Enhancing Cerberus and UK Single Trade Window:

Advancing Border Security Through Multi-Technology Synergy

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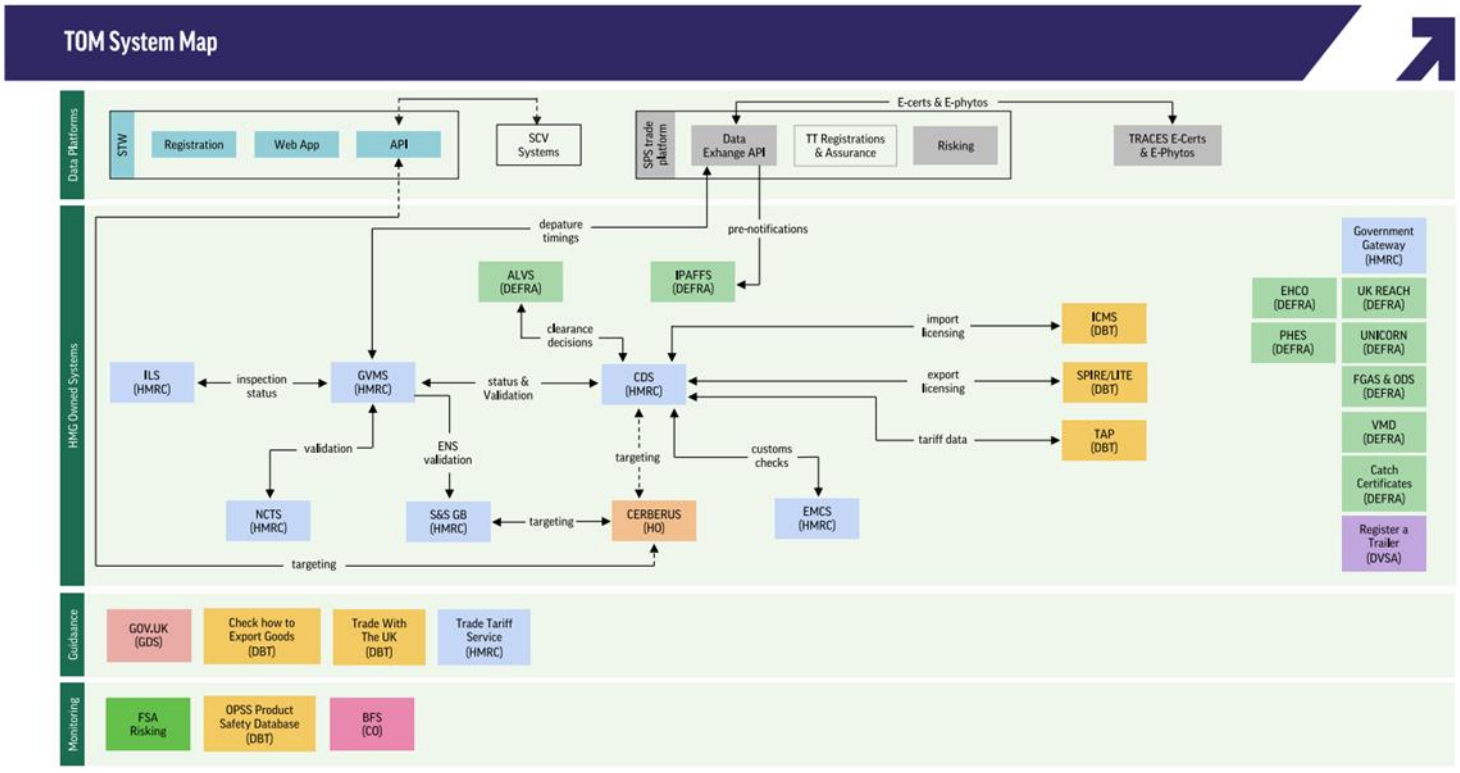
Introduction

In accordance with the latest UK Border Target Operating Model [UK BTOM, 2023], in 2024 the UK Government will enforce the first phase of the UK Single Trade Window. This will enable traders to submit import and safety & security declarations free of charge via the STW[i] portal and provide extra functionalities such as 'multiple users' and live status declarations. The third phase will introduce the supply chain connectivity that can be a game changer especially for traders utilizing the ASN'[ii] [Hanna, 2023] based trade information flow system, that could be incorporated directly into UK STW. Supply chain connection to the STW environment has already been adopted by the US Customs and Border Protection and has proven successful [Altana, 2023]. Additionally, with potential incorporations of OCR – based technologies into STW, these can further improve customs documentary checks in the absence of or in addition to the trade information flow (e.g. ASN).

Within the BTOM, the TOM System Map, as illustrated in Diagram 1.0, demonstrates the STW's connections to various border agency systems, either directly or through APIs. A pivotal system to be linked with the STW is Cerberus, a Home Office analytics system developed in partnership with BAE Systems [TechTarget BAE Systems], also known as 'The Data Futures' project [Home Office, 2024]. As the UK STW and Cerberus undergo development, there are a number of safeguards and enhancements, that can be implemented from the customs authorities' perspective to intercept high-risk shipments, that could pose a threat to the UK's national security. Several methods and parameters, that are thoroughly discussed in subsequent chapters, will not only improve targeted customs audits, but will also facilitate a smoother flow of goods across UK borders.

Diagram 1.0 TOM System Map



Chapter 1

Cerberus Improvements – Combined methods

According to the TOM System Map (Diagram 1.0), Cerberus system will be targeting the CDS[iii] which contains all shipment data, used for import/export declarations creation [CDS,2023]. CDS can select goods for customs audit since it is directly connected to GVMS[iv] and with Cerberus, which being integral to the UK's STW, plays a crucial role in safeguarding passengers and traders by securing data against threats from terrorist activities and organised crime. It achieves this through real-time risk assessments and comprehensive analysis of border data. Customs auditing methods used by various customs specialists working for international businesses could be incorporated into the Cerberus risk assessments to enhance its analysis for better targeting of high-risk shipments. Listed below are the usual customs auditing elements that are checked during the shipment's audits:

- **HTS / Commodity Codes of goods and packaging**
- **Customs Procedure Codes**
- **Non approved brokers / Odd deferment ac's used**
- **Preference codes**
- **Value of goods**
- **All item document codes**

HTS and the value of goods elements mentioned above are aligned with the already established methods of customs audits aimed at combating money laundering activities. These methods include thorough checks concerning the exporter/importer, the end user (consignee), and broker details, as well as scrutinising the unit price and commodity activities over a specified period [Hoffmann, 2013]. With current technological advancements, various AI models / algorithms and strategies are utilised for improved effectiveness of customs inspections [Sundong et al., 2023] and are also used in forecasting [Kim et al., 2022] or within Finance to track fraudulent transactions [Baesens et al., 2015] to support high levels of security and compliance. Moreover, with growing data sets arriving at increasing speeds, it is important to use more sophisticated and effective data analysis methods [Ahmed and Pathan, 2018] and keep up with the constant changes in technology.
According to the '*Performance measurement of the KCS [v] customs selectivity system'* study the manual selection of goods for inspection has the highest fraud detection efficiency rates with other methods (rule-based and random selections) show promising numbers [Chang-Ryung and Ireland, 2014]. Learning from various customs risk assessment methods and solutions, several best practices can be drawn up and used to further enhance Cerberus risk assessments.
These best practices comprise historically proven elements to be checked as a background with the addition of current customs professionals' post-shipment audit practices (e.g. odd deferment a/cs

used, document or preference codes not in line with shipping paperwork that potentially can be selected for documentary checks) with an adoption of already existing AI models with additional enhancements (such as the 'Seasonality factor', described in Chapter 2). Based on that model, Figure 2.0 illustrates the concept of mixed risk assessment methods:

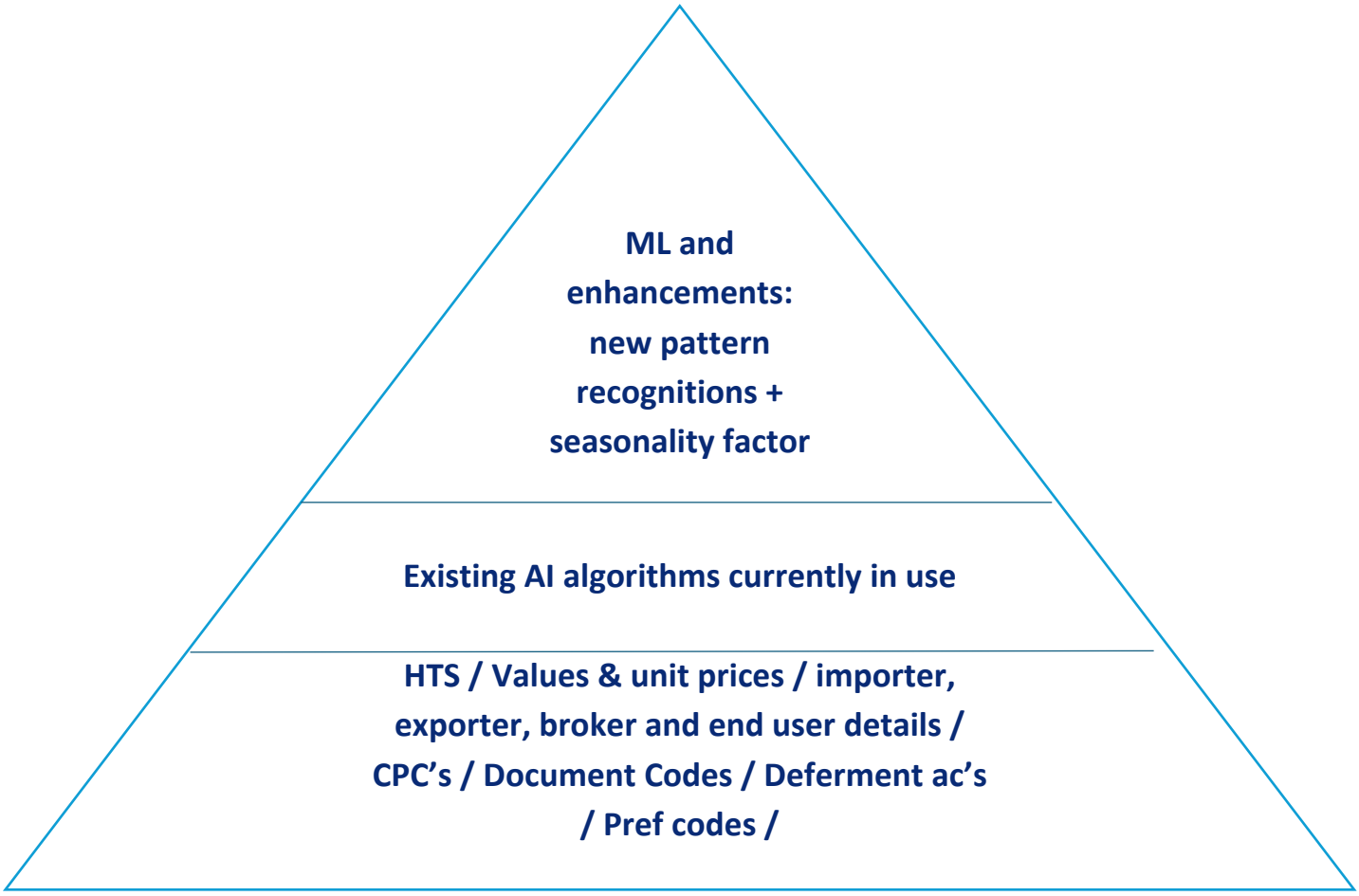


Figure 2.0 Mixed risk assessment methods

Incorporation of additional parameters into UK STW (consisting full interoperability between Cerberus, CDS and GVMS systems) will enhance more targeted high-risk shipments and the table below explains in more detail how such parameters can be communicated / incorporated into the AI/ML algorithms, to better assess the risk and communicate to CDS-GVMS to stop the incoming consignment for inspection. Table 3.0 describes various trade compliance elements that are audited on (UK) import entries by trade compliance specialists upon post-audits. Table 3.0 contains additional auditing considerations that could be taken into account by customs officials for additional compliance measures.

Element	Nature of check	Actions and Questioning
HTS / Commodity Codes	- Check for product description / nature of the business,	Record any deviations:

	unusual HTS codes suddenly used by a business - Check if declared packaging type / mode of transport is logical for the type of goods	- Does the HTS code description differ from product description or type of industry (e.g. HTS for washing machine or hair dryers imported by an aerospace business)? - Are packaging HTS codes in line with product nature/designation
Customs Procedure Codes	Unusual activity associated with a new CPC code	Check for deviations in CPCs used by importer (check if the forwarder / importer is authorized and fully aware of the CPC used)
Deferment accounts	Deferment account declared in customs declarations deviate from importer's / forwarder's assigned deferment a/c	Are importer's deferment a/c frequently used, are there too many deviations and are there several broker's deferment a/c being used instead?
Preference codes	Preference code 300 shipments attract higher risk of non-compliance (and pose severe consequences for importers)	Documentary checks on goods declared other than pref code 100 should be introduced to ensure general compliance. e.g. with rule of origin
All item document codes	Deviations of document codes from declared data versus shipping paperwork and regulatory requirements	Documentary checks: Are expectations met for various document codes such as 'AE' (origin statement present on the invoice) 'JP' (is importer of record aware the preference is claimed based on importer's knowledge)
Other patterns	Nature of imported goods vs packaging utilised	Are perishable goods packed in non-refrigerated lorry, are food items packed in e.g. violin cases
EORI / VAT	Standard EORI/VAT checks	Documentary checks, if EORI/VAT details are in line with the business name and address against all documents

Table 3.0

Chapter 2

Seasonality factor

The *'Active Learning for Human-in-the-Loop Customs Inspection'* that proposes ML-based detection Algorithm for customs inspections improvement model, has been tested on 3 African countries [Sundong et al., 2023]. Trade between Africa and ROW significantly differs from the UK trade patterns due to its asymmetrical nature [Luke, 2023]. Whilst numerous trade compliance and risk assessment models can share common ground, it is important to enhance the existing risk assessment patterns to fit domestic scenarios and address specific issues experienced by individual customs territories. Shipment information presented to customs at the time goods cross the border differs from customs audits conducted by the businesses which are conducted after the goods arrive. The algorithms must predict and assess the risk quickly and this can be a challenge, because trade volumes of certain goods differ due to seasonality [Harrison, 2009] [Graczyk et al., 2017] and can create fluctuations. There are techniques in Logistics Operations that could be utilised to smooth the seasonality factor to facilitate consistency and accuracy of risk assessments, such as Winters Triple Exponential Smoothing (TES) [R. Hyndman, G. Athanasopoulos, 2018], commonly used in forecasting. This logic could be applied in risk assessment AI/ML algorithm within Cerberus to improve not only the efficiency of customs inspections, but also to improve planning ahead the resource (customs officers) allocations. This solution would facilitate a targeted and more transparent response to sudden high trade volumes crossing borders, which can be affected by either short-term patterns, e.g. by dynamics of retailing operations caused by panic buying [Kogan and Herbon, 2022]; medium trends patterns, e.g. changes in lifestyle / current trends [Piernas et al., 2022]; or long-term and more predictable patterns, e.g. seasonal perishable goods' imports [Cororaton and Peterson, 2012].
Fluctuated border crossings and trade volumes could be therefore better assessed and handled accordingly without compromising the number of customs inspections, due to trade fluctuations being manageable thanks to TES method that could be incorporated into Cerberus system. In practice, Winters Triple Exponential Smoothing can be applied to the ERP systems to model the time series of the server systems and provide high results of anomalies detection and forecasting incidents [*Dubrovin et al., 2020]; or facilitate planning and respond to peoples' movements / passenger forecasting [Setiawan et al, 2016] or passenger traffic [Sitzimis, 2022]. TES has also gained its popularity in supply chain strategic planning and data analysis to address issues around under/over stocking (inventory management), staff shortages or delays in product arrivals or production operations [Shibu et al., 2023]. The seasonality factor could be incorporated into the ML/AI algorithm in order to constantly learn new trade volume patterns (not having to rely only on historical data), so it can better respond to sudden fluctuations and provide precise and consistent forecasting in customs audits. Incorporation of TES Mathematical formula into Cerberus system could allow for this function to work more effectively.

Chapter 3

Supply Chain connections – Phase 3 of the UK STW

Phase 3 of the UK STW will provide additional functionality to connect various supply chain actors to the single trade window via APIs, allowing business ERP system connections. Currently the customs software providers are connected to CDS [gov.uk Guide] to create import and export declarations filed by freight forwarders, customs intermediaries or businesses themselves (self-declarations). Many larger businesses importing/exporting large volumes of shipments, utilise third-party customs software in conjunction with customs special procedures, such as CFSP / SCDP, CSE, Authorised Consignor or IPR/OPR. Many large businesses exchange shipment data via ASNs or EDI messaging with its suppliers/exporters and such method is especially common within retail and automotive sectors [Hanna, 2023]. Following the ASN or EDI trade information exchange models, the same logic could be applied to UK STW, so that shipping information flows directly to the single window system instead of importers (or from importer's ERP the data is directed into STW). Furthermore, with the multiple-user functionality of the UK STW, shipment data can be further enriched by additional information if needed. For these reasons, supply chain connectivity function can be a game changer for many larger importers and it not only speeds up the border crossings / customs clearances, but also allows the end-to-end shipment info to be used for trade volume / pattern recognitions and to enhance Machine Learning. The Diagram 4.0 below visualizes the ASN/EDI Messaging concept incorporated into the UK STW:

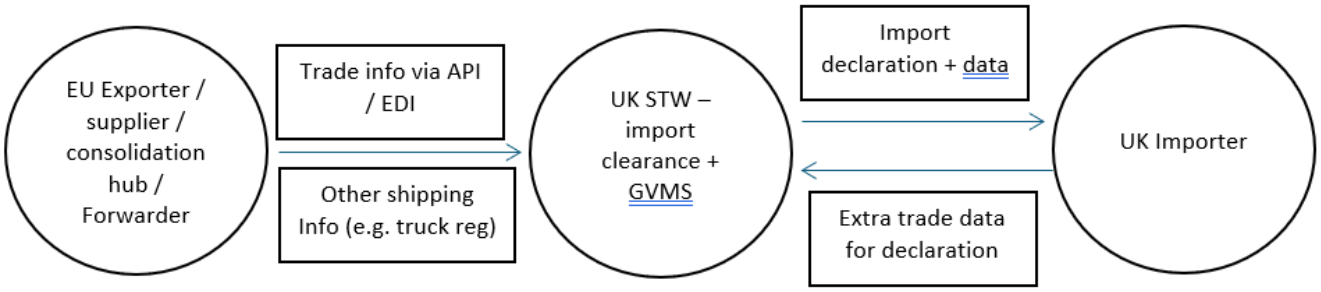


Diagram 4.0

Incorporation of certain ready AI models for shipment documents' (e.g. uploaded into CDS/STW commercial invoices) data extraction for import entry comparisons / auditing can also be considered and adapted into the STW. For example, when end to end supply chain visibility is possible, utilising technology such as IBM Watson could be taken into account [Sabharwal et al., 2020]. Watson's document conversion could be connected to the natural language understanding (to analyse the text to extract meta-data from content, using natural language classifier), so that the AI model can conduct

a data extraction from the shipping document and compare it with CDS / declaration data for pre-lodged and pre-uploaded shipping documents. The downside of using ready AI platforms is that they may limit utilization of certain technological techniques which could be more suitable for certain tasks, for example utilization of more popular OCR[vi] over VDU[vii] AI models [Geewook et al., 2022] and such technology is not error-free. On the other hand, in case of poor data quality, there are ways to improve document parsing. AI/ML algorithms can be taught by a 'human Expert' [Hattori et al., 2023] and data mapping can be conducted and facilitate a form of interactive learning [Baviskar et al., 2021]. Similar approach/technology had already been used to map geographical locations using Toponym extraction method to analyse and allocate the data correctly [Habib and van Keulen, 2013].
Additionally, to facilitate error-free environment, solution to improve on data accuracy could be around usage of various error correcting codes, such as Bidirectional Encoder Representation from Transformers (BERT) [Sida et al., 2022], Bose-Chaudhuri-Hocquenghem (BCH) [Wahbi et al., 2021] or Reed-Solomon code [Erl-Huei et al., 2013], (RS and BCH are also used in improvements of digital information transfers [Wahbi et al., 2021]). Moreover, utilisation of several other techniques for program improvements, such as using the few-shot learning [Nan et al., 2021], using synthetic document generators to pre-train the models (e.g. Microsoft Synthetic Document Generator), or fine-tuning [Fine-tuning OpenAI] could also be incorporated. As a counterargument, OCR-like solution for document comparisons may encounter various issues resulting from different shipment documentation formats used by various traders and high volumes, however such technology could be considered on specific movements / industries upon documentary checks. There are various companies promoting and utilising the OCR and similar technology for data extractions for customs declaration completions, such as Raft platform [Raft.ai] offering time and error reductions in manual data entries [Magaya.com]. The forwarding industry is one of the main beneficiaries of this technology due to handling high volumes of shipping data and customs declarations.

Interoperability

With the introduction of the interoperability function in the final phase of the UK's Single Trade Window (STW), it will become feasible to check end-to-end information through the integration of customs – to - customs systems [UN/CEFACT Recommendation 33]. Among many other benefits such as potential pre-lodgments of customs declarations and sharing intelligence data, this advancement could further facilitate trade by recognising shipments leaving customs territories, potentially addressing challenges associated with non-closure / non recognition of exports from a customs territory such as EU [Title VIII UCC, 2023]. There are several projects globally evidencing the successful customs collaborations, such as China - Singapore Single Window Connectivity Data Exchange Project [Chen, 2022] or the ASW Live Operation [Asean.org] / the U.S.-ASEAN Comprehensive Strategic Partnership [state.gov., 2023].
Amid these developments, it is crucial to address data security concerns, as commercially sensitive data is being exchanged not only between traders and domestic border agencies, but various countries' customs agencies. In response to data security concerns, the UK Government holds public

consultations to openly discuss this topic with the private sector [gov.uk, 2022]. Although the WCO SAFE Framework of Standards [WCO SAFE] provides foundational security standards for electronic information exchanges within the STW environment, prioritising cybersecurity remains critical.

Ultimately, interoperability of the UK STW will facilitate the flow of trade information improving processes for exporters / importers, freight forwarders and customs brokers. It will also enable customs officials to better access trade data in advance, allowing them to make necessary decisions on customs audits and high-risk shipment detections more effectively.

Conclusion

This paper has identified two primary enhancements that could potentially improve the capabilities of the UK customs and border protection systems.
Chapters 1 and 2 focus on Cerberus improvements on high-risk shipment detections through incorporation of additional customs element checks, typically conducted by customs specialists during post-shipment auditing and are supported by various examples found within academic literature. These customs data elements are integrated alongside already recognised and utilised customs practices serving as a foundation and include incorporation of Winters Triple Exponential Smoothing (TES) - to smooth trade volume fluctuations and support more precise and consistent customs audits.
Chapter 3 focuses on UK STW supply chain connectivity and highlights the ASN/EDI messaging model as highly beneficial not only from the importers' perspective, but also from customs authorities' side, as it facilitates better visibility of shipment data. Furthermore, it critically explores technological advancements such as utilisation of ready AI models or OCR/VDU for document information extraction (including ways for error corrections), used for comparisons with import entries to enhance customs compliance. Interoperability functionality of the UK STW is also explored for further understanding of supply chain connectivity and provides meaningful insights into the integration and secure data exchanges across customs territories.
These enhancements offer a modern and combined methodological approach for improvements in UK customs and border security operations and highlight the evolution in trade and customs technologies. Whilst this analysis refers to specific technological applications and solutions, it does not encompass the full spectrum of emerging technologies in trade. Technologies such as Internet of Things or Blockchain that are utilised by some customs authorities globally [WCO The role of Advanced technologies, 2022] [Tsois et al., 2017] have not been mentioned, yet such studies are essential to provide a better understanding of customs digitalisation - its benefits and impacts for both customs authorities and traders. Furthermore, comparisons with other global single trade windows could be conducted for various STW function comparisons and some best practices could be extracted and analysed.

Historically, trade and customs technology has been referred to by various bodies and conventions worldwide. For instance, UNECE presented a single window roadmap in 2005 followed by 'lessons learnt' gathered from various economies around the globe [UNECE, 2005], or revised Kyoto Convention in 2008 [UN, 2008] and its Chapter 7 that addresses: *'Application of information technology'.* The Single trade window is not a new concept, but it has been increasingly applied by various countries globally in recent years [UN/CEFACT STW Case Studies] and serves as evidence that trade is being actively facilitated in practice. Therefore, monitoring of advancements in customs and trade technology is essential for maintaining efficient, transparent and secure border crossings and customs compliance. Moreover, active involvement of higher education institutions in researching similar topics can contribute to the development of best practices in customs, enhance border security, drive innovation and can better prepare future border agency officials to handle border frictions and IT challenges.

Literature & Endnotes

[UK BTOM, 2023] UK Border Target Operating Model, August 2023 https://www.gov.uk/government/publications/the-border-target-operating-model-august-2023

[Hanna, 2023] TechTarget ERP, definition 'advanced shipping notice (ASN)' by Katie Terrell Hanna, October 2023 https://www.techtarget.com/searcherp/definition/advanced-shipping-notice-ASN

[Altana, 2023] [Altana, 2023] 'United States Customs and Border Protection Chooses Altana to Help Drive Implementation of the Uyghur Forced Labor Prevention Act', Altana, By Altana Technologies, July 2023 https://altana.ai/blog/united-states-customs-and-border-protection-chooses-altana

[TechTarget BAE Systems] 'Home Office partners with BAE Systems on border analytics' TechTarget, Computer Weekly.com, article by Sebastian Klovig Skelton, published in February 2023 https://www.computerweekly.com/news/365531375/Home-Office-partners-with-BAE-Systems-on-border-analytics

[Home Office, 2024] 'Transparency data, Cerberus program: SRO appointment letter (accessible version)', Home Office, letter delivered by e-mail dated 15 March 2021, last updated in January 2024 https://www.gov.uk/government/publications/home-office-major-projects-appointment-letters-for-senior-responsible-owners/cerberus-programme-sro-appointment-letter-accessible-version

[CDS, 2023] HMRC Guidance 'Subscribe to the Customs Declaration Service' last updated in December 2023 https://www.gov.uk/guidance/get-access-to-the-customs-declaration-service

[Hoffmann, 2013] HOFFMANN, L., 2013. A Critical Look at the Current International Response to Combat Trade-Based Money Laundering: The Risk-Based Customs Audit as a Solution. Texas International Law Journal, 48(2), pp. 325-348.

[Sundong et al., 2023] Kim, Sundong & Mai, Tung-Duong & Han, Sungwon & Park, Sungwon & Nguyen, Thi & So, Jaechan & Singh, Karandeep & Cha, Meeyoung. (2022). Active Learning for Human-in-the-Loop Customs Inspection. IEEE Transactions on Knowledge and Data Engineering. PP. 1-1. 10.1109/TKDE.2022.3144299.

[Kim et al., 2022] KIM, M., LEE, J., LEE, C. and JEONG, J., 2022. Framework of 2D KDE and LSTM-Based Forecasting for Cost-Effective Inventory Management in Smart Manufacturing. Applied Sciences, 12(5), pp. 2380.

[Ahmed and Pathan, 2018] 'Data Analytics, Concepts, Techniques, and Applications' 1st Edition, edited by Mohiuddin Ahmed and Al-Sakib Khan Pathan, published by Taylor & Francis Group in October 2018

[Chang-Ryung and Ireland, 2014] 'Performance measurement of the kcs customs selectivity system' Risk Management Journal, February 2014, Vol. 16, No. 1 (February 2014), pp. 25-43 Author(s): Chang-Ryung Han and Robert Ireland, Published by: Palgrave Macmillan Journals https://www.jstor.org/stable/43695697

[UN/CEFACT Recommendation 33] United Nations: 'UNECE Recommendation and Guidelines on Establishing a Single Window to enhance the efficient exchange of international trade information between trade and government', Recommendation No. 33, 2020 Edition, United Nations for Trade Facilitation and Electronic Business (UN/CEFACT), Geneva 2020

[Sabharwal et al., 2020] 'Developing Cognitive Bots Using the IBM Watson Engine' Practical, Hands-on Guide to Developing Complex Cognitive Bots Using the IBM Watson Platform by Navin Sabharwal, Sudipta Barua, Neha Anand and Pallavi Aggarwal, published in 2020

[Geewook et al., 2022] 'OCR-free Document Understanding Transformer', Computer Science, Machine Learning, Cornell University, by Geewook Kim, Teakgyu Hong, Moonbin Yim, Jeongyeon Nam, Jinyoung Park, Jinyeong Yim, Wonseok Hwang, Sangdoo Yun, Dongyoon Han, Seunghyun Park, published in November 2021, revised in October 2022

[Baviskar et al., 2021] 'Multi-Layout Invoice Document Dataset (MIDD): A Dataset for Named Entity Recognition' Baviskar, D.; Ahirrao, S.; Kotecha, K. Data 2021, 6, 78. https://doi.org/10.3390/data6070078

[Habib and van Keulen, 2013] Habib, M.B., van Keulen, M. (2013). 'A Hybrid Approach for Robust Multilingual Toponym Extraction and Disambiguation', part of Lecture Notes in Computer Science book series LNISA, Volume 7912, published in 2013.

[Sida et al., 2022] 'ECC-BERT: Classification of error correcting codes using the improved bidirectional encoder representation from transformers' Original research paper, The Institution of Engineering and Technology, Volume 16, Issue 4, by Li Sida, Hu Xiaochang, Huang Zhiping and Zhou Jing, published in March 2022

[Wahbi et al., 2021] 'Design, Optimization and Real Time Implementation of a New Embedded Chien Search Block for Reed-Solomon (RS) and Bose- Chaudhuri-Hocquenghem (BCH) Codes on FPGA Board' International Journal of Communication Networks and Information Security, 13(1), pp. 9-14. By WAHBI, A., EL IDRISSI, A.,EL HABTI, ROUKHE, A., BENSASSI, B. and HLOU, L., published in April 2021

[Erl-Huei et al., 2013] ‘Method for correcting both errors and erasures of RS codes using error-only and erasure-only decoding algorithms’ Electronic Letters, Information and communications, Volume 49, Issue 15, by Lu Erl-Huei, Lu Pen-Yao and Chen Tso-Cho, published in July 2013

[Nan et al., 2021] ‘Learning to Learn Adaptive Classifier–Predictor for Few-Shot Learning’ in IEEE Transactions on Neural Networks and Learning Systems, vol. 32, no. 8, pp. 3458-3470, by N. Lai, M. Kan, C. Han, X. Song and S. Shan, published in August 2021

[Fine-tuning OpenAI] Fine-tuning in OpenAI platform https://platform.openai.com/docs/guides/fine-tuning

[Raft.ai] ‘AI-powered workflow automation for freight forwarders & customs brokers’ https://www.raft.ai/

[Magaya.com] ‘6 Ways Freight Forwarders Can Benefit From OCR Technology’ https://www.magaya.com/6-ways-freight-forwarders-can-benefit-from-ocr-technology/

[Title VIII UCC, 2023] ‘EXPORT AND EXIT OUT OF THE EUROPEAN UNION – Title VIII UCC Guidance document for MSs and Trade Revised’ European Commission, page 33, published in 2023

[Luke, 2023] ‘Understanding African trade is key to helping its development’ Economics, Race Equity by Professor David Luke, published by The London School of Economics and Political Science, 2023

[Harrison, 2009] ‘Gone fishin’: Seasonality in trading activity and asset prices". Journal of financial markets (Amsterdam, Netherlands) (1386-4181), 12 (4), p. 672, published in 2009

[Graczyk et al., 2017] ‘Intraday Seasonalities and Nonstationarity of Trading Volume in Financial Markets: Individual and Cross-Sectional Features’ by Graczyk, Michelle B; Duarte Queirós, Sílvio M, 07/2017, Volume 12, Issue 7 https://doi.org/10.48550/arXiv.1810.12099

[R. Hyndman, G. Athanasopoulos, 2018] ‘Forecasting: principles and practice’ by Rob J Hyndman and George Athanasopoulos, 2018 2nd edition, Chapter 7 Exponential smoothing; and Winters, P. R. (1960). ‘Forecasting sales by exponentially weighted moving averages’. Management Science

[Kogan and Herbon, 2022] ‘Retailing under panic buying and consumer stockpiling: Can governmental intervention make a difference?’ International Journal of Production Economics, Volume 254, December 2022, 108631 https://doi.org/10.1016/j.ijpe.2022.108631

[Piernas et al., 2022] Piernas C, Harmer G, Jebb SA. Removing seasonal confectionery from prominent store locations and purchasing behaviour within a major UK supermarket: Evaluation of a nonrandomised controlled intervention study. PLoS Med. 2022 Mar 24;19(3):e1003951. doi: 10.1371/journal.pmed.1003951. PMID: 35324903; PMCID: PMC8946674.

[Cororaton and Peterson, 2012] 'Potential of Regional and Seasonal Requirements in US Regulation of Fresh Lemon Imports' World economy (0378-5920), 35 (8), p. 1022. by Caesar B. Cororaton, Everett B. Peterson, published in 2012

[*Dubrovin et al., 2020] DUBROVIN, M.G., GLUHIH, I.N. and KARYAKIN, I.Y., 2020. Forecasting the server status using the triple exponential smoothing model. Journal of Physics: Conference Series, 1661(1),. (Nov 2020). DOI:10.1088/1742-6596/1661/1/012031 * **Please note the address:** *'Tyumen State University, 6, Volodarskogo Ave., Tyumen, 625003, Russia'*

[Setiawan et al, 2016] W. Setiawan, E. Juniati and I. Farida, "The use of Triple Exponential Smoothing Method (Winter) in forecasting passenger of PT Kereta Api Indonesia with optimization alpha, beta, and gamma parameters," 2016 2nd International Conference on Science in Information Technology (ICSITech), Balikpapan, Indonesia, 2016, pp. 198-202, doi: 10.1109/ICSITech.2016.7852633.

[Sitzimis, 2022] Sitzimis, Ioannis (01.2022). "An Optimal Forecasting Method of Passenger Traffic in Greek Coastal Shipping". International Journal of Business and Economic Sciences Applied Research (2408-0098), 14 (3), p. 72.

[Shibu et al., 2023] N. Shibu and R. Agarwal, "Analysing and Visualising trends for Supply Chain Demand Forecasting," 2023 International Conference on Computational Intelligence and Sustainable Engineering Solutions (CISES), Greater Noida, India, 2023, pp. 901-906, doi: 10.1109/CISES58720.2023.10183439.

[gov.uk Guide] 'Customs Declarations end-to-end service guide' Gov.uk Last updated 14/03/2024 https://developer.service.hmrc.gov.uk/guides/customs-declarations-end-to-end-service-guide/#end-to-end-user-journeys

[Chen, 2022] 'China and Singapore Jointly Issue a Cooperation Plan on the ILSTC' I Chong Qing, by Zhan Chen, published in June 2022 https://www.ichongqing.info/2022/06/10/china-and-singapore-jointly-issue-a-cooperation-plan-on-the-ilstc/

[Asean.org] ASEAN Single Window https://asean.org/our-communities/economic-community/asean-single-window/

[state.gov., 2023] 'The United States-ASEAN Relationship' Fact sheet, published in July 2023 https://www.state.gov/the-united-states-asean-relationship-2/

[gov.uk, 2022] 'Closed consultation; The UK Single Trade Window: Consultation on Features to Inform Design and Legislation' published in July 2022 https://www.gov.uk/government/consultations/the-uk-single-trade-window-public-consultation/the-uk-single-trade-window-consultation-on-features-to-inform-design-and-legislation

[WCO SAFE] World Customs Organisation WCO SAFE Framework of Standards to Secure and Facilitate Global Trade https://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/frameworks-of-standards/safe_package.aspx

[WCO The role of Advanced technologies, 2022] World Customs Organisation 'The role of advanced technologies in cross-border trade: A customs perspective' published in March 2022 https://www.wto.org/english/res_e/booksp_e/wcotech22_e.pdf

[Tsois et al., 2017] 'Using Container Status Messages to improve targeting of high-risk cargo containers' European Commission, JRC Publications Repository, by TSOIS Aris; COTELO LEMA Jose Antonio; MAKRIDIS Michail; CHECCHI Enrico, published in 2017 https://publications.jrc.ec.europa.eu/repository/handle/JRC102880

[UNECE, 2005] United Nations Economic Commission For Europe: 'Paperless Trade In International Supply Chains Enhancing Efficiency and Security', forum opened by Acting Deputy Secretary of UNECE in 2005, published by United Nations in New York and Geneva in 2008 https://unece.org/DAM/cefact/publica/ece_trade_351-PaperlessTrade.pdf

[UN, 2008] Revised Kyoto Convention, by United Nations, published in December 2008, Chapter 7 and General Annex Guidelines for Chapter 7 https://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/conventions/pf_revised_kyoto_conv/kyoto_new/gach7.aspx

[UN/CEFACT STW Case Studies] United Nations Digital Library https://digitallibrary.un.org/record/556563?ln=en&v=pdf

[i] **STW – Single Trade Window**

[ii] **ASN – Advanced Shipment Notice – system where exporter/supplier sends shipment information needed for customs declaration directly to importer's desired system**

[iii] **CDS – Customs Declaration Service**

[iv] **GVMS – Goods Vehicle Movement System**

[v] KCS – Korea Customs Service
[vi] OCR – Optical Character Recognition
[vii] VDU – Visual Document Understanding