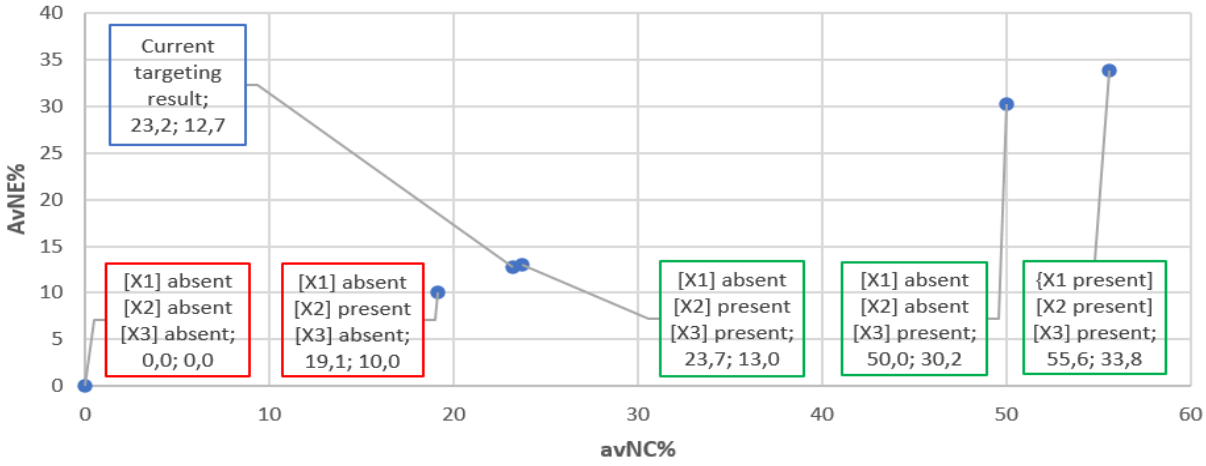
Meaning of research results for re-considering current targeting choices

From the start of supervision activities on the RoHS Directive, for risk profiling purposes in different ways over time a distinction was made between relatively low customs value/net weight ratios and other customs value/net weight ratios. The research results regarding evaluation of risk indicator [X3] supports the current choice for higher selection percentages of shipments with a relatively low customs value/net weight ratios, since presence of these ratios show a statistically significant positive effect on the output variables avNC% and avNE%, compared to absence of these customs value/net weight ratios. Summarized, the research results justify the current targeting choice with regard to higher selection percentages for shipments with a relatively low customs value/net weight ratios, compared to the average of the HS-code declared for the goods.

7.4 Influence of risk indicators [X1-3] on avNC% [Y1] & avNE% [Y2]

The different varying compositions of the three former tested risk indicators are mapped below, meant to determine potential for improving process performance. In this graphic representation each combination of risk indicator [X1], [X2] and/or [X3] present or absent in the data is depicted, showing the relative performance of combinations of risk indicators present or absent in relation to targeting performance.

FIGURE 11
Graphic representation of targeting process performance related to the group of cases for which combinations of risk indicators [X1], [X2] and/or [X3] are present or absent, compared to current targeting process performance



The combination in the upper right corner contributes in the most positive way to both output indicators for effectiveness of the targeting process: avNC% and avNE%. The different combinations are marked for their positive contribution (green squares) or for their negative contribution (red squares) to current targeting process performance.

As explained in paragraph 7.1 and 7.2 for risk indicator [X1] and [X2] the outcomes of the statistical tests do not lead to hard conclusions due to limited group sizes. Together with the interpretation of the ANOVA test results for risk indicator [X3], this map in principle provides the basis for exploring the potential of adjustments for risk indictor [X3] for targeting process improvement. And it provides the argument to avoid shipment selections without any of the risk indicators [X1], [X2] and [X3] present in import declarations. This makes further analyzing presence of [X3] the first priority for exploring possible improvement of the targeting process performance. The outcomes of corresponding detailed analysis of influence of risk indicator [X3] on the targeting process performance is presented in paragraph 8.1.

7.5 Influence of repeated inspections per consignee on avNC% [Y1] & avNE% [Y2]

Hypothesis to be tested

For determining the influence of repeatedly inspecting shipments of consignees on the targeting process performance, the following hypotheses have been tested:

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between results of a first inspection experience and average level for non-compliance to RoHS based on later inspection experiences
H1	There is a statistically significant negative relation between results of a first inspection experience and average level for non-compliance to RoHS based on later inspection experiences

Hypothesis	Hypothesis description
H0	There is no statistically significant negative relation between results of a first inspection experience and average level for norm exceedance for RoHS based on later inspection experiences
H1	There is a statistically significant negative relation between results of a first inspection experience and average level for norm exceedance for RoHS based on later inspection experiences

The average time between sampling a shipment and the analysis by the laboratory of Dutch Customs being ready, is 8,9 calendar days. If the individual values of the time between these moments would have a normal distribution, with the calculated standard deviation of 11,4 days for 95% (average + 2*SD) of the cases the outcome of the analysis was known within 31,7 days. Besides this, based on a recent data dump from the internal registry of the laboratory, for 1445 out of 1544 cases (93,6%) the result is known within 31 days. Taken into account that behaviour is influenced by stimuli, and the fact that an inspection result

can be seen as a stimulus for (adjusting) behaviour of inspected consignees, the former mentioned 'mark' of 31 days is taken as a starting point for creating first images for the analysis of the relation between repeated inspections per consignee and avNC% and avNE%. Therefore, the category 'later inspection experiences' does not include inspection experiences within 30 days after the first inspection experience. Furthermore, only 83 out of 246 consignees present in the data had inspection experiences, later than 30 days after the first one. The data of these 83 consignees has been used for the following analysis.

Summarized test results

The following table shows the summarized test results and interpretation thereof, as commented below.

TABLE 4

Summarized results of ANOVA test and additional calculations for influence of first inspection experience on inspection experiences >30 days after the first inspection experience present in the dataset on targeting process performance indicators avNC% and avNE%

Risk factor	**Actors**	**avNC%**			**avNE%**		
First or later inspection experience	Actors	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
First inspection experience	83	30,2	Pushing up	P-value ANOVA: 0,218 Difference between groups as % and factor: 7,82 / 1,35	15,0	Pushing up	P-value ANOVA: 0,623 Difference between groups as % and factor: 2,06 / 1,16
Later inspection experiences	83	22,4	Pulling down		12,9	Pulling down	

Interpretation of results: statistical significance of differences between means of the defined groups

Because the P-value for testing both avNC% (0,218) and avNE% (0,623) is higher than 0,05, meaning a lack of statistically significant difference between the means of the two groups 'first inspection experience' and 'later inspection experiences', the negative relation between presence of first and later inspection experiences in the dataset is not statistically significant, based on variances of both groups. Therefore, H0 is not rejected, based on the means and variances of individual values of both groups.

Interpretation of results: influence of presence/absence of risk indicator on targeting process performance

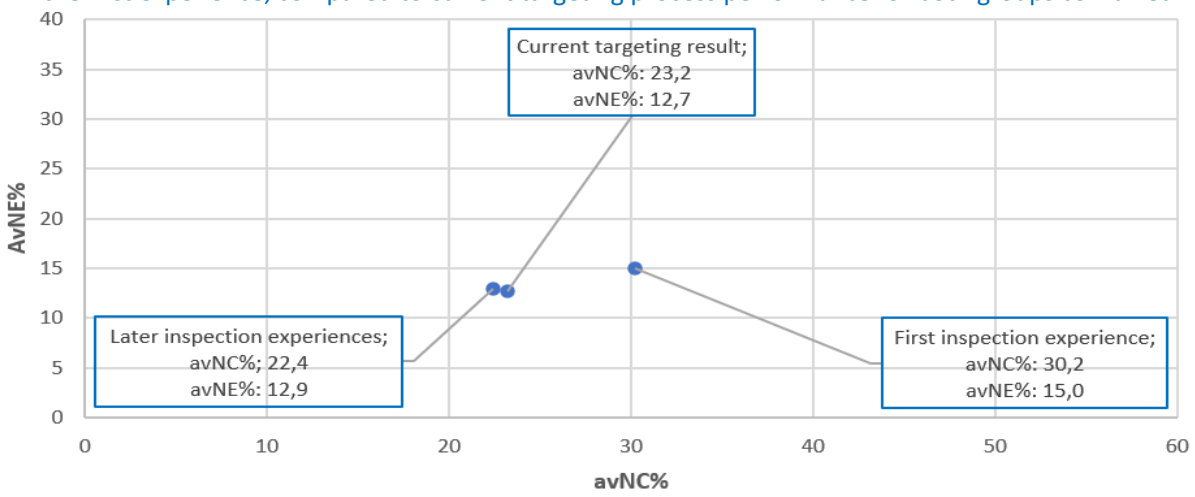
The avNC% of current targeting is 23,2%. The avNC% for 'first inspection experiences' for these 83 companies is 30,2%, against 22,4% for later inspection experiences. The absolute difference between both values is 7,8%, and the difference stated as ratio for first inspection experience/later inspection experience is 1,35. Based on these calculations, targeting for first inspection experiences is more effective than for other inspection experiences, with regard to avNC%. With regard to avNC% the results of 'first inspection experiences' pushes the targeting process performance upwards, whereas the results of 'later inspection experiences' pull performance down, slightly.

The avNE% of current targeting is 12,7%. The avNE% for 'first inspection experiences' for these 83 companies is 15,0%, against 12,9% for 'later inspection experiences'. The absolute difference between both values is 2,06, and the difference stated as ratio for first inspection experience/later inspection experience is 1,16. Based on these calculations, targeting for 'first inspection experiences' is more effective than for 'later inspection experiences', with regard to avNE%. With regard to avNE% the results of 'first inspection experiences' pushes the targeting process performance more upwards than 'later inspection experiences'.

Down below the avNC% and avNE% of 'first inspection experiences' and 'later inspection experiences' of the 83 companies are depicted, in relation to the current targeting process performance, to illustrate the influence of repeated sampling with regard to the average process performance so far.

FIGURE 12

Graphic representation of targeting process performance related to the group of cases representing a first inspection experience and the group of cases representing later inspection experiences >30 days after the first experience, compared to current targeting process performance for both groups combined



Meaning of research results for re-considering current targeting choices

At the start of supervision activities on the RoHS Directive, for risk profiling purposes no difference was made between consignees that already got inspected and consignees that had not been inspected yet. A first inspection with a compliant result did not lead to lower selection percentage of future shipments of a consignee, nor did any first inspection being non-compliant lead to a higher selection percentage of future shipments of a consignee. This changed over time. Nowadays, first inspection results are input for risk profiling as well, with distinguishing between shipments of consignees with a first inspection result being compliant and non-compliant. With the absence of a statistically significant difference between the means of the groups 'first inspection experiences' and 'later inspection experiences', it can be questioned whether the approach of repeatedly inspecting shipments of consignees is effective with regard to compliance performance of consignees. Summarized, the research results do not show a statistically significant difference for both groups 'first inspection experience = compliant' and 'first inspection experience = non-compliant' *together*. This makes further analysing both groups *separately* the second priority for exploring possible targeting process improvement. The outcomes of this part of the research are presented in paragraph 8.2.

8. Research results: improving targeting process performance

8.1 Improving targeting process performance by adjusting of choices for [X3]

Starting point for the exploration of possible improvement of targeting process performance by adjusting choices regarding usage of risk indicator [X3] are the test results as presented in paragraph 7.3. In order to determine whether and to which extent lower ratios for customs value / kilogram net weight result in increasing avNC% and/or increase of avNE%, additional ANOVA tests are performed. For the 3 additional ANOVA tests, the risk indicator '[X3] present' is adjusted to respectively <-25% of average (test 2), < -50% of average (test 3) and < -75% of average (test 4). For each test, the values that have not been categorized as '[X3] present' have been labeled as '[X3] absent'. Underneath, the results of these tests are separately presented and interpreted for both avNC% and avNE%. The tables include the results of paragraph 7.3.

TABLE 5
Summarized results of ANOVA test and additional calculations for influence of presence and absence of risk indicator [X3] (relatively low customs value/net weight ratio) on targeting process performance indicator avNC%

Source of the Variance	Count for: [X3] present / [X3] absent	Averages value for [X3] present	Difference between averages	F-value	P-value	Critical area of F-test
[X3] present: < average	1079 / 428	25,12	6,89	8,21	0,004	3,85
[X3] present: < -25% of average	795 / 712	29,56	13,55	39,71	3,85267E-10	3,85
[X3] present: < -50% of average	474 / 1033	37,34	20,69	82,34	3,49583E-19	3,85
[X3] present < -75% of average	243 / 1264	46,91	28,32	97,70	2,29202E-22	3,85

TABLE 6
Summarized results of ANOVA test and additional calculations for influence of presence and absence of risk indicator [X3] (relatively low customs value/net weight ratios) on targeting process performance indicator avNE%

Source of the Variance	Count for: [X3] present / [X3] absent	Averages value for [X3] present	Difference between averages	F-value	P-value	Critical area of F-test
[X3] present: < average	1079 / 428	14,00	4,41	8,38	0,004	3,85
[X3] present: < -25% of average	795 / 712	17,09	9,20	45,93	1,75795E-11	3,85
[X3] present: < -50% of average	474 / 1033	22,00	13,5	87,87	2,46722E-20	3,85
[X3] present < -75% of average	243 / 1264	28,42	18,69	106,89	2,9787E-24	3,85

For customs value/net weight ratios lower than the average for the declared HS-codes the P-value is lower than 0,05, meaning a statistically significant difference between the means of the two groups '[X3] present' and '[X3] absent'. For lower customs value/net weight ratios (-25%, -50% and -75% of average for HS-code declared) the P-value even decreases, indicating increasingly statistical support for differences between means of the two groups '[X3 present]' and '[X3] absent' for these tests. At the same time, average non-compliance percentage (avNC%) of the group '[X3] present' increases for lower customs value/net weight ratios. With the P-value < 0,05 for customs value/net weight ratios lower than average for the declared HS code and decreasing of the P-value for even lower ratios while at the same time the average non-compliance percentage increases, it can be stated that there is a statistically significant positive effect of lower customs value/net weight ratios on avNC%. Exact the same reasoning and conclusions hold for the relation between lower customs value/net weight ratios and avNE%.

The statistical method Correlation and Regression (C&R) is used to determine whether and to what extent a gradual connection between this ratio and avNC% and avNE% can be statistically supported. To explore a possible connection, first the C&R test is performed or the individual ratios of every single case, divided into ratio classes of 25%. This class classification connects 1-on-1 to the classes used in the ANOVA tests above. Furthermore, classes of 12,5% and 5% are used and finally C&R analysis has been done using the individual ratios per case, without dividing them into any classes. The next table contains a summary of the test results.

TABLE 7
Summarized results of Correlation & Regression tests for connection between presence of risk indicator [X3] (relatively low customs value/net weight ratios) and targeting process performance indicators avNC% and avNE%

	Cases	avNC%			avNE%		
	Cases	Correlation coefficient	Standard error	F-Value	Correlation coefficient	Standard error	F-Value
Individual ratios from -100 till 0% deviation	472	0,302	39,599	47,284	0,304	25,840	47,980
Individual ratios divided in 5% deviation classes	20	0,721	11,225	19,432	0,695	7,850	16,788
Individual ratios divided in 12,5% deviation classes	8	0,881	7,631	20,837	0,878	5,136	20,093
Individual ratios divided in 25% deviation classes	4	0,960	5,145	23,656	0,964	3,252	26,3775

The C&R test for customs value/net weight ratio of individual cases, not divided into classes, with a correlation coefficient of approximately 0,30 based on 472 measuring points, shows only a very weak connection between the customs value / net weight ratios on individual case level and avNC% and avNE%. And the standard error of nearly 40 for avNC% and nearly 26 for avNE% is not promising for usability for targeting purposes. Categorizing the values for customs value/net weight ratios of individual cases into classes of 25%, leads to a relatively high correlation coefficient for both avNC% and avNE%, compared to the outcomes of the other tests. Based on the averages that this class deviation provides, the result of the C&R test shows very strong connection between the ratio and avNC% and avNE%. However, a factor that influences this result is that there are only 4 measurement points that are situated in a fairly straight line. But, looking at the results of the other 2 tests, especially the test with classes of 5%, they as well seem to shed a light on a possible connection between customs value/weight ratios and avNC% and avNE%. With a correlation coefficient of approximately 0,70, based on 20 measurement values, there is a statistically reasonable connection present between the researched ratio and both avNC% and avNE%. The graphical representation of the results of the tests for avNC% and avNE% based on 5% classes are depicted below.

FIGURE 13
Graphical representation of results of Correlation & Regression tests for connection between presence of risk indicator [X3] (relatively low customs value/net weight ratios) and targeting process performance indicators avNC%, for which the percentage of deviation of customs value/net weight ratio of individual cases has been divided into classes of 5 percent.

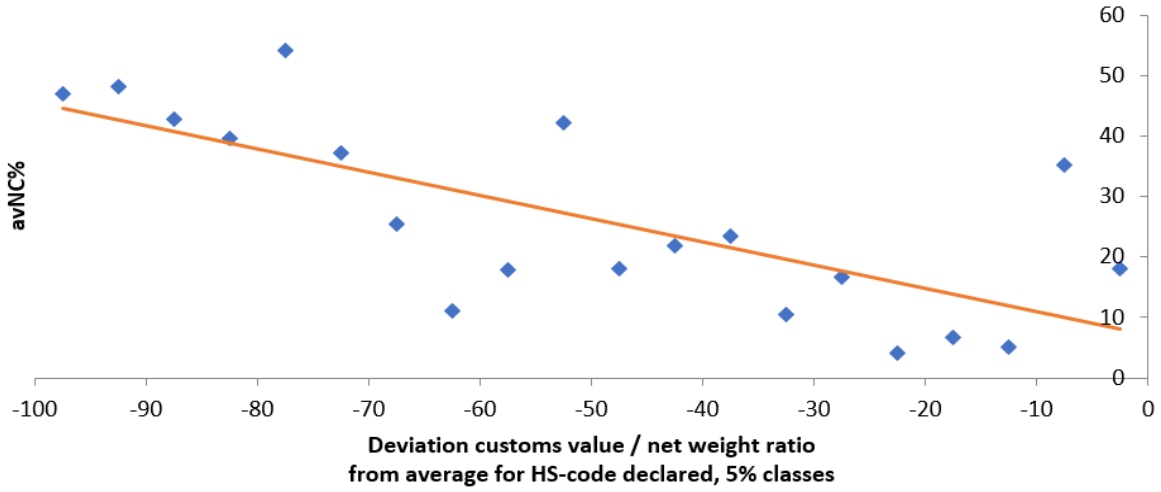
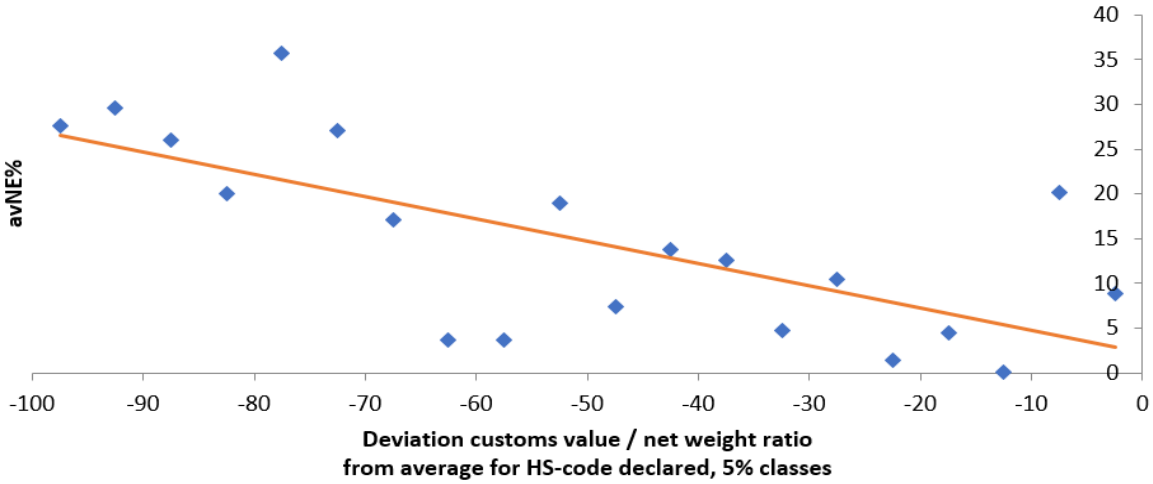


FIGURE 14
Graphical representation of results of Correlation & Regression tests for connection between presence of risk indicator [X3] (relatively low customs value/net weight ratios) and targeting process performance indicators avNE%, for which the percentage of deviation of customs value/net weight ratio of individual cases has been divided into classes of 5 percent



Meaning of research results for re-considering current targeting choices

Currently risk indicator [X3] is used in risk profiling for customs value/net weight ratios below the average value for the HS-code used in the declarations for release for free circulation. From targeting process performance point of view the results presented in this paragraph objectively justify adjusting the currently used values for this risk indicator for risk profiling into lower values, for example corresponding with -50% of the average for the HS-code used.

8.2 Improving targeting process performance by adjusting repeating inspections

8.2.1 1st and other inspection experiences, f.or groups 1st = compliant and 1st = non-compliant

1st and other inspection experiences, for group 1st = compliant

Of all consignees, 55 consignees have one or more experiences more than 30 days after their first and the result of their first inspection experience was 0% NC. This sub-group of consignees has been used for the following ANOVA test, to determine any statistically significant difference between the mean value of their first inspection result and the avNC% of their *combined* later results. The former mentioned sub-group of consignees has also been used for an ANOVA test, to determine any statistically significant difference between the mean value of their first inspection result and the avNE% of their *combined* later results. The following table shows summarized test results and interpretation thereof, as commented below.

TABLE 8
Summarized results of ANOVA test and additional calculations for influence of first inspection experience on inspection experiences >30 days after the first inspection experience present in the dataset with regard to targeting process performance indicators avNC% and avNE%, first inspection result compliant

	Cases	**avNC%**			**avNE%**		
	Cases	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
1st inspection experience	55	0,00	Pulling down	P-value ANOVA: 0,000	0,00	Pulling down	P-value ANOVA: 0,000
Other experiences, >30 days	55	18,44	Pulling down		11,47	Pulling down	

Because the P-value for testing avNC% is lower than 0,05, meaning a statistically significant difference between the means of the two groups 'first inspection experience' and 'other inspection experiences', and the mean value for avNC% of the second group being higher than for the first one, a positive relation is statistically plausible: with regard to avNC% future results of consignees with a first result of 0% for avNC% are higher, representing an higher average level of non-compliance. The same conclusions hold for avNE%: future results for avNE% are higher, representing a higher average level of norm exceedance.

1st and other inspection experiences, for group 1st = non-compliant

Of all consignees, 28 consignees have one or more inspection experiences more than 30 days after their first and the result of their first inspection experience was higher than 0% NC. This sub-group of consignees has been used for the following ANOVA test, to determine any statistically significant difference between the mean value of their first inspection result and the avNC% of their combined later results. The former mentioned sub-group of consignees has also been used for the ANOVA test, to determine any statistically significant difference between the mean value of their first inspection result and the avNE% of their combined later results.

TABLE 9

Summarized results of ANOVA test and additional calculations for influence of first inspection experience on inspection experiences >30 days after the first inspection experience present in the dataset with regard to targeting process performance indicators avNC% and avNE%, 1st result non-compliant

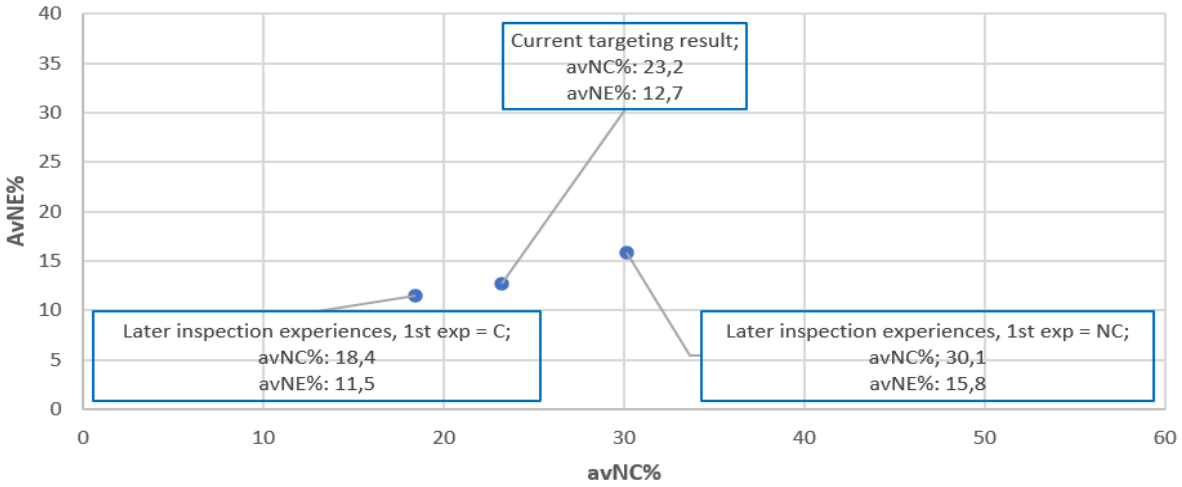
	Cases	**avNC%**			**avNE%**		
	Cases	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
1st inspection experience	28	89,52	Pushing up	P-value ANOVA: 0,000	44,44	Pushing up	P-value ANOVA: 0,001
Other experiences >30 days	28	30,11	Pushing up		15,81	Pushing up	

Because the P-value for testing avNC% is lower than 0,05, meaning a statistically significant difference between the means of the two groups 'first inspection experience' and 'other inspection experiences', and the mean value for avNC% of the second group being lower than for the first one, a negative relation is statistically plausible. With regard to avNC% future results of consignees with a first result higher than 0% for avNC% are lower, which represents, on average, a higher compliance level. The same conclusions hold for avNE%: future results of consignees with a first result higher than 0% for avNE% are lower, which represents, on average, a lower level of norm exceedance.

Below avNC% and avNE% of later (not first) experiences of both groups (1st experience = compliant and 1st experience = non-compliant) are depicted, in relation to the current targeting process performance, to illustrate the influence of the tested risk indicator with regard to the average process performance so far.

FIGURE 15

Graphic representation of targeting process performance related cases representing inspection experiences >30 days after a first experience for the group of which the result of the first inspection experience was compliant and the group for which it was non-compliant, compared to current targeting process performance for both groups combined



Based on the results of the former tests, of which the categories for later inspection experiences results are depicted above, targeting for later inspections is more effective in case the first one was non-compliant. However, this conclusion is only based on averages of tested categories. This does not say anything about the 'compliance journey' of the evaluated individual companies, based on their later inspection experiences. Therefore, the question remains, how do companies perform after their 1st experience? Therefore, in addition to the former analysis, a multiple case study is executed to zoom in on the development of non-compliance and norm exceedance from the moment of the first inspection experience present in the dataset. For this part of the research, the data of all 24 consignees with at least 3 sample experiences later dan 30 days after their first sample experience has been used for further analysis. With this data, the development of avNC% and avNE% of this group of consignees is analysed, based on their first sample experience and sample experience # 2 till 4, if later than 30 days after their first experience, under the condition that for each of their inspection experiences a measurement value is present within the data. The results of this multiple case study are presented below.

8.2.2 1st and other inspection experiences, for group '1st inspection experience = compliant'

All 17 companies with a first inspection result being compliant and being present in the dataset with 3 or more inspection experiences more than 30 days after their first, and experience no. 2 >30 days after the first experience, are used for the following additional analysis.

TABLE 10

Summarized results of ANOVA test and additional calculations for influence of first inspection experience on individual later inspection experiences >30 days after the first inspection experience present in the dataset with regard to targeting process performance indicators avNC% and avNE%, in case the first inspection result is compliant

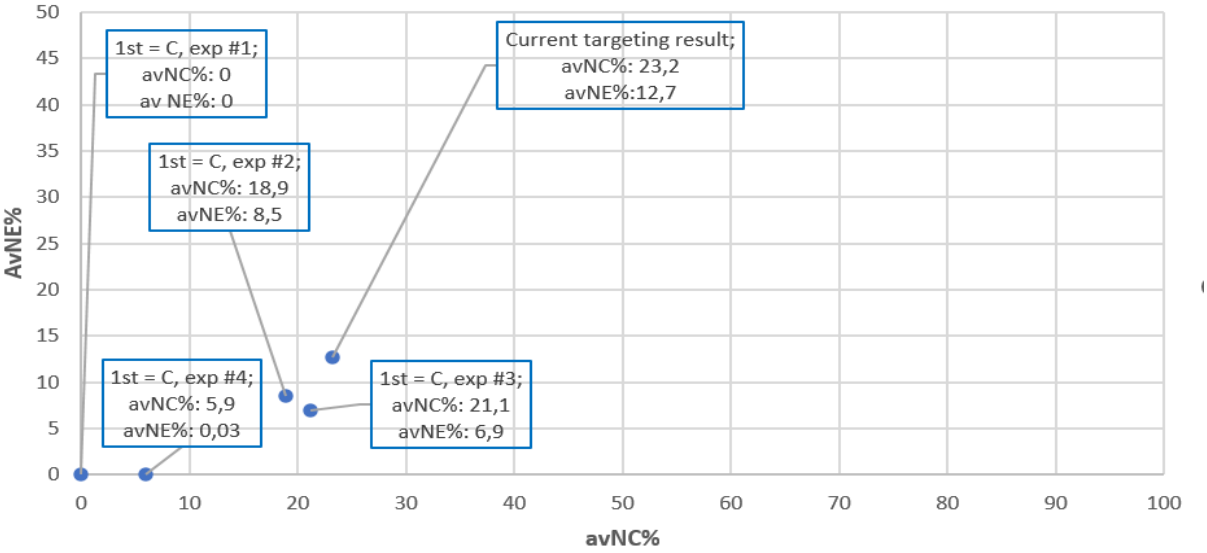
	Cases	**avNC%**			**avNE%**		
	Cases	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
Experience 1	17	0,00	Pulling down	P-value ANOVA: 0,135	0,00	Pulling down	P-value ANOVA: 0,178
Experience 2	17	18,91	Pulling down		44,39	Pushing up	
Experience 3	17	21,12	Pulling down		16,42	Pushing up	
Experience 4	17	5,88	Pulling down		0,59	Pulling down	

Down below the avNC% and avNE% of first and each other experience of the group for which the first inspection experience resulted in a compliant judgement (avNC%=0%) are depicted, in relation to the

current targeting process performance, to illustrate the influence of repeated inspections for this group with regard to the average process performance so far.

FIGURE 16

Graphic representation of separate inspection experiences for the group of which the result of the first inspection experience was compliant (1st=C), compared to current targeting process performance



Logically, the result of a first inspection experience for consignees of this group pulls the process performance down, since every compliant judgement means a result for NC% of 0% and no norm exceedance. Based on the ANOVA test results, experience 2 and 3 of this group of 17 companies pulls process performance down, but selecting consignees for a 2nd and 3rd inspection can be justified because of the average norm exceedance. Targeting for a 4th experience for consignees within this group was much less effective and has a severe negative influence on the targeting process performance. But the P-values do not indicate a statistically significant difference between means for avNC% and avNE%.

8.2.3 1st and other inspection experiences, for group '1st inspection experience = non-compliant'

The group of consignees with a first inspection result being non-compliant and being present in the dataset with 3 or more other experiences contained 7 companies. For 2 or more and 1 or more other experiences for this group, the dataset contained 8 consignees. Therefore, the additional analysis for this group has been done with 7 consignees that are present in the dataset with 3 or more inspection experiences later than 30 days after their first, and experience no. 2 >30 days after the first experience. The approach is the same as for the group for which the result of the first experience was 0%NC. These results are presented in 8.2.2.

TABLE 11

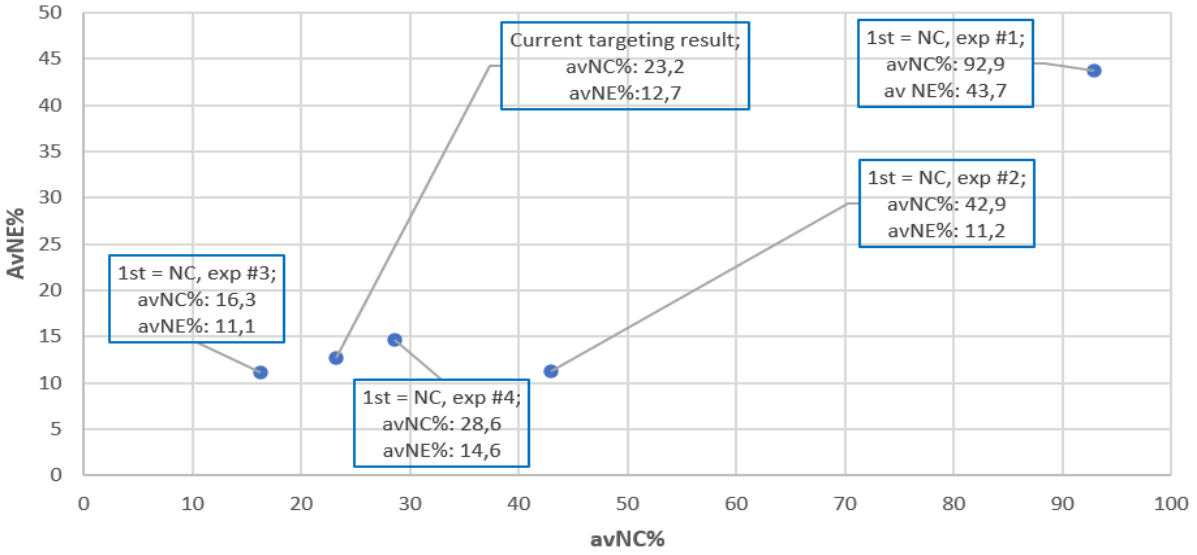
Summarized results of ANOVA test and additional calculations for influence of first inspection experience on individual later inspection experiences >30 days after the first inspection experience present in the dataset with regard to targeting process performance indicators avNC% and avNE%, in case the first inspection result is non-compliant

	Cases	**avNC%**			**avNE%**		
	Cases	Value for avNC%	Effect on process performance	Basis for judgement on effectiveness	Value for avNE%	Effect on process performance	Basis for judgement on effectiveness
Experience 1	7	92,86	Pushing up	P-value ANOVA: 0,012	43,68	Pushing up	P-value ANOVA: 0,156
Experience 2	7	42,86	Pushing up		11,16	Pulling down	
Experience 3	7	16,33	Pulling down		11,06	Pulling down	
Experience 4	7	28,57	Pushing up		14,00	Pushing up	

Down below the avNC% and avNE% of first and each other experience of the group for which the first inspection experience resulted in a non-compliant judgement (avNC%>0%) are depicted, in relation to the

current targeting process performance, to illustrate the influence of repeated inspections for this group with regard to the average process performance so far.

FIGURE 17
Graphic representation of separate inspection experiences for the group of which the result of the first inspection experience was non-compliant (1st=NC), compared to current targeting process performance

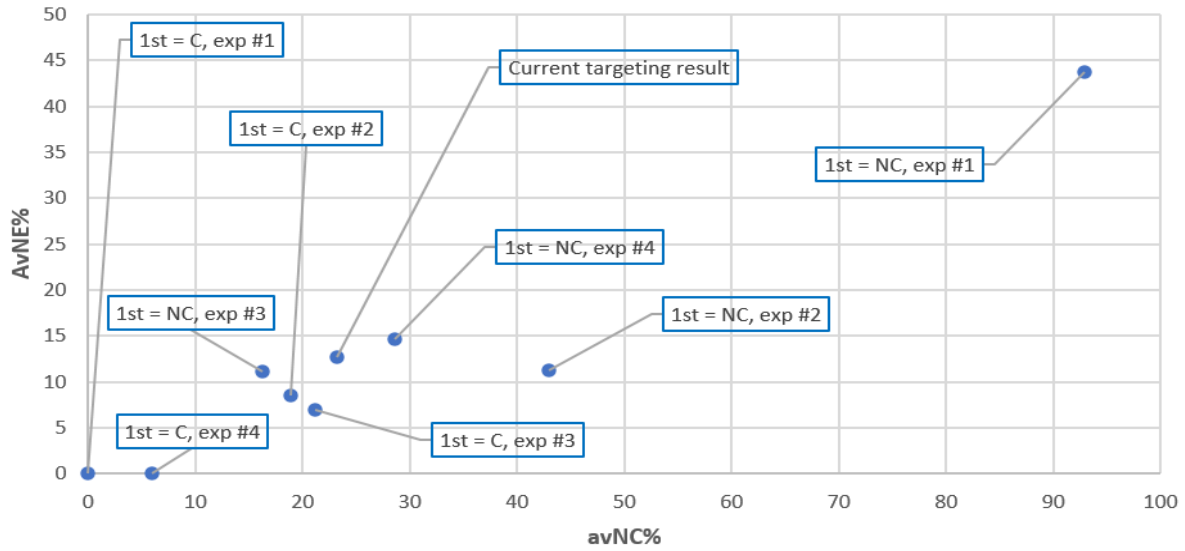


The result of a first inspection experience for consignees of this group pushes the process performance upwards, both for avNC% as for avNE%. Based on the ANOVA test results, experience 2 and 4 of this group of 7 companies have a positive effect on current process performance, but experience number 3, in between of them, pulls process performance down. From process performance point of view, selecting consignees of this group for a 2nd inspection can be relatively easy justified because of avNC% and avNE% for the 2nd inspections. Targeting for a 3rd or 4th experience for consignees within this group is less effective, from targeting process performance point of view. The ANOVA test result indicates only a statistically significant difference in means for the tested groups with regard to avNC% and not regarding avNE%. However, with only 7 consignees evaluated, the test results do not lead to hard conclusions.

8.2.4 Combined results of groups '1st = compliant' and '1st = non-compliant' combined

For the group of consignees (n=17) with a first inspection experience resulting in 0% non-compliance, with obviously 0% norm exceedance as well, the values of avNC% and avNE% of this group for experience 2-4 do not show a 'clean sheet' regarding non-compliance. A first inspection experience with compliant judgement is not always followed by the same result. For the group of consignees (n=7) of which the first inspection experience resulted in a non-compliant judgement due to norm exceedance, the average results of inspection 2-4 show a large pushing effect on process performance on both dimensions avNC% and avNE%. The absolute figures show, that the results of the first group are on average better from compliance perspective, but worse from targeting process performance point of view, than the results of the second group, on both dimensions. However, the positive development of avNC% and avNE% of the group for which the first experience was non-compliant gives more hope for effectiveness of targeting than the negative development on both dimensions with regard to the group of consignees with a compliant judgement on their first inspection experience. The extent to which the results of inspection 1 and 2-4 for both groups contribute to the targeting process performance is depicted below.

Figure 18
Graphic representation of separate inspection experiences for the group of which the result of the first inspection experience was compliant (1st=C) and for the group of which the result of the first inspection experiences was non-compliant (1st=NC), compared to current targeting process performance



After the first inspection, a consignee can be labelled for either the group '1st=Compliant' or '1st=Non-Compliant'. The graph above shows, that after this distinction is made, it is more effective to put efforts into repeatedly inspecting '1st=NC' consignees rather than '1st=C' consignees. And for repeatedly inspecting consignees focussing on a second inspection experience of consignees with a first result being non-compliant is most effective of all depicted 'options'. But for this group, experience no. 4 pushes up the targeting process performance as well, although experience no. 3 pulls it down. Differentiating chances for inspection based on first inspection result enables improvement of targeting process performance, especially if above mentioned considerations with regard to the group '1st=NC' is combined with less attention for repeatedly inspecting shipments of consignees of the group '1st=C', since after a 2nd or 3rd experience for this group, the process performance is likely to increase as well. The contribution of repeatedly selecting shipments of the group '1st=C' is from process performance point of view less beneficial than repeated selections of the group '1st=NC'.

Meaning of research results for re-considering current targeting choices

Currently shipments of consignees with a first inspection result are being selected via risk profiling until three compliant judgements in a row are present in the data before lowering selection chances for their shipments. From targeting process performance point of view, the results presented in this paragraph question whether this targeting choice should be maintained for the group of 'first inspection experience = compliant' because of the negative influence of current policy on targeting process performance. For the group 'first inspection experience = non-compliant' the results of this paragraph provide input for considerations about defining a tipping point for 'replacing' a possible future repeated inspection of such a consignee by using the same control capacity for inspecting a first shipment of an 'unknown' consignee.

8.3 Scenarios for improving targeting process performance by adjusting choices

As a result of the evaluation of current targeting choices as presented in paragraph 7.1 till 7.5 and the identified potential improvement of the targeting process performance by adjusting current choices, underneath several scenarios are presented. Based on the used data for this research, the theoretical impact of each scenario on the dimensions avNC% and avNE% for targeting process performance has been calculated to support decision making with regard to preferred targeting choices. Adjustment 1 is related to the conclusions with regard to customs value/net weight ratios as presented in paragraph 8.1. Adjustments 2 and 3 are based on the results with regard to repeated inspections for consignees as presented in paragraph 8.2. Summarized the scenarios for which calculations have been done in order to quantify potential improvement of targeting process performance are:

Scenario 1: Adjusting [X3] present

Adjustment 1: Targeting for shipments with -100% till -50% deviation from average customs value/net weight ratio for HS-code declared

Scenario 2A: Adjusting [X3] present and repeatedly inspecting consignees with 1st result avNC% > 0%

Adjustment 1: Targeting for shipments with -100% till -50% deviation from average customs value/net weight ratio for HS-code declared, for a first inspection experience

Adjustment 2: For repeatedly inspecting consignees only target for consignees of which the first inspection experience based on adjustment 1 lead to a non-compliant judgement, with sample experience #2-n at least 30 days after experience #

Scenario 2B: Adjusting [X3] present and inspecting consignees with 1st result avNC% > 0% once more

Adjustment 1: Targeting for shipments with -100% till -50% deviation from average customs value/net weight ratio for HS-code declared, for a first inspection experience

Adjustment 2: For inspecting consignees only a second time target for consignees of which the first inspection experience based on adjustment 1 lead to a non-compliant judgement, with sample experience #2 at least 30 days after experience #1

Scenario 3A: Adjusting [X3] present and repeatedly inspecting consignees with 1st result avNC% > 0%, and inspecting consignees with 1st result avNC% = 0% once more

Adjustment 1: Targeting for shipments with -100% till -50% deviation from average customs value/net weight ratio for HS-code declared, for a first inspection experience

Adjustment 2: For repeatedly inspecting consignees target for consignees of which the first inspection experience based on adjustment 1 lead to a non-compliant judgement, with sample experience #2-n at least 30 days after experience #1

Adjustment 3: For inspecting consignees only a second time target for consignees of which the first inspection experience based on adjustment 1 lead to a conform judgement, with sample experience #2-n at least 30 days after experience #1

Scenario 3B: Adjusting [X3] present and inspecting consignees with 1st result avNC% > 0% once more, combined with inspecting consignees with 1st result avNC%=0% once more

Adjustment 1: Targeting for shipments with -100% till -50% deviation from average customs value/net weight ratio for HS-code declared, for a first inspection experience

Adjustment 2: For inspecting consignees a second time target for consignees of which the first inspection experience based on adjustment 1 lead to a non-compliant judgement, with sample experience #2 at least 30 days after experience #1

Adjustment 3: For inspecting consignees a second time target for consignees of which the first inspection experience based on adjustment 1 lead to a conform judgement, with sample experience #2 at least 30 days after experience #1

The calculations for each scenario are presented in the table below, together with the theoretical relative improvement of each scenario for both dimensions avNC% and avNE%.

TABLE 12
Overview of possible scenarios for improving targeting process performance

Targeting choice	# Cases	avNC%	avNE%	Relative improvement for avNC% for scenario	Relative improvement for avNE% for scenario
Targeting process performance before adjustments	1507	23,2%	12,7%	0%	0%
Scenario 1: 1 customs value/net weight ratio < -50% of average for HS-code	474	37,3%	22,0%	+60,8%	+73,2%
Scenario 2A: 1 customs value/net weight ratio < -50% of average 2 repeatedly inspecting the consignees with avNC% first experience > 0%, based on adjustment 1	308	48,4%	28,9%	+108,6%	+127,6%
Scenario 2B: 1 customs value/net weight ratio < -50% of average 2 once more inspecting the consignees with avNC% first experience > 0%, based on adjustment 1	262	47,7%	28,3%	+105,6%	+122,8%
Scenario 3A: 1 customs value/net weight ratio < -50% of average 2 repeatedly inspecting the consignees with avNC% first experience > 0%, based on adjustment 1 3 once more inspecting the consignees with avNC% first experience = 0%, based on adjustment 1	333	44,1%	27,7%	+90,1%	+118,1%
Scenario 3B: 1 customs value/net weight ratio < -50% of average 2 once more inspecting the consignees with avNC% first experience > 0%, based on adjustment 1 3 once more inspecting the consignees with avNC% first experience = 0%, based on adjustment 1	287	43,6%	27,0%	+87,9%	+112,6%

Based on the data used for this research, adjusting the targeting with regard to customs value / net weight ratio from '< average' to '< -50% of average', is considered to be the most dominant factor for improving targeting process performance. Knowing that adjusting to '< -75% of average' would push up targeting process performance even further, but would generate much smaller number of inspections. Furthermore, the differences between scenario 2A, 2B and 3A are relatively small. Any choice between the above presented scenarios 2A, 2B, 3A and 3B should be based on, or input for adjustment of, the law enforcement strategy of the national market surveillance authority responsible for supervision on RoHS.

The main consideration for any choice between these four scenarios is about how many times a consignee should be inspected, based on the result of its first inspection experience. Part of this consideration is that with limited control capacity every additional inspection of a consignee prevents another consignee from being inspected for the first time. Another relevant aspect for a choice between these scenarios is the aspect to what extent repeatedly inspecting shipments of a consignee is expected to influence its compliance performance in a preferred way. Finally, for adjustments based on policy with regard to repeatedly selecting shipments of consignees it is important to realize that the statements for 1st=C consignees are statistically more solid than for 1st=NC consignees, because of the relatively small number of evaluated consignees for the last group: 7 consignees.

9. Vision of domain experts on presented research results

On February 17th 2023, an expert session took place to discuss the research results as presented in chapter 7 and 8 to gather qualitative input for interpreting these quantitative research results. The group of experts present during the session consisted of: the tactical and operational expert of ILT for law enforcement on RoHS, the former risk analyst and profiling expert within Dutch Customs for this law enforcement domain, the former and current responsible persons for coordinating the activities of the laboratory of Dutch Customs for this law enforcement domain and the responsible manager of Dutch Customs with regard to supervision on RoHS via risk-based targeting for declaration-oriented supervision. The following is based on discussions and exchange of knowledge of these experts during the session.

Statistical analysis design

All experts agreed on the fact that the methodological approach of the performed research is innovative and promising, based on the existing need for improving objectiveness of evaluation of targeting choices, as well as the continuous need to enhance targeting process performance to make better use of limited control capacity. They agreed on generic applicability of the approach and the used statistical methods. Based on the presented example for RoHS, the experts experienced the possibility for justifying and/or questioning current targeting choices and substantiated motivation for maintaining or adjusting them. They experienced the scenarios presented in paragraph 8.3 as very valuable input for considerations for changing targeting choices and starting experiments for testing the scenarios in daily practice. In their opinion, the research also contains a few points of attention. Firstly, the limited quantity of the dataset makes statistical analysis in certain respects precarious. Secondly the research focusses on mean values, whereas adding a measure for spread of individual values is seen as a valuable next methodological step. Thirdly, although the experts agree on the fact that for the dimension avNE% using the norm exceedance percentage for lead is the best the researcher could have done to quantify the environmental impact of inspection activities, they agree on the fact that this dimension ideally should be quantified by calculation of total quantity of lead prevented entering the Union market. However, they also stated that current inspection process activities do not make it possible at all to make this step forward for quantification and that using norm exceedance percentage is a valid basis for avNE% from the perspective of judging upon the RoHS-conformity of the production process of inspected products. For the latter, according to the expert of ILT, lower norm exceedance indicates a modernized but polluted production process, whereas higher norm exceedance indicates a traditional production process, without any adjustments for RoHS. All experts agreed on the value of statistically evaluating the contribution of individual targeting choices.

Research part 1: evaluation of used risk indicators

The experts of Dutch Customs stated that the image of nearly no customs declarations of AEO certified consignees in the used dataset meets their expectations, since AEO certified companies prefer to use the possibility of ‘entry in declarant’s records’, which excludes them from declaration-oriented inspections. This means that the used dataset is biased towards declarations of AEO certified consignees, since their declarations by ‘entry in the declarant’s records’ were not offered to the evaluated selection process. Furthermore, for the customs experts the relatively low compliance score of the AEO certified consignee was not surprising, since AEO certification is mainly focused on fiscal aspects and auditing internal procedures for compliance to customs legislation, and not on non-fiscal legislation or product compliance. The compliance performance of the AEO certified consignee begged the question for broader research. With regard to the influence of country of origin on targeting process performance, the experts did not expect the values for both groups to be as close as presented in this research. At first, this led to doubts about whether customs declarations actually contain the right country of origin, given the fact that legal provisions to determine the country of origin are very complex for traders. But on the other hand, the experts of ILT and the laboratory found a possible explanation for the small differences between the two groups of country of origin. They stated that the product components relevant for RoHS inspections are not necessarily connected to the legally correct country of origin as stated in the customs declaration. In addition, based on the large difference between the number of cases for both defined groups for country of origin, the experts pleaded for further investigation, without deciding the way to do this. With regard to the risk indicator used to select shipments with relatively cheap products, the law enforcement domain experts experienced that the statistical analysis confirmed their daily observations.

The experts agreed on usefulness and necessity of testing adjustments, based on this research result.

Research part 2: repeatedly inspecting shipments of consignees

During the expert session, the present experts have indicated that the presented quantitative research results provided them with valuable insights. The expert of ILT stated that the results confirmed his personal observations and the knowledge he has of experiences of other Member States of the Union. At the same time, the research results trigger discussion and considerations with regard to effectiveness of targeting choices and possible adjustments to improve the targeting process performance level.

First of all, the experts were pleased about the fact that the research results gave insights in the difference between the results of first inspection experiences present in the data and later inspection experiences as presented in paragraph 7.5. The law enforcement domain experts gave notice about the fact that they actually hoped for, and counted on, a larger effect of an earlier inspection on later inspections per consignee, than the data actually showed. The question arose, to what extent repeated inspections actually contribute to the aimed effects of the law enforcement intervention strategy. The experts stated that the insights with regard to the groups '1st inspection experience compliant' and '1st inspection experience non-compliant' as provided in paragraph 8.2, are very useful for evaluating the component 'repeated sampling' of the current law enforcement strategy, since both groups have different characteristics that are relevant for considerations regarding their treatment for sampling. Although no clear choices for adjustments were made during the expert session, the expert of ILT and former risk analyst declared that the presented insights are food for thought with regard to adjusting current considerations and defining new priorities with regard to this component of risk-based profiling. The experts stated that the insights are potentially very relevant for considerations with regard to where to draw the line for repeated inspections for both groups '1st compliant' and '1st non-compliant'.

In their opinion, there are also some points of attention with regard to the presented research results for repeated inspections. First, the relatively small number of consignees that fitted the criteria for evaluation effectiveness of repeated inspections caused some reservation about using the research results for 'hard' decisions. Therefore, based on the research results, the experts prefer testing adjustments to the current risk-profiling next to the current approach, instead of replacing the current approach completely. This especially concerns the group of '1st non-compliant' due to the very limited number of consignees: only 7. Secondly, the small number of consignees that fitted the criteria attracted the attention of the experts. With the structural policy of repeated inspections, they actually expected a larger number of consignees that could be evaluated for this part of the research. According to them, one of the possible explanations is that consignees that got confronted with a first inspection experience are able to move their incoming good flow and customs declaration to another Member State of the Union. In that case their shipments become invisible for risk-based declaration-oriented shipment selection by Dutch Customs. The experts find it interesting to use the dataset to investigate if this side effect actually happened in daily practice.

With regard to side effects, during the expert session the expert of ILT shared his knowledge about images of international groups of experts about non-compliance results. According to him, based on his years of experience with supervision on RoHS, production processes are not as stable as is desired. He confirmed the image of this research that a first compliant test result does not guarantee future compliance at all, and that a non-compliant inspection result does not automatically lead to future compliance of actors. According to the experts, producers could count on the fact that due to limited control capacity for law enforcement after an inspection of a shipment their next future shipments are not likely to be inspected. But more likely, the expert of ILT explained that producers in particular countries do not control their production processes in the way and on the level as is expected and required for consistent compliance.

Regarding measuring the effectiveness of law enforcement for RoHS with risk-based targeting by Dutch Customs, the expert of ILT stated that shipment selections of Dutch Customs have not led to any other or additional law enforcement related interventions of ILT. Based on this, in the eyes of the experts, possible interference of other law enforcement activities on the presented research results does not apply.

10. Contribution for research and practice

Contribution for research

Firstly, in line with observations of Winter and De Ridder (2010), this research evaluates effectiveness of a part of the supervision process on RoHS, measured along two dimensions for insights on the extent to which appliance of risk-based profiling leads to the achievement of the objectives of the targeting process, as basis for inspection activities. This research makes use of the observation of Winter and De Ridder (2010) that a possible starting point of effectiveness research can be applying legal rules that are violated by behaviour. Furthermore, this research operationalizes the recommendations of Winter and De Ridder (2010) with regard to transforming vaguely formulated objectives into measurable goals and to start with a simple research design for conducting effectiveness research for supervisors that are not (yet) experienced with it, to make first statements about effectiveness of their supervision activities. In addition, this research combines lessons learned from effectiveness research, with appliance of the guidelines of Van Mourik *et al* (2007), operationalized by defining targeting process-oriented models, and statistical testing effectiveness modelled targeting choices for supervision purposes, based on principles of Lean Six Sigma philosophy. With this multi-disciplinary approach, suitable indicators for universal and widely applicable evaluating effectiveness of targeting choices have been defined and evaluated. Based on statistical analysis, statements are made about the effectiveness of targeting choices related to law enforcement activities, for both risk indicators as repeated inspections policy.

Contribution for practice

The programmatic law enforcement philosophy aims for defining and executing law enforcement interventions best suitable for maintaining good compliance behaviour and reduce chance and/or impact of bad compliance behaviour of distinguished target groups. This research provides a general methodological approach and case-related input for considerations with regard to step 1 of this cyclical philosophy: risk analysis. This step aims for motivating and defining general priorities for law enforcement activities in a structured way, via defining target groups that have the most negative effect on aimed compliance level. And although this research does not pinpoint compliance and violation motives of target groups, it does provide a general methodological approach and case-related input for reconsidering a part of the intervention strategy for RoHS, which is the other part of step 2 of this philosophy. With regard to step 4 of the philosophy, this research is an example of measuring effectiveness (evaluation) of the executed law enforcement strategy from targeting process performance point of view, to test if assumptions for compliance interventions were valid. For law enforcement agencies, appliance of risk management is not only legally obliged but also necessary in daily practice for optimal allocation of scarce resources. By adding the 'impact of violations' dimension, measured as avNE%, to the up till now by Dutch Customs only evaluated 'chance of violation' dimension, measured as avNC%, this research provides a methodological enrichment of the current evaluation process for targeting process performance of Dutch Customs. In addition, the executed statistical analysis design of this research provides relevant insights for Dutch Customs to make an important step forward in more objectively justifying targeting choices and with that avoid or at least reduce (perceived appearance of) arbitrariness in risk-profiling. Derived from this, applying statistical analysis for targeting choices can facilitate external imaging around integrity of inspection agencies and their employees. And it could contribute to smarter law enforcement in combination with smooth logistics, based on advanced data analysis and auto detection by transforming into a more data-driven organization, as aimed for by Dutch Customs. Finally, periodically statistical evaluation of targeting choices can contribute to reducing the number of 'false positives' and 'false negatives' in shipment selections, to improve compliance management level of Dutch Customs, by structural attention for improving targeting process performance. This contributes to applying principles of responsive regulation and enforcement vision of Dutch Customs.

11. Conclusions & recommendations

11.1 Conclusions

The main question for this research is stated as: *"What is the effectiveness of current targeting choices in risk-based targeting for inspections related to supervision on the RoHS Directive and how can adjusting them lead to improvement of the effectiveness?"* To answer this question, three sub questions have been formulated and answered within this research report. The statistical analysis design of chapter 4 is derived from the literature research, with which the first sub question is answered: *"How can the effectiveness of targeting choices be evaluated, using available knowledge on measuring process performance and effectiveness of supervision activities by statistical testing?"* With regard to the second sub question, Chapter 7 provides the research results for evaluating the targeting choices with regard to effectiveness of used risk indicators and effectiveness of repeatedly inspecting shipments of consignees, from targeting process performance point of view. These results are the answers to the second research question: *"To what extent are current targeting choices for risk profiling for law enforcement on the RoHS Directive effective?"* The research results of chapter 8, and especially the scenarios of paragraph 8.3, provide the answer to sub question 3: *How can adjusting the current targeting choices lead to improvement of the effectiveness of the targeting process?*

The conclusions with regard to these three sub questions are presented below. Derived from these conclusions, and based on the scenarios presented in paragraph 8.3, for answering the third sub question paragraph 11.2 also contains argued recommendations. Calculations based on the used dataset suggest that applying these recommendations will lead to improvement of targeting process performance. To interpret the research results correctly and in order to correctly valuate the recommendations, the boundary conditions, as discussed after the following conclusions, should be taken into consideration.

Sub question 1: "How can the effectiveness of targeting choices be evaluated, using available knowledge on measuring process performance and effectiveness of supervision activities by statistical testing?"
Ideally, in order to meet expectations about desired output, any targeting process has to deliver a number of inspections in line with the planned number of inspections and within that range the targeting choices should lead to a high chance of detecting non-compliance and detecting high norm exceedance. For translating the desired output of a targeting process into measurable output variables to evaluate effectiveness of targeting choices, two Key Process Indicators (KPI's) can be defined: one for likelihood of non-compliance (avNC%) and one for norm exceedance (avNE%).

These KPI's can be used to evaluate the effectiveness of targeting choices, by performing ANOVA tests to compare means of groups, which are distinguished by one targeting choice (presence versus absence of a risk factor) at the time. A statistically significant difference between the groups 'risk factor present' and 'risk factor absent', measured along the output dimensions avNC% and avNE%, can be a powerful tool to determine the effectiveness of individual targeting choices, based on their effect on targeting process performance. In addition, for metric values, the statistical technique Correlation and Regression can provide valuable insights with regard to predictive connectivity between targeting choices and targeting process performance.

Sub question 2: "To what extent are current targeting choices for risk profiling for law enforcement on the RoHS Directive effective?"

<u>Research part 1: evaluation of effectiveness of used risk indicators for targeting process performance</u>
For this research, risk indicator '[X1] present' means that the consignee is AEO-certified. Based on the ANOVA test, the group of cases for which risk indicator [X1] is present in the data has a statistically significant higher average value for both avNC% as for avNE%. Theoretically, from targeting process performance point of view, the current targeting choice of using both '[X1] present' as '[X1] absent' for risk profiling gives a better result than only using '[X1] absent', which is the only reasonable alternative. However, based on the extreme difference in size between the two tested groups and with only 36 cases

for group '[X1] present', all related to one of 246 inspected consignees, no hard conclusions can be drawn for any relationship between presence of [X1] and average non-compliance and norm exceedance levels. Another reason for this is, as concluded in chapter 9, that the used dataset is biased towards AEO certified consignees, because AEO certified companies prefer to use 'entry into the declarant's records' for their import declarations, causing these declarations not to be offered to the evaluated selection process.

Risk indicator '[X2] present' means that the Country of Origin perceived to be of highest risk is present in the customs declaration for release for free circulation selected for inspection for compliance to RoHS. Based on the ANOVA test, the group of cases for which risk indicator [X2] is present in the data has no statistically significant higher average value for avNC%, nor for avNE%. Theoretically, from targeting process performance point of view, the targeting choice of using [X2] present for focus in risk profiling did not lead to statistically significant better results than inspected shipments for which [X2] was absent. However, based on the extreme difference in size between the two tested groups, with only 35 cases for group '[X2] absent', no hard conclusions can be drawn for any (lack of) relationship between absence of [X2] and average non-compliance and average norm exceedance levels. Therefore, selecting shipments for which [X2] is absent is needed to evaluate their contribution to the targeting process performance.

Risk indicator '[X3] present' means that the customs value/net weight ratio of an individual declaration for release for free circulation is below the average customs value/net weight ratio of the HS-code used. Based on the initial ANOVA test, the group of cases for which risk indicator [X3] is present in the data has a statistically significant higher average value for avNC% and for avNE%. Therefore, from targeting process performance point of view, the targeting choice of using '[X3] present' for focus in risk profiling led to significant better results than inspected shipments for which [X3] was absent.

Research part 2: evaluation of effectiveness of repeated inspections for targeting process performance
Regarding the effectiveness of repeatedly selecting shipments of individual consignees, the following can be said, based on the analysis of 83 consignees with 3 or more inspection experiences more than 30 days after their first, and with a second inspection experience later than 30 days after their first one. Although the values for avNC% and avNE% for these 83 consignees are both lower for 'later experiences' than for their 'first experiences', there is no statistically significant difference between the means of these two groups of inspection experiences. In general, effectiveness of repeated inspections for consignees with the aim to improve the average compliance of the total sample population can be questioned, since the aimed effect of improvement of compliance of all consignees together is not present in the analysed data.

From the angle of targeting process performance, repeatedly inspection shipments of consignees can be justified. Based on the analysis of inspected shipments of 17 consignees, the fact that the judgement of their first inspection experience being compliant does not guarantee compliance of future shipments. On the contrary: there is a statistically significant difference between the values for avNC% and avNE% of first and later experiences of this group, meaning a statistically significant decrease in compliance after the first inspection experience. Furthermore, the statistical analysis of shipments of 7 consignees with a first inspection experience that led to a value for avNC% higher than 0% show statistically significant lower values for both avNC% and avNE% for later inspection experiences compared to the first experience, but not lower than these values of later inspection experiences of the group of which the first one was compliant. And the average values for avNC% and avNE% for the second inspection for consignees of this group pushes up current targeting process performance.

Sub question 3: How can adjusting the current targeting choices lead to improvement of the effectiveness of the targeting process?

Research part 1: improvement effectiveness of targeting choices regarding customs value/weight ratio
Applying the results of the analysis for adjusting the use of this risk indicator is expected to facilitate improvement of targeting process performance, by focussing future targeting on shipments with lower customs value/net weight ratios than the currently used ratio of lower than average for the HS-code used in the customs declaration. Based on the presented scenarios, this adjustment is likely to support improvement of the targeting process performance on both dimensions avNC% and avNE%, compared to

results so far. The recommended scenario as discussed in paragraph 11.2 contains an strong advice for adjusting the usage of this risk indicator in order to achieve a better targeting process performance.

Research part 2: improvement effectiveness of targeting choices with regard to repeated inspections
Using the results of the analysis for each of the two groups of consignees '1st inspection result = compliant' and '1st inspection result = non-compliant' for adjusting targeting choices with regard to repeated inspections can contribute to improvement of targeting process performance, via focussing future targeting on shipments that meet the criteria that are determined to contribute to higher levels of avNC% and avNE% than is achieved with the targeting choices so far. However, the statistical power of these conclusions with regard to evaluation of effectiveness of repeated inspections are limited due to the relatively small number of companies that could be analysed for both defined groups. Together both groups represent 24 of 246 inspected consignees, but the group 'first inspection experience = non-compliant' contained only seven consignees. The recommended scenario as discussed in paragraph 11.2 contains considerations regarding adjusting current targeting choices related to repeated inspections.

Boundary conditions for conclusions to hold
As announced in chapter 2, the research results and conclusions of this research are based on the import declarations filed in Dutch Customs declaration system AGS Invoer, being lodged within the period 1 January 2017 and 30 June 2022, of which samples relevant for supervision on the RoHS Directive have been inspected for exceeding norms for usage of lead, after selection shipments with risk-based profiling.

Therefore the research results, conclusions and recommendations presented in this report only hold for import declarations filed in AGS Invoer, with HS-codes present in the dataset used for the analysis, for shipments above 250 kilograms that are addressed to consignees situated in the Netherlands, of which products have been inspected by the laboratory of Dutch Customs, for norm exceedance for lead, after selecting shipments for inspection by appliance of risk profiles of Dutch Customs for law enforcement on RoHS. The research results explicitly do not hold for customs declarations in courier declaration processes of Dutch Customs, nor for shipments declared by 'Entry in Declarant's Records' of Dutch consignees, nor for products tested for conformity with other laws and regulations than the RoHS Directive, nor for products tested by the laboratory of Dutch Customs for other substances than lead.

For interpreting the research results, and setting up experiments based on the presented research results and derived scenarios for improving targeting process performance, it is important to take into consideration the results of the ANOVA tests for homogeneity of the used dataset. Most importantly, it should be realized that the dataset contains considerably unequally numbers of cases for the different HS-codes present in the dataset, with partly very large differences in number of cases between individual HS-codes. For testing adjustments to targeting choices based on the research results and recommendations, this matter can cause practical results to differ from the theoretical potential of possible adjustments. Therefore, caution and accurate real-time monitoring is advised to ensure that adjustments are effective.

11.2 Recommendations

Recommended scenario for improving targeting process performance for RoHS inspections
The current targeting process performance for avNC% is 23,2% and for avNE% is 12,7%. The analyses for risk indicator [X3] and with regard to repeated selection of shipments of consignees resulted in scenarios for improving the targeting process performance.

The adjustments in targeting choices for risk indicator [X3], leading to alternative scenario 1, are expected to lead to a substantial increase in targeting process performance. The calculated values for avNC% of this scenario are 37,3% and for avNE% 22,0%. Combining the adjustment of usage of risk indicator [X3] with one of the presented adjustments regarding repeated inspections, theoretically should lead to a further increase of targeting process performance. The different scenarios 2A, 2B, 3A and 3B, all related to adjusting choices with regard to repeated selection of shipments of consignees, have in common that the calculated values for avNC% and avNE% of these scenarios are lying close together. For avNC% the range of the different scenarios is roughly 5% and for avNE% the range is roughly 3%. Every single one of these scenarios theoretically leads to an increase of the targeting process performance for avNC% of nearly 88%

and for avNE% of more than 112%.

The difference between scenario's 2A, 2B, 3A and 3B lies in the frequency of repeated shipment selection for consignees of which a first inspection result was non-compliant and the fact whether or not a compliant judgement of the first inspection experience should lead to a second inspection. Since these differences from the view of targeting process performance are relatively small, one other argument can and should be considered. The responsible inspectorate ILT, as well as Dutch Customs, have only limited control capacity available for law enforcement on the RoHS Directive. Repeatedly selecting shipments of 'known' consignees rules out selecting shipments of 'unknown' consignees with the same limited control capacity. With the available control capacity, it is not only desired to achieve compliance by repeated stimuli, if necessary, but also through a first stimulus leading to a positive 'jump' in compliance level and/or norm exceedance. The group of 7 consignees with a first inspection experience being non-compliant, on average, showed remarkably better performance on both avNC% as well as avNE% after their first inspection experience, but on average a smaller improvement after the second experience. In addition, selecting shipment 2, 3 and 4 of consignees for which the first inspection experience resulted in a conform judgment, and the 2nd, 3rd and 4th inspection experience was not within 30 days after the 1st inspection experience, contributed less to targeting process performance than a 2nd, 3rd or 4th inspection experience of the group for which the first inspection experience was non-compliant. In addition, the expert session provided relevant input for selecting consignees with a first experiences being non-compliant for later inspections. Norm exceedance percentage of first inspection experiences, can shed light on whether a production process indicates to be 'polluted' or to be kept 'traditional' after the RoHS Directive became applicable. The latter category causes larger norm exceedance: a better chance for pushing up avNE%.

For the former reasons, it should be considered to use the available inspection capacity for broadening the number of inspected consignees by focussing more on providing 'uninspected' consignees a first behavioural stimulus instead of the current focus on generating repeated stimuli for already inspected consignees. The research results show that it can be objectively justified to limit repeated selections to 1 time for both groups of '1st inspection = compliant' and '1st inspection = non-compliant' actors to 'make room' for other consignees. For the first group because of the negative influence of any repeated inspections on targeting process performance. And for the second group because of the relatively large average positive compliance effect of a second inspection compared to a third and fourth inspection, as well as for a relative smaller positive effect of a third and fourth inspection on targeting process performance compared to a second one. Furthermore, for repeatedly inspecting consignees of the group '1st inspection = non-compliant' the norm exceedance could be taken into account: only select a second time if the norm exceedance of the first inspection experience was severe e.g. relatively high, indicating a traditional production process instead of a polluted production process. And selecting any second shipment at least 30 days after the first experience is recommended, to give the first behavioural stimulus a serious chance. For the former reasoning, for increasing effectiveness of targeting for supervision on RoHS, at least scenario 1 should be implemented, and experimenting with scenario 3B is recommended. For the latter, using relative high norm exceedance percentages for '1st = non-compliant' is important.

Finally, although outside of scope for this research, from targeting process performance point of view, the following recommendation is made. Current targeting is focussed on maintaining good compliance behaviour of consignees and initiate positive compliance change of consignees with a bad track record. However, in fact the production processes of producers determine (non-) compliance of inspected products. It could very well be, that willing consignees have only limited power to actually achieve structural compliance of production processes of their suppliers and/or the stimulus of (consequences of) current incidental inspection is not severe enough for suppliers to change their compliance behaviour. Instead of, or in addition to, focussing targeting partly on consignees, targeting process performance could benefit from paying attention to producers of imported products for risk-profiling purposes as well.

Further research on usage of data analysis for improving targeting process performance

Currently, the evaluation of effectiveness of the targeting process is done based on the achievement of planned number of inspections, combined with non-compliant percentage based on inspection results.

The performed research provided interesting insights with regard to adding the dimension of norm exceedance to the evaluation process, and measure, evaluate and adjust targeting choices along two qualitative dimensions, from point of view of targeting process performance: likelihood of non-compliance and extent of exceedance of norms. Domain experts for supervision on RoHS confirmed that the insights of the applied statistical analysis design are valuable for evaluating effectiveness of targeting choices. Therefore, it is recommended to further analyse the more structural usage of data analysis for improving effectiveness of targeting, by using the applied approach of targeting process performance.

Other recommendations with regard to current supervision on RoHS

The current targeting is aiming for selecting shipments meant to be brought on the Union market within the Netherlands. The dataset used for analysis contained not only data of consignees situated in the Netherlands and not only shipments destined for the Netherlands. To achieve a better match with the current targeting priorities of principal ILT, the targeting of Dutch Customs should contain both parameters 'shipments destined for the Netherlands' as well as 'consignee being situated in the Netherlands', instead of only the latter as is currently the case.

Within the Netherlands, for RoHS the national market authority ILT acts as principal for Dutch Customs, with its risk indicators and priorities for supervision. One of these priorities is the national interests of ILT with regard to supervision and stimulating compliance of consignees. This national interest directly affects shipment selections in such a way, that goods declared for release for free circulation with destinations outside The Netherlands receive far less attention than declarations for goods meant for the Netherlands. Supervision activities of ILT should be shifted towards mitigating risks for the whole Union market, based on responsibilities, instead of using geographical and organizational motives for targeting choices.

The current inspections to mitigate risks regarding Union border crossing goods that have to comply to the RoHS legislation and are meant to be placed on the market, is fully focussed on import declarations in AGS Invoer. However, the declaration systems for courier shipments also contains goods relevant for supervision. And consignees declaring their goods with monthly Automated Periodical Declarations (APD, in Dutch: Geautomatiseerde Periodieke Aangifte) stay out of sight with the current law enforcement focus. Goods declared by APD and by courier declarations should be made subject of supervision as well.

With the relatively high 'hit rate' of the inspection activities for law enforcement on the RoHS Directive so far, compared to other law enforcement domains, and the volume of goods that needs to be supervised, the limited capacity for supervising all relevant goods should be used to create maximum possible impact. Although any increase in capacity for supervision on RoHS would not take away the experienced capacity and compliance problem, a substantial increase in capacity should be considered, in order to facilitate a better return on law enforcement efforts made. Continuing supervision without increasing the capacity can be seen as an expression of risk appetite of responsible inspection agencies. Especially when potential extra capacity can be used in a more effective way, for example by using the outcomes of this research to increase the targeting process performance.

As for a lot of other law enforcement domains, current supervision on the RoHS directive fully focusses on (non-) compliance. Until presenting the research results in this report, the dimension of norm exceedance as relevant output for targeting process performance has not been in the picture for targeting choices. For effectiveness of targeting, it is highly recommended to take this impact dimension into consideration.

Until now, the risk-oriented profiling for RoHS enforcement has been characterized by cycles of temporarily active profiles per product group, with which the annual agreed number of inspections are achieved with only a few product groups. This temporary activation of profiles is based on the annually changing priorities of the ILT with regard to product groups. With the insights from this research, it is recommended to consider adjusting this working method, for example with an experiment in which risk profiles are kept active for a wide range of product groups on a structural basis, but with a strongly increased priority in the risk selection with regard to products with relatively (extremely) low customs value per kilogram. Provided that this is properly adjusted, this can go well within the agreed control

numbers with some additional annual priorities and is expected to lead to better process performance.

Yearly for each law enforcement domain and each process within it, a number of inspections is assigned to execute the supervision. With this limited number of inspections assigned for RoHS, together with the non-compliance and norm exceedance and costs per inspection, it is vital to prevent taking more samples of shipments than absolutely necessary. This is a facilitating factor for widening the range of consignees that can be inspected with the available analysing/control capacity. At the same time, it is important that samples taken from a certain shipment represent the whole shipment, to prevent that consignees can successfully claim the absence of this representativeness in case of a non-compliant judgment, and actual non-homogeneous shipments are treated as if they were homogeneous in case of a compliant judgement. However, this is not easy. From the outside, it cannot be determined whether goods are homogeneous. This complex matter asks for internal guidelines with regard to taking samples from selected shipments for supervision on the RoHS Directive.

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Appendices

Appendix 1 - Creating the dataset of inspected samples for statistical analysis

1. Primary basis for creating dataset used for the statistical analysis

The basis for the data used for performing the data analysis for the results presented in this thesis report is the combination of information from the following datasets, linked via the customs declaration number that is mentioned in both datasets:

[1] Internal registries of the laboratory of Dutch Customs about the outcomes of inspections for law enforcement, extracted from the software LIMS, that is used within the laboratory for administering the lab analysis results, providing a judgment on (non) compliance of inspected samples and the exceedance of norms of the RoHS Directive in case of non-compliance;

[2] All information provided by the submitter of customs declarations for release for free circulation in the Dutch import declaration system AGS Invoer of inspected shipments for law enforcement on the RoHS Directive and the additional information this computerized customs declaration system provides about these particular lodged customs declarations

2. Merge data of internal registries and customs declaration data into one dataset

2.1 Relevant content Internal registries of laboratory of Dutch Customs

The received dataset about inspected shipments, based on the internal registries of the laboratory of Dutch Customs, contained the following information, that was used to create the dataset for the performed statistical analysis, of which the results are presented in this thesis report:

Data element	Example of data element	Explanation data element
Customs declaration ID	17NLJ03UTQAT57WD50	Reference number of the customs declaration for release for free circulation, as provided by AGS Invoer
Inspection ID (PLATO)	1528169-02	Internal reference number of the internal order to take a sample from a selected customs declaration
Customs Laboratory ID (LIMS)	U-02944-17	Internal reference number of the laboratory of Dutch Customs to identify the inspected sample product
ILT case ID (HOLMES)	145134	Internal reference number of Dutch market authority ILT for handling shipments judged to be non-compliant
sample date	16-3-2017	Date the sample was physically taken from the inspected shipment in order to be analysed by the lab
Sample name	Princess Tower Fan	Short description of the sample, based on the visual perception of the lab technician handling the sample
Commodity code declared	8414510090	Commodity code under which the sampled product has been declared in the declaration for free circulation
Sample handling code	93	Internal code for requested type of laboratory analysis of the provided sample. 93 Stands for RoHS analysis
Violation code	93	Internal code for exceedance of relevant norms, tested by the laboratory. 93 Stands for non-compliance to RoHS

The received dataset about measurement results, based on the internal registries of the laboratory of Dutch Customs, contained, amongst other things, the following information, that was added to the dataset mentioned under sub paragraph 2.1.1 to create the dataset for the performed statistical analysis, of which the results are presented in this thesis report:

Data element	Example of data element	Explanation data element
Customs Laboratory ID (LIMS)	U-02944-17	Internal reference number of the laboratory of Dutch Customs to identify the inspected sample product
Measurement result [%]	61.9	Measured value of heavy metal in the inspected sample, of which the usage is restricted via the RoHS Directive

Action 1: merging data internal registry about inspected samples and registered measurement results

Linking the measurement values to the particular samples was done using the laboratory ID number.

2.2 Content Import declarations related to inspected samples for law enforcement on RoHS

The information provided by the submitter of customs declarations for release for free circulation in the Dutch import declaration system AGS Invoer regarding inspected shipments for law enforcement on the RoHS Directive, contains, among other things, the following information used for the dataset for analysis:

Data element	Example of data element	Explanation data element
Customs import declaration ID	17NLJ03UTQAT57WD50	Reference number of the customs declaration for release for free circulation, as provided by AGS Invoer
Declaration acceptance date	28-4-2017	Date on which the customs declaration for release for free circulation was accepted for receipt by AGS Invoer
Country of origin	TW	Declared country of origin of the goods, based on rules applying to (assembling) components and production
Shipping country	HK	Declared country of shipping the goods, being the last third country before entering the Territory of the Union
Country of destination	NL	Declared country of destination, being the intended country to deliver the goods
Commodity code	8414510090	European HS code applicable for correctly classifying declared goods as mentioned in the import declaration
Goods description	Electric Fan	Common trade name and/or textual remarks relevant to identify the type and composition of declared goods
Net weight	1500	Net weight of declared goods
Former customs procedure	00	Customs procedure that was applicable for the goods until the moment of the lodged customs declaration
Requested customs procedure	40	Customs procedure that is requested for the goods at the moment of lodging the customs declaration
Delivery conditions	CIF	Conditions for delivery of goods, based on the incoterms and the place mentioned for the goods to be delivered
Invoice value of the goods	1500 USD	The value of the goods, as declared to be stated on the commercial invoice belonging to the declared goods
Customs value of the goods	1435 EUR	The calculated customs value of the goods, based on the invoice value in Euros and the declared incoterm
Submitter import declaration	ABC Customs Matters	Name, identification number, address, zip code, place and country of submitter of the customs declaration
Principal import declaration	Fan Discounter B.V.	Name, identification number, address, zip code, place and country of principal of the customs declaration
Representative customs decl.	ABC Customs Matters	Name, identification number, address, zip code, place and country of representative of customs declaration
Debtor import declaration	Fan Discounter B.V.	Name, identification number, address, zip code, place and country of debtor of the customs declaration
Consignee of declared goods	Fan Discounter B.V.	Name, identification number, address, zip code, place and country of consignee of the customs declaration
Consignor of declared goods	Fan shop Ltd.	Name, identification number, address, zip code, place and country of consignor of the customs declaration
Buyer of declared goods	Fan Discounter B.V.	Name, identification number, address, zip code, place and country of buyer of the customs declaration
Seller of declared goods	Fan shop Ltd.	Name, identification number, address, zip code, place and country of seller of the customs declaration
Risk profile ID number	H1234567	Risk profile that was triggered by the lodged customs declaration, and was the basis for inspection activities
PLATO ID number	123456-01	Internal reference number of the internal order to take a sample from a selected customs declaration

For connecting the information from the import declaration to the internal registry of inspected samples, the information belonging to the customs declaration numbers of the internal registry of the Dutch customs laboratory has been collected, with an internal query request for the relevant data from AGS Invoer. From the received data, only data lines with a risk profile number for RoHS inspections were used.

Action 2: Merging data internal registry about inspections with import declaration data of AGS Invoer

Connecting data of the internal registry to the import declaration data was done by using the first 18 digits of the import declaration as primary key.

3. Additions to the data, needed for further preparation of the data to perform the analysis

3.1 Relevant content AEO registry data for the dataset about inspected samples

The information received as the result of an internal request for information about AEO certificates per company, contains, among other things, the following information used for additions to the dataset:

Data element	Example of data element	Explanation data element
EORI number	NL123456789	Identification number of a company, used for customs matters within the Territory of the Union
AEO certificate type	AEOC	Coding for the type of certificate: AEO Customs (AEOC), AEO Safety & Security (AEOS) or AEO Full (AEOF), which means a certificate that covers both AEOC and AEOS
AEO certificate start date	10-10-2017	Date from which the company, identified with the EORI number, was AEO certified
AEO certificate end date	31-12-9999	Date until which the company, identified with the EORI number, was AEO certified

Action 3: Adding relevant data from query AEO registry data to dataset about inspected samples for RoHS

Connecting data of the query on AEO registry data to the dataset about inspected samples for RoHS was done by using the EORI number of consignees, as mentioned in the AGS Invoer data, as primary key. Separately, the same connection was made for the relevant data for submitters of declaration.

3.2 Relevant content average customs value per HS code for the dataset about inspected samples

The basis for evaluating the effectiveness of current risk-based profiling are the inspection results about (non) compliance to the RoHS Directive, for which a customs declaration for 'release for free circulation' was submitted in the customs declaration system for import declarations of the Netherlands, called AGS. The result is, that for every inspected sample the declared commodity code is known. For each commodity code, data of the researched period has been collected with a data query of the AGS declaration system, providing, amongst other things, the following information per AGS declaration (line):

Data element	Example of data element	Explanation data element
Customs import declaration ID	17NLJ03UTQAT57WD50	Reference number of the customs declaration for release for free circulation, as provided by AGS Invoer
Declaration acceptance date	28-4-2017	Date on which the customs declaration for release for free circulation was accepted for receipt by AGS Invoer
Commodity code	8414510090	HS code as declared for the sampled goods, mentioned in the customs declaration for release for free circulation
Customs value	1435	Customs value based on the invoice value declared in the customs declaration for release for free circulation and appliance of rules about cost additions and subtractions related to used incoterms for delivery
Net weight	1500	Net weight of the shipment of the sampled goods, as declared in the customs declaration mentioned in kgs
Country of destination	NL	Declared country of destination, being the intended country to deliver the goods

With the calculated customs value, based on the declared invoice value and the incoterm used, and the net as declared, the average customs value per kilogram net weight is being calculated for each HS code present in the data of the internal registry on inspected samples. Since trade developments can affect this value, this average value per commodity code has been calculated per year, using the acceptance date of the declaration. Furthermore, two filters filter for this value have been used for only calculating this value by selecting data lines with declared country of destination 'NL' and a shipment size above the threshold.

Action 4: Adding relevant data from queries per HS code to dataset about inspected samples for RoHS

Connecting the average value per kilogram net weight to the dataset about inspected samples for RoHS was done by matching the commodity code as declared in a certain year with a table containing the average customs value per kilogram net weight per commodity code per year.

4. Additions to the data set, further preparation to perform the analysis

4.1 Additions to the dataset, needed for [Y1]: (non-) compliance judgement

4.1.1 Addition: (non-) compliance label

In this research, [Y1] is about the compliance of inspected samples, which can be expressed as:

- 'compliant' if used substances do not exceed the norms of the RoHS Directive and
- 'non-compliant' if the used substances exceed the norms of the RoHS Directive

For generating the above mentioned 'labels' in the data, the data about 'inspection violation code' was the starting point. If this column contains code '93', it means that the sample was not compliant to the norms of the RoHS Directive. The presence and absence of code 93 has been used to label the data on row level. If code 93 was present, label 'non-compliant' was added to the data. The absence of code 93 lead to the addition of the label 'compliant'. For short overview, additions made are shown in the table below.

Basis for addition	Trigger	Addition to the data
Presence/absence of code 93 in column 'inspection violation code'	Absence of code 93	Label 'compliant' in column 'inspection result – compliance judgement'
	Presence of code 93	Label 'non-compliant' in column 'inspection result – compliance judgement'

4.1.2 Addition: (non-) compliance percentage

In this research, [Y1] is about the compliance of inspected samples, which can be expressed as:

- compliance score of 100% if used substances do not exceed the norms of the RoHS Directive and
- compliance score of 0% if the used substances exceed the norms of the RoHS Directive

For generating the above mentioned compliance scores in the data, the data about 'inspection violation code' was the starting point. If this column contains code '93', it means that the sample was not compliant to the norms of the RoHS Directive. The presence and absence of code 93 has been used to label the data on row level. If 93 was present, compliance score '0%' was added to the data. The absence of code 93 lead to addition of compliance score '100%'. For short overview, additions made are shown in the table below.

Basis for addition	Trigger	Addition to the data
Presence/absence of code 93 in column 'inspection violation code'	Absence of code 93	Compliance score '100%' in column 'inspection result – compliance percentage'
	Presence of code 93	Compliance score '100%' in column 'inspection result – compliance percentage'

4.2 Addition to the dataset, needed for [Y2]: absolute percentage exceedance of norms

In this research, [Y2] is about the norm exceedance of inspected samples, which can be expressed as the measured percentage of regulated substances present minus the norm for the substance stated in the RoHS Directive.

For generating the percentage norm exceedance, the data about 'Measurement result (%)' was the starting point. If a number was present in this column, the inspected sample exceeded the RoHS norm. The relevant norm was added in a separate column. In the original data of the registry of the laboratory, the measurement result was stated with a dot, instead of a comma. This has been corrected in a separate column, in order to be able to calculate the above-mentioned exceedance of the norm. For short overview, additions made are shown in the table below.

Basis for addition	Trigger	Addition to the data

Presence/absence measured value in column 'Measurement result (%)'	Absence of measurement value	No calculation of exceedance of norm in column 'exceedance of compliance norm'
	Presence of measurement value	Calculation of exceedance of norm in column 'exceedance of compliance norm'

4.3 Addition to the dataset, needed to determine influence AEO status on compliance

One of the researched factors is about AEO status of companies involved with the inspected shipment, at the time the customs declaration for release for free circulation was made, which can be expressed as:

- 'AEO C or F' if the company was AEO C or F certified at time of lodging the customs declaration
- 'no AEO' if the company was not AEO C or F certified at time of lodging the customs declaration

For generating the above mentioned 'labels' in the data, the data about 'EORI consignee' was the starting point. If this column contains an EORI number present in the list of AEO certified companies as received on an internal query request, and the date of the customs declaration was later than the start date of the AEO certification, the company involved was AEO certified at the moment the declaration was lodged. The presence and absence of an EORI number mentioned in the received list of AEO certified companies, has been used to label the data on row level. If the EORI number mentioned in the customs declaration was present in the list of AEO certified companies, and the company is listed as AEO C or F certified and the date of lodging the declaration was after the start date of the certification, the label 'AEO C or F' was added to the data. Absence of one of these criteria lead to the addition of the label 'no AEO'. For short overview, additions made are shown in the table below.

Basis for addition	Trigger	Addition to the data
Presence/absence of listed EORI number in column 'EORI consignee'	Absence of EORI number with AEO C or F status at time of lodging declaration	Label 'AEO C or F' in column 'AEO status consignee at moment of declaration'
	Presence of EORI number with AEO C or F status at time of lodging declaration	Label 'no AEO' in column 'AEO status consignee at moment of declaration'

4.4 Addition to the dataset, needed to determine influence country of origin on compliance

One of the researched factors is about country of origin of the goods of the inspected shipment, which can be expressed as:

- 'Perceived highest risk CoO' if the declared country of origin is perceived to be the most risky country of origin for compliance to the norms in the RoHS Directive, based on perception of ILT
- 'Other CoO than perceived highest risk CoO' if the declared country of origin is not the country of origin that is perceived to be the most risky country of origin for compliance to the norms in the RoHS Directive, based on perception of ILT

For generating the above mentioned 'labels' in the data, the data about the declared country of origin of the goods was the starting point. The presence and absence of the country of origin that is perceived to be of highest risk for compliance to RoHS has been used to label the data on row level. If the data contains the country of origin that is perceived to be the highest compliance risk in the eyes of the ILT, the label 'CoO = perceived highest risk CoO' was added to the data. Absence of this particular country of origin lead to the addition 'CoO <> perceived highest risk CoO' For short overview, additions made are shown in the table below.

Basis for addition	Trigger	Addition to the data
Presence/absence of perceived highest risk country of origin of goods in column 'Country of Origin'	Absence of perceived highest risk CoO of goods	Label 'CoO = perceived highest risk CoO' in column 'Country of Origin – perceived risk'
	Presence of perceived highest risk CoO of goods	Label 'CoO <> perceived highest risk CoO' in column 'Country of Origin – perceived risk'

4.5 Additions to the dataset, needed to determine influence customs value/kgs on compliance

4.5.1 Customs value/kgs net weight: higher or lower than average, based on declaration

One of the researched factors is about the customs value per kilogram net weight of the goods of the inspected shipment, which can be expressed as:

- 'CV/kgs NW < Average CV/kgs NW for HS-code' if the declared customs value per kilogram net weight of the inspected goods is lower than the average customs value per kilogram net weight for the commodity code used in the customs declaration, based on year of declaration
- 'CV/kgs NW > Average CV/kgs NW for HS-code' if the declared customs value per kilogram net weight of the inspected goods is higher than the average customs value per kilogram net weight for the commodity code used in the customs declaration, based on year of declaration

For generating the above mentioned 'labels' in the data, the declared customs value of the goods is been divided by the declared net weight of the goods and compared to the average customs value per kilogram net weight for the declared commodity code, based on the data of the calendar year in which the customs declaration was lodged. For this calculation, only shipments with a net weight above the threshold and with destination 'NL' were taken into consideration. If the declaration data shows a customs value per kilogram net weight lower than the relevant calculated average value, the label 'CV/kgs NW < Average CV/kgs NW for HS-code' was added to the data. If the declaration data shows a customs value per kilogram net weight higher than the relevant calculated average value, this led to adding the label 'CV/kgs NW > Average CV/kgs NW for HS-code'. For short overview, additions made are shown in the table below.

Basis for addition	Trigger	Addition to the data
Presence/absence of customs value per kilogram net weight for declared goods lower than average value per kilogram net weight for used HS code	Absence of lower than average customs value per kg net weight of goods	Label 'CV/kgs NW > Average CV/kgs NW for HS-code' in column 'CV/kgs NW vs Average CV/kgs NW HS code'
	Presence of lower than average customs value per kg net weight of goods	Label 'CV/kgs NW < Average CV/kgs NW for HS-code' in column 'CV/kgs NW vs Average CV/kgs NW HS code'

4.5.2 Customs value/kgs net weight: deviation from average, based on declaration

One of the researched factors is about the customs value per kilogram net weight of the goods of the inspected shipment, which can be expressed as the difference of the value calculated at the declaration date, compared to the average value for the commodity used, stated as a percentage.

Using the same calculations as mentioned above, provides the possibility to express the difference in a percentage deviation from the average value, which is the basis for adding a label on row level about the class division of this difference. If for example the customs value per kilogram net weight of the customs declaration is 5% lower than the average value for the HS code used in the declaration, the 'label' added to the date is the class in which this difference is classified.

Again, for the calculation of the average value per kilogram net weight for the used commodity code, only shipments with a net weight above the threshold and with destination 'NL' were taken into consideration.

Basis for addition	Trigger	Addition to the data
Presence/absence of difference of customs value per kilogram net weight for declared goods compared to average value per kilogram net weight for used HS code in declaration year	Difference between customs value per kilogram net weight of declared goods and average value for commodity code used	Class division of difference between customs value per kilogram net weight of declared goods and average value per kilogram for commodity code used, based on data per declaration year

4.6 Additions to the data, needed to determine influence of repeated sampling on compliance

4.6.1 Addition: Customer experience consignee - ID sample experience (EORI_Sample date)

In order to analyse the possible influence of the first sample experience on future compliance levels determined by repeated sampling of shipments of a certain consignee, the first step is to create a unique ID to distinguish data of separate sampling moments. Therefore, the EORI number of consignees is combined with the sample date to create a unique ID per sample experience.

4.6.2 Addition: Customer experience consignee - sample date

The sample date as administered by the laboratory, based on the information on the document that accompanied the received sample, is being interpreted as the date the consignee was confronted with the sampling effort/activity of Dutch Customs, including motivation for the sampling event.

4.6.3 Addition: Customer experience consignee - date first sample

With the sample experience ID chronologically sorted per consignee, based on the date in this ID, the first ranked sample experience ID contains the date of the first sample experience. This date for the first sample experience has been added to the data set by linking to the EORI number of the consignee.

4.6.4 Addition: Customer experience consignee - first/ other sample experience

With the sample experience ID chronologically sorted per consignee, based on the date in this ID, the first ranked sample experience ID contains the date of the first sample experience. This is the basis for adding the label 'first sample experience' to the data set. Other sample experiences are labelled as 'not first sample experience'. This data is added to the data set via linkage with the sample experience ID.

4.6.5 Addition: Customer experience consignee - sample experience number

With the sample experience ID chronologically sorted per consignee, based on the date in this ID, the sample experiences are sorted chronologically. This is the basis for adding a number to the data set, representing the ranking/order of sampling experiences per consignee. This data is added to the data set via linkage with the sample experience ID.

4.6.6 Addition: Customer experience consignee - # days sample date after first sample experience

For each sample in the registry, the laboratory administered the sample date as mentioned on the document that accompanied the received sample. Since the date of the first sample experience is determined (as explained in 4.6.3), the difference between the sample date and the date of the first sample experience can be calculated. The outcome represents the number of days the sampling of a product took place after the date of the first sample experience.

4.6.7 Addition: Customer experience consignee - sample date >30 days after first sample

With the calculated number of days a sample experience took place after the first sample experience (as explained in 4.6.6), it is possible to determine whether or not a sample experience took place within or outside a certain time period, such as 30 days. The result is added to each data row.

5. Anonymization of the data set, needed to perform anonymized analysis

5.1 Reasons for anonymization of the dataset

One of the conditions for this research, required by the company client, is that the data used for the statistical analysis needs be anonymized. Firstly, this is a requirement for approval of bringing needed for the analysis outside the network of the company client. Secondly, the company client required that the results shown in the thesis report must be anonymized as well, with no ability of linkages of results to individual custom declarations or companies via the underlying data.

5.2 Anonymization of Laboratory ID

The dataset of the laboratory, used for preparation for the analysis of this research, contains a unique number per sample inspected by the laboratory of Dutch Customs: the Laboratory ID.

In the originally prepared dataset, every single Laboratory ID has been connected to another unique reference number per inspected sample, which is called 'sample case ID'. The dataset that has been used for the statistical analysis for this research, does only contain the 'sample case ID - anonymized' and not the laboratory ID.

5.3 Anonymization of Customs declaration ID

The dataset of the customs declaration system AGS is connected to the dataset of the laboratory of Dutch Customs with the unique custom declaration ID. This means that the data used for preparation for the analysis of this research, contains a unique number per shipment of which a sample has been inspected by the laboratory of Dutch Customs: the customs declaration ID.

In the originally prepared dataset, every single Custom declaration ID has been connected to another unique reference number per inspected shipment, which is called 'Custom declaration ID – anonymized'. The dataset that has been used for the statistical analysis for this research, does only contain the 'Custom declaration ID – anonymized' and not the original customs declaration ID of the customs declaration system AGS Invoer.

5.4 Anonymization of Consignee ID

The dataset of the customs declaration system AGS, that has been connected to the dataset of the laboratory of Dutch Customs, contains a unique consignee ID per shipment of which a sample has been inspected by the laboratory of Dutch Customs: the 'EORI Number' of the consignee of the shipment.

In the originally prepared dataset, the EORI Numbers of consignees have been connected to another unique reference number per EORI number, which is called 'Consignee ID - anonymized'. The dataset that has been used for the statistical analysis for this research, does only contain the 'Consignee ID - anonymized' and not the EORI number of the consignee involved.

5.5 Anonymization of Consignee ID

In the originally prepared dataset, with the EORI Numbers of consignees and the dates of their sample experiences, a unique reference number for each sample experience has been generated: 'Sample experience ID'. The dataset that has been used for the statistical analysis for this research, does only contain the 'Sample experience ID - anonymized', consisting of the anonymised EORI number of the consignee and the date the sampling for each particular sample experience took place.

6. Exclude particular cases from the analysis, making the data set suitable for the aimed analysis

The original data set contains 1,603 files of individual samples with an own laboratory ID. However, not all files can be used for the aimed analysis. There are a number of files that need to be excluded from the analysis, because these are for some reason outside the scope of this research project or not usable for analysis. After excluding the following cases, 1,507 cases remained to perform the statistical analysis with:

Rijlabels	Aantal van Inspection result - compliance percentage
Exclusion 01 - Control sample	1
Exclusion 02 - Sampling based on courier declaration	31
Exclusion 03 - Sampling based on inland inspection initiative	8
Exclusion 04 - Reference numbers not usable for match with AGS data	2
Exclusion 05 - Missing measurement result for non conform sample	2
Exclusion 06 - Not usable measurement result for non conform sample	6
Exclusion 07 - Commodity code not within scope based on HS-code	23
Exclusion 08 - Original declared customs value and net weight unknown	23
Eindtotaal	**96**

Exclusion 01 - Control sample

Mistakenly, the dataset contained 1 case about the control sample, that is used to verify the operation of the XRF-scanner with. Of course, this file is not relevant for the aimed analysis, since the result is not based on a sample taken from a shipment, which became subject of inspection with risk-based profiling.

Exclusion 02 - Sampling based on courier declaration

The dataset contained cases of samples that were taken from shipment on the basis of a customs declaration in the so called courier process. This means that these samples were not send to the laboratory based on a risk based shipment selection in the Dutch customs declaration system AGS Invoer. Therefore, the samples based on courier declarations are outside scope of this research and not relevant for analysis.

Exclusion 03 - Sampling based on inland inspection initiative

The dataset contained cases of samples that were taken from shipment on the basis of an inland supervision activities, not based on risk-based profiles for law enforcement on RoHS. This means that these samples were not send to the laboratory based on a risk based shipment selection in the Dutch customs declaration system AGS Invoer. Therefore, the samples based on inland inspection initiative are not relevant for analysis.

Exclusion 04 - Reference numbers not usable for match with AGS data

The dataset contained 1 case, which could not be matched with customs declaration data of AGS Invoer. First of all, the AGS Invoer ID was not found in the AGS Invoer data set and a separate search via query possibilities gave no result as well. The other reference numbers did not give access to another customs declaration ID. Because for this particular sample file the AGS Invoer data could not be made available for analysis, this particular sample file was excluded from the analysis.

Exclusion 05 - Missing measurement result for non-conform sample

The dataset contained 2 cases for which measurement results were not present, despite the fact that the judgement was non-conform. Retrieving the required data for analysis was not possible.

Exclusion 06 - Not usable measurement result for non-compliant sample

The dataset contained 2 cases for which the measurement result was not mentioned as an exact number but for example as “>5%”. Retrieving the required data for analysis was not possible.

Exclusion 07 – Commodity code not within scope based on HS-code

The scope of this research is on chapter 84, 85, 91, 94 and 95 of the Harmonized System, because of the electrical circuits required to test on the presence of lead for supervision on the RoHS Directive. The dataset contained 23 cases with a commodity code that was outside of scope for this research.

Exclusion 08 – Original declared customs value and net weight unknown

The dataset contained 23 cases for which the original declared customs value and/or net weight that have been adjusted by customs officers, for administrative reasons, to be able to handle non-compliance that lead to either re-export or destruction within the Dutch import declaration system AGS Invoer. Due to this matter, for these cases the customs value / net weight ratio could not be determined correctly.